वार्षिक प्रतिवेदन
Annual Report

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Cultivating Wellness:
Empowering India with Natural Sweetness and Climate-Smart Apples

सीएसआईआर–हिमालय जैवसंपदा प्रौद्योगिकी संस्थान
CSIR-Institute of Himalayan Bioresource Technology
पालमपुर–176 061 (हि.प्र.) Palampur-176 061 (H.P.)

संस्थान गान

हे हिमालय हम तेरे, हैं प्रबुद्ध अन्वेषी।

हे हिमालय हम तेरे, हैं प्रबुद्ध अन्वेषी।
जैवसंपदा को तेरी, सुरक्षित करते जाएंगे।
सुरक्षित करते जाएंगे।।

हिम आंचल से तेरे, प्रगति कर दिखलाएंगे।
ज्ञान से अज्ञान तिमिर, हम मिटाते जाएंगे।
हम मिटाते जाएंगे।।

प्रौद्योगिकी से देश को, स्वावलंबी बनाएंगे।
अनुसंधान से जग में, अर्थ विकास कराएंगे।
अर्थ विकास कराएंगे।।

मातृभूमि की भव्यता, विज्ञान से बढ़ाएंगे।
हो समर्पित हम सभी, जन उत्थान कराएंगे।

जन उत्थान कराएंगे।
जन उत्थान कराएंगे।
जन उत्थान कराएंगे।

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वार्षिक प्रतिवेदन
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2025-26

With Best
Compliments from Dr. Sudesh Kumar Yadav
Director

सीएसआईआर–हिमालय जैवसंपदा प्रौद्योगिकी संस्थान
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पालमपुर–176 061 (हि.प्र.) Palampur-176 061 (H.P.)

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Dr. Sudesh Kumar Yadav
CSIR-Institute of Himalayan Bioresource Technology
Palampur (HP)-176061, India.
Phone: +91-1894-230411
Fax: +91-1894-230433
Email: director.ihbt@csir.res.in
Web: https://www.ihbt.res.in

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सीएसआईआर–आईएचबीटी का अवलोकन

परिकल्पनाः जैवार्थिकी के उन्नयन हेतु प्रौद्योगिकीय उद्भवता एवं विकास में हिमालयी जैवसंपदा के संपोषणीय उपयोग द्वारा विश्व स्तर पर अग्रणी होना।

उद्देश्यः सामाजिक, औद्योगिक, पर्यावरणीय और अकादमिक हित हेतु हिमालयी जैवसंपदा से प्रक्रमों, उत्पादों और प्रौद्योगिकियों की खोज, नवोन्मेष, विकास एवं प्रसार।

पश्चिमी हिमालय में धौलाधार पर्वतमाला की हिमच्छादित पर्वतमाला की तलहटी में बसे सीएसआईआर–हिमालय जैवसंपदा प्रौद्योगिकी संस्थान (सीएसआईआर–आईएचबीटी) का इतिहास 1960 के दशक का है, जब जिला कांगड़ा पंजाब राज्य का एक भाग था। राज्य सरकार ने विज्ञान और प्रौद्योगिकी मंत्रालय, भारत सरकार के अंतर्गत एक स्वायत्त संगठन, वैज्ञानिक और औद्योगिक अनुसंधान परिषद (सीएसआईआर) की एक घटक प्रयोगशाला के रूप में पालमपुर में राष्ट्रीय जीवविज्ञान अनुसंधान संस्थान (एनबीआरआई) स्थापित करने पर विचार किया।

इस उद्देश्य के लिए जनवरी 1966 में, पंजाब सरकार के चिकित्सा और स्वास्थ्य विभाग द्वारा पालमपुर में होल्टा टी एस्टेट से लगभग 12396 करनाल भूमि अधिग्रहण की प्रक्रिया शुरू करने के लिए एक अधिसूचना जारी की गई। जिसमें सरकार द्वारा भूमि हस्तांतरण की प्रक्रिया में कुछ और समय लगा और सितंबर 1966 में पंजाब राज्य के पुनर्गठन के साथ जिला कांगड़ा का हिमाचल प्रदेश राज्य में विलय हो गया, और कम से कम आने वाले कुछ और समय में पालमपुर में एनबीआरआई की स्थापना का मुद्दा प्राथमिकता खोता गया।

समय बीतने के साथ, हिमाचल प्रदेश सरकार ने अन्य प्रतिष्ठानों के निर्माण के लिए एनबीआरआई की कुल चिह्नित भूमि का कुछ भाग उन्हें आवंटित कर दिया। परिणामस्वरुप, बनुरी और होल्टा में भूमि का एक छोटा टुकड़ा ही शेष रहा, जिसका इस संस्थान के निर्माण के लिए प्रारंभिक समय में अधिग्रहण किया गया था। 1970 के दशक शुरू में सीएसआईआर ने हिमाचल प्रदेश राज्य में अपनी उपस्थिति दर्ज की, जब क्षेत्रीय अनुसंधान प्रयोगशाला (आरआरएल) जम्मू ने पालमपुर में बंदला टी एस्टेट में किराए के भवन में अपना विस्तार केंद्र स्थापित किया। पालमपुर में एक स्वतंत्र सीएसआईआर प्रयोगशाला स्थापित करने के विचार ने एक बार फिर गति पकड़ी। पालमपुर में प्रस्तावित अनुसंधान संस्थान की स्थापना के उद्देश्य से एनबीआरआई के नाम से खाली पड़ी 186.2 एकड़ भूमि को आरआरएल, जम्मू के कब्जे में दे दिया गया।

इस प्रकार सीएसआईआर कॉम्प्लेक्स पालमपुर की आधारशिला 2 जुलाई, 1983 को सीएसआईआर के उपाध्यक्ष और विज्ञान और प्रौद्योगिकी मंत्री, भारत सरकार प्रो. नूरुल हसन, द्वारा, हिमाचल प्रदेश के तत्कालीन मुख्यमंत्री, सीएसआईआर के महानिदेशक, डॉ. जी.एस. सिद्धू और अन्य गणमान्य व्यक्तियों की उपस्थिति में रखी। इसके अतिरिक्त, प्रौद्योगिकीय पहल के माध्यम से उच्च पर्वतीय क्षेत्रों की अर्थव्यवस्था को सुदृढ़ करने के लिए, अक्टूबर 2011 को रिब्लिंग (केलांग के पास समुद्र तल से 3450 मीटर ऊँचाई पर), जिला लाहौल और स्पीति, हिमाचल प्रदेश में उच्च तुंगता जीवविज्ञान केंद्र (सीहैब) की स्थापना की गई।

संस्थान आधारभूत और ट्रांसलेशनल अनुसंधान के लिए बहुआयामी अत्याधुनिक सुविधाओं के माध्यम से प्रक्रमों और उत्पादों को विकसित करने के लिए हिमालयी जैवसंपदा के संपोषणीय उपयोग के प्रति अग्रसर है। संस्थान के पास अत्याधुनिक विज्ञान पर आधारित एक मजबूत पेटेंट आधार और औद्योगिक विकास को बढ़ावा देने के लिए प्रौद्योगिकियों के सफल व्यावसायीकरण का व्यापक अनुभव है। संस्थान ने पुष्प, औषधीय और सगंध पौधों की खेती और मूल्यवर्धन के लिए स्थानीय संसाधनों के प्रसंस्करण के माध्यम से उच्च तुंगता वाले क्षेत्रों के जनजातीय और अन्य समुदायों के सशक्तिकरण और आजीविका को बढ़ाने के माध्यम से आर्थिकी को बढ़ावा देने में पहचान बनाई है।

OVERVIEW OF CSIR-IHBT

Vision: To be a global leader on technologies for boosting bioeconomy through sustainable utilization of Himalayan bioresources

Mission: To discover, innovate, develop and disseminate the processes, products and technologies from Himalayan bioresources for society, industry, environment and academia

CSIR-Institute of Himalayan Bioresource Technology (CSIR-IHBT), perched in the lap of majestic snow clad mountains of Dhauladhar range in the western Himalaya, has a history that dates back to 1960s, when District Kangra was still a part of the State of Punjab. The state Government considered to set up the National Biological Research Institute (NBRI) at Palampur, as a constituent establishment of the Council of Scientific and Industrial Research (CSIR), an autonomous society under the Ministry of Science and Technology, Government of India.

In January 1966, a notification was issued by the Medical and Health Department of the Government of Punjab to initiate the process of acquiring land measuring about 12396 karnals for the purpose from the Holta Tea Estate at Palampur. The process of land transfer took some more time and with a turn of events followed with reorganization of the state of Punjab in September 1966 that led to merger of District Kangra with state of HP, and the issue of setting up of NBRI at Palampur lost priority, at least for some more time to come. With the passage of time, the HP Government allocated part of the total land earmark for creation of NBRI, to other establishments. Consequently, a smaller piece of land was left at Banuri and Holta, for the purpose for which it was acquired initially. By 1970s, CSIR marked its presence in the state of HP when Regional Research Laboratory (RRL) Jammu set up its Extension Centre in a rented building at the Bundla Tea Estate at Palampur. The idea of setting up of an independent CSIR laboratory at Palampur picked up momentum once again. An area 186.2 acres of land lying vacant, that figured in the name of NBRI, was put in possession of RRL, Jammu, for the purpose of establishing the proposed research institute at Palampur.

Finally, the foundation stone of CSIR Complex Palampur was laid on July 2, 1983 by the Vice-President of CSIR and Minister of Science and Technology, Government of India, Prof. Nurul Hasan, in presence of the then Chief Minister of HP Sh. Virbhadra Singh, DG CSIR, Dr. G.S. Sidhu and other dignitaries. Further, to catalyze the economy of the high mountains through technological interventions, a Centre for High Altitude Biology (CeHAB) was established at Ribling (3450 m amsl, near Keylong), district Lahaul & Spiti, (HP) in October 2011.

The institute is involved in harnessing and sustainable utilization of Himalayan bioresources through multifaceted state-of-the-art facilities for basic as well as translational research to develop end-to-end processes and products. The institute has a strong patent portfolio based on cutting edge science and vast experience of successful commercialization of technologies for propelling industrial growth. The institute has proven credentials in boosting economy through empowerment and enhancing livelihood of tribal and other communities of high altitude areas through floriculture, cultivation of medicinal & aromatic plants and processing of local resources for value addition.

संस्थागत संरचना

श्री नरेद्र मोदी
माननीय प्रधानमंत्री भारत
अध्यक्ष, सीएसआईआर

डॉ. जितेंद्र सिंह
विज्ञान और प्रौद्योगिकी मंत्रालय और पृथ्वी विज्ञान मंत्रालय के राज्य मंत्री और प्रधानमंत्री कार्यालय के राज्य मंत्री; कार्मिक, लोक शिकायत और पेंशन; परमाणु ऊर्जा विभाग और अंतरिक्ष विभाग
उपाध्यक्ष, सीएसआईआर

डॉ. (श्रीमती) एन. कलैसेल्वी
सचिव, डीएसआईआर एवं महानिदेशक, सीएसआईआर

निदेशक
सीएसआईआर–आईएचबीटी

अनुसंधान परिषद

प्रबन्ध परिषद

अनुसंधान एवं विकास क्षेत्र
- कृषिप्रौद्योगिकी
- जैवप्रौद्योगिकी
- रसायन प्रौद्योगिकी
- अहारिकी और पौषण प्रौद्योगिकी
- पर्यावरण प्रौद्योगिकी
- किण्वन और फाइटोफार्मिंग प्रौद्योगिकी

सहयोगी सेवाएं
- व्यवसाय विकास एवं विपणन इकाई
- योजना, परियोजना निगरानी और मूल्यांकन
- अभियांत्रिकी सेवा इकाई
- पुस्तकालय
- बौद्धिक संपदा इकाई
- कम्प्यूटर इकाई
- उपकरण
- प्रेस एवं मीडिया इकाई

आंतरिक सेवाएं / व्यवस्था
- प्रशासन
- वित्त एवं लेखा
- भण्डार एवं क्रय
- सुरक्षा
- हिंदी अनुभाग
- अतिथिगृह एवं छात्रावास
- प्रयोगिक फार्म

ORGANIZATIONAL STRUCTURE

Shree Narendra Modi
Hon'ble Prime Minister of India
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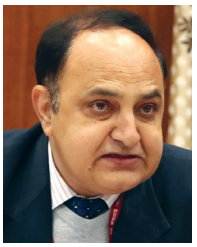

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Dr. Alok K Sinha

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Staff Scientist VII
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National Institute of Plant Genome Research, Aruna Asaf Ali Marg, New Delhi - 110067

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Scientist 'F'
Department of Biotechnology,
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Government of India,
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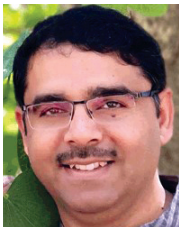

Dr. Sanjeev Khosla
Director
CSIR- Institute of Microbial Technology
Sector 39A,
Chandigarh 160036

Dr. Aparna Maitra Pati
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CSIR-Institute of Himalayan Bioresource Technology
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Palampur - 176061 (H.P.)

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CSIR-Institute of Himalayan Bioresource Technology
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CSIR-Institute of Himalayan Bioresource Technology
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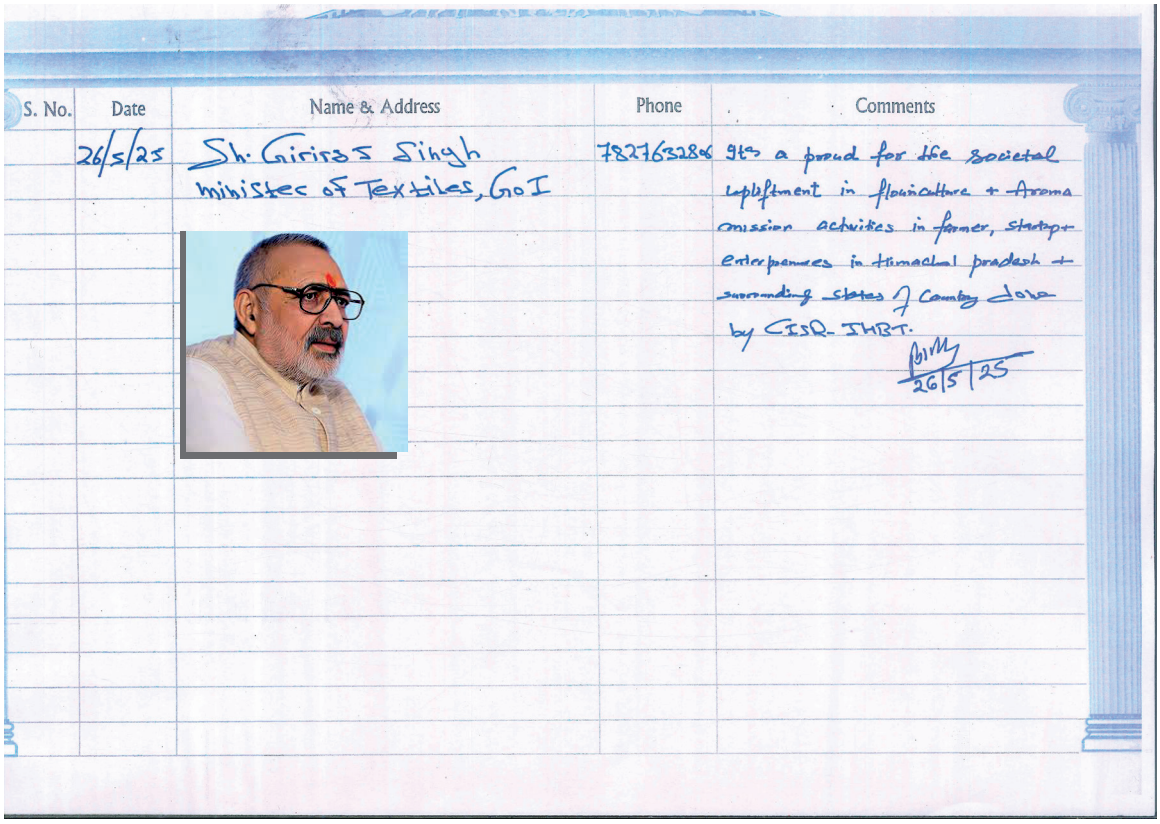
IMPRESSIONS



S. No.	Date	Name & Address	Phone	Comments
	26/5/25	Sh. Girirs Singh minister of Textiles, GoI	7827632806	Its a proud for the societal upliftment in flouriculture + Aroma mission activities in farmer, startup + enterpreneurs in Himachal pradesh + surrounding states of Country done by CISR-IHBT. 26/5/25

निदेशकीय प्रतिवेदन

सीएसआईआर–हिमालय जैवसंपदा प्रौद्योगिकी संस्थान के वार्षिक प्रतिवेदन–2025–26 को प्रस्तुत करते हुए मुझे गर्व एवं हर्ष हो रहा है। इसमें शोध एवं विकास के नए क्षेत्रों में संस्थान के सार्थक योगदान को परिलक्षित किया गया है। यह सीएसआईआर और हमारे विशिष्ट सहयोगियों, जिनमें केंद्र एवं राज्य सरकारें, सार्वजनिक और निजी क्षेत्र के उद्योग तथा शिक्षा जगत शामिल हैं, के निरंतर सहयोग से संभव हो पाया है। यह रिपोर्ट वर्ष के दौरान अर्जित प्रमुख उपलब्धियों और मान्यता के साथ–साथ, उच्च स्तरीय प्रकाशनों और बौद्धिक संपदा को भी प्रस्तुत करती है। प्रमुख वैज्ञानिक गतिविधियों, आउटरीच कार्यक्रमों और क्षमता–निर्माण की पहलों का विवरण भी इसमें प्रस्तुत किया गया है।

सीएसआईआर अरोमा मिशन (चरण–III) के तीसरे वर्ष में, सीएसआईआर–आईएचबीटी ने तेरह राज्यों और दो केंद्र शासित प्रदेशों में 685 हेक्टेयर अतिरिक्त क्षेत्र को कवर किया। लगभग 25.9 टन सगंध तेल का उत्पादन हुआ, जिससे 8.22 करोड़ रुपये का राजस्व प्राप्त हुआ। किसानों को आबंटित करने के लिए दस लाख पौधे और 950 किलोग्राम बीज तैयार किए गए। हिमाचल प्रदेश में लेमनग्रास के तीन नए क्षेत्र/क्लस्टर विकसित किए गए। किसानों से सीधे सगंध तेल खरीदने के लिए उद्यमों/उद्योगों के साथ संबंध स्थापित किए गए। इस वर्ष, हिमाचल प्रदेश ने 3.5 टन तेल के उत्पादन के साथ देश में सगंध गेंदे के तेल के सबसे बड़े उत्पादक के तौर पर अपनी जगह बनाए रखी।

देश में हींग की खेती में एक बड़ी सफलता तब मिली, जब मई 2025 में सीएसआईआर–आईएचबीटी, पालमपुर के प्रक्षेत्र में हींग के पौधों में पहली बार फूल आए और उसके बाद जुलाई 2025 में उच्च तुंगता जीवविज्ञान केन्द्र (CeHAB), रिबलिंग, लाहौल और स्पीति में भी फूल खिले। इसी प्रकार, लाहौल और स्पीति के सलग्रां गाँव में एक किसान के खेतों में भी हींग के पौधों में पुष्पण हुआ।

सीएसआईआर–आईएचबीटी ने सीएसआईआर–फाइटोफार्मास्युटिकल मिशन के अंतर्गत औषधीय पौधों, जैसे कि *इनुला रेसमोसा, पिक्रोराइजा कुरोआ* और हींग की खेती को भी बढ़ावा दिया। इसके अलावा, किसानों को *वैलेरियाना जटामांसी*, स्टीविया, ब्रह्मी (*बेकोपा*) और तुलसी (*ओसीमम*) जैसे अन्य औषधीय पौधों की पांच लाख पौध सामग्री भी वितरित की गई। संस्थान ने औषधीय और सुगंधित पौधों–हल्दी (*करकुमा केसिया*) और क्लेरी सेज (*साल्विया स्क्लेरिया*) की कृषि तकनीक भी विकसित की। सीएसआईआर के ''जैवसंपदा संरक्षण एवं प्रॉस्पेक्शन'' मिशन के अंतर्गत, हिमालयी जैवसंपदा के संरक्षण एवं प्रोत्साहित करने के लिए एक विशेष 'जैवसंपदा उद्यान' बनाया गया। इसमें औषधीय, सुगंधित, रंग देने वाले, मसाले वाले, खाद्य और

सजावटी पौधों की 50 से ज्यादा प्रजातियां शामिल हैं। इस वर्ष, सीएसआईआर अरोमा मिशन टीम को कृषि विज्ञान श्रेणी में प्रतिष्ठित 'राष्ट्रीय विज्ञान पुरस्कार 2025' से सम्मानित किया गया। इसमें शामिल संस्थानों में से, सीएसआईआर–हिमालय जैवसंपदा प्रौद्योगिकी संस्थान ने मिशन टीम के एक मुख्य सदस्य के तौर पर सक्रिय और महत्वपूर्ण भूमिका निभाई।

हमारी नई शोध एवं कृषि–नवोन्मेष पहलों के अंतर्गत, संस्थान ने एवोकाडो, ब्लूबेरी और ड्रैगन फ्रूट जैसी उच्च मूल्यवान विदेशी फसलों को सफलतापूर्वक उगाने की पहल की है। ये महत्वपूर्ण पहल हिमालयी बागवानी में विविधता लाने और जलवायु–अनुकूल, उच्च आय वाली खेती के उपायों को बढ़ावा देने की दिशा में एक अग्रणी कदम हैं। इस तरह की पहल वैज्ञानिक शोध को सतत सामाजिक–आर्थिक प्रभाव में बदलने के प्रति संस्थान की निरंतर प्रतिबद्धता को दर्शाती हैं।

इस वर्ष संस्थान ने जैवसंपदा, आर्टिफिशियल इंटेलिजेंस, पादप विज्ञान और सस्टेनेबल मटीरियल्स रिसर्च के क्षेत्र में उल्लेखनीय प्रगति की है। वैज्ञानिकों ने नए कॉपर–चीलेटिंग फ्लोरोसेंट कार्बन डॉट्स विकसित किए, जो प्रोटीन एग्रीगेशन को कम करने और लिपिड होमियोस्टैसिस को बहाल करने में सक्षम हैं; ये न्यूरोडीजेनेरेटिव रोगों के निदान में आशाजनक क्षमता प्रदान करते हैं। कंप्यूटेशनल बायोलॉजी के क्षेत्र में, PTF–Vāc नाम का एक 'एक्सप्लेनेबल जेनरेटिव AI–आधारित' प्लेटफॉर्म विकसित किया गया। यह प्लेटफॉर्म 'ab initio' (शुरुआत से) तरीके से पौधों के ट्रांसक्रिप्शन फैक्टर बाइंडिंग साइट्स की खोज करता है। इसने मौजूदा मोटिफ–खोजने वाले टूल्स की बड़ी कमियों को दूर किया है और जीनोमिक एनोटेशन व रेगुलेटरी बायोलॉजी में नए रास्ते खोले हैं। केसर के जीवविज्ञान में भी महत्वपूर्ण सफलताएँ मिली हैं, इसमें तापमान से नियंत्रित होने वाले फूलों के खिलने की प्रक्रिया को संचालित करने वाले मुख्य रेगुलेटर्स की पहचान की गई है। इससे इस बहुमूल्य फसल के जेनेटिक सुधार और पैदावार बढ़ाने के लिए महत्वपूर्ण जानकारी मिली है। संस्थान ने प्राकृतिक बायो–पॉलिमर पर आधारित बायोडिग्रेडेबल एक्टिव पैकेजिंग फिल्मों को विकसित करके सतत और पर्यावरण–अनुकूल तकनीकों में अपने योगदान को और सुदृढ़ किया। प्राकृतिक जैवसक्रिय यौगिकों से भरपूर नई सोडियम एल्गिनेट और κ–कैरागीनन कम्पोजिट फिल्म्स ने बेहतर मैकेनिकल मजबूती, एंटीऑक्सीडेंट और एंटीबैक्टीरियल

गुण, खाने को ज्यादा समय तक सुरक्षित रखने की क्षमता और तेजी से बायोडिग्रेड होने की खूबी दिखाई है। इससे पता चलता है कि ये पारंपरिक प्लास्टिक पैकेजिंग के सतत विकल्प बन सकते हैं।

इस वर्ष संस्थान ने बायोमास वैलोराइजेशन, हरित रासायनिकी, प्राकृतिक उत्पादों और प्रक्रम नवाचार के क्षेत्र में उल्लेखनीय प्रगति की। लिग्नोसेल्युलोजिक बायोमास को सफलतापूर्वक वैनिलिन, वैनिलिक एसिड और एसीटोवैनिलोन जैसे मूल्यवर्धित रसायनों में बदला गया। बायोमास से मिलने वाले फरफुरल को 2,5–फुरानडाइकार्बोक्सिलिक एसिड (FDCA) में बदलने के लिए एक नई कैटलिस्ट–आधारित विधि विकसित की गईय जो FDCA, पॉलीइथिलीन फुरानोएट (PEF) के लिए एक मुख्य मोनोमर है। संस्थान ने कई जैवसक्रिय प्राकृतिक उत्पादों को विलगित किया और उनकी विशेषताओं का पता लगाया, जिनमें *नार्डोस्टैचिस जटामांसी* से प्राप्त एक नया सेस्क्यूटरपेनॉइड और *थैलिकट्रम* व *स्वर्टिया* से प्राप्त नए यौगिक शामिल हैं। NABL एक्रेडिटेशन (ISO/IEC 17025:2017) प्राप्त किया गया, सात सर्टिफाइड रेफरेंस मटीरियल (CRMS) विकसित किए गए और एटिसिनियम क्लोराइड के लिए पेटेंट फाइल किया गया। सहयोगात्मक शोध से लेदर के प्रयोग के लिए टैनिन–युक्त चाय का अर्क तैयार किया गया। अन्य उपलब्धियों में पर्यावरण के अनुकूल विश्लेषणात्मक विधियां, NADES–आधारित निष्कर्षण प्रक्रियाएँ, सिट्रस सगंध तेल के लिए पेटेंटेड हाइड्रो–डिस्टिलेशन प्रकिया और विनाइलट्राइफ्लोरोमिथाइलेटेड डेरिवेटिव्स के लिए एक नया कैटेलिटिक उपाय शामिल है।

पोषण और न्यूट्रास्युटिकल प्रौद्योगिकी के क्षेत्र में, संस्थान ने कुपोषण और पुराने रोगों से निपटने के लिए सतत कार्यात्मक खाद्य और जैवसक्रिय उपायों को विकसित करने पर ध्यान केंद्रित किया। हिमालयी फूलों के अपशिष्ट से समृद्ध मिलेट–आधारित प्रोबायोटिक सूप मिश्रण, बेहतर कोदो मिलेट पेय, और सतत रूप से प्रसंस्कृत हिमालयी फलियों में बेहतर पोषण गुणवत्ता, उन्नत जैवसक्रिय संरचना, बेहतर पाचनशक्ति और उच्च उपभोक्ता स्वीकार्यता देखी गई। *प्रूनस सेरासोइड्स* (Prunus cerasoides), सूक्ष्मशैवाल (माइक्रोएल्गी) और हिमालय के जंगली खाद्य पदार्थों जैसे स्थानीय जैविक संसाधनों की पहचान एंटीऑक्सीडेंट, प्रोटीन और स्वास्थ्य के लिए उपयोगी तत्वों के मूल्यवान स्रोतों के रूप में की गई, वहीं, 'पोषण अभियान' के अंतर्गत शामिल किए गए मोटे अनाज (मिलेट) से बने उत्पादों ने पोषण सुरक्षा में योगदान दिया।

संस्थान ने एडवांस्ड डिलीवरी सिस्टम भी विकसित किए, जिनमें साइक्लोडेक्सट्रिन नैनोस्पंज, लिपोसोमल नैनोफाइबर, बायोडिग्रेडेबल पैकेजिंग फिल्में, आयुर्वेद–आधारित खेल पोषण (स्पोर्ट्स न्यूट्रिशन) उत्पाद और बेहतर स्वास्थ्य प्रबंधन के लिए हर्बल फॉर्मूलेशन शामिल हैं। खाद्य कार्यक्षमता, अनुकूलन (पर्सनलाइजेशन) और वहनीयता (सस्टेनेबिलिटी) को बेहतर बनाने के लिए कोल्ड प्लाज्मा प्रोसेसिंग और 3D फूड प्रिंटिंग जैसी नई तकनीकों पर काम किया गया। पौधे और आहार–आधारित चिकित्सीय पहलों में भी महत्वपूर्ण प्रगति हुई, जहां *अर्टिका डियोइका* के अर्क ने न्यूरोप्रोटेक्टिव प्रभाव दिखाया, मध्यम–श्रृंखला ट्राइग्लिसराइड्स ने दौरे की गंभीरता और अवसादग्रस्तता जैसे व्यवहार को कम किया, *लिनम यूसिटाटिसिमम* ने संधिशोथ में सूजन–रोधी गतिविधि का प्रदर्शन किया, और *ओफियोकॉर्डिसेप्स इंडिका* ने आईजीए नेफ्रोपैथी में रेनोप्रोटेक्टिव क्षमता का प्रदर्शन किया। कुपोषण से होने वाली लिवर की क्षति पर हुए अध्ययन ने लिपिड मेटाबॉलिज्म और गट–लिवर एक्सिस में अवरोधों को और उजागर किया है, जो मेटाबोलिक डिसफंक्शन–एसोसिएटेड स्टीटोटिक लिवर डिजीज (MASLD) से जुड़ी हैं।

हिमालय में किए गए प्रक्षेत्र–आधारित वनस्पति सर्वेक्षणों ने वहाँ की समृद्ध जैव–विविधता को दर्ज करने में महत्वपूर्ण योगदान दिया है। इसी क्रम में, हमारे टैक्सोनोमिस्ट (वर्गीकरण–विशेषज्ञों) ने दो नई प्रजातियों का वर्णन किया है। *क्रेमेन्थोडियम कलैसेल्वे* विक. कुमार और राहुल कुमार को दिबांग घाटी से खोजा गया था, जबकि *टैराक्सैकम डिलुकुलोरम* विक. कुमार, किर्श्नर वस्टेपानेक को अरुणाचल प्रदेश के तवांग जिले से प्रलेखित किया गया है। इसके अलावा, हिमाचल प्रदेश के किन्नौर जिले की सैराग घाटी में फील्डवर्क के दौरान, भारत में *एलियम रोजेनबैचियानम* रेगेल के वितरण का एक नया रिकॉर्ड दर्ज किया गया। ये खोजें इस क्षेत्र की वनस्पतियों की विविधता को और बढ़ाती हैं।

संस्थान ने पश्चिमी हिमालय में जलवायु–अनुकूल पारिस्थिकी प्रबन्धन/इकोसिस्टम मैनेजमेंट और प्रिसिजन एग्रीकल्चर (सटीक खेती) की दिशा में महत्वपूर्ण योगदान दिया है। जलवायु के कारण भूमि और पर्यावरण में होने वाले बदलावों के विस्तृत आकलन से सतत नीति–निर्माण और इकोसिस्टम के संरक्षण के लिए महत्वपूर्ण जानकारी मिली। हिमालयी क्षेत्र में औषधीय फसलों की व्यवस्थित मानचित्रण, निगरानी और संरक्षण के लिए 'हिममेडक्रॉप' (HimMedCrop) नाम का एक जियो–टैग वाला डिजिटल प्लेटफॉर्म विकसित किया गया। AI/ML–आधारित हाइपरस्पेक्ट्रल एनालिटिक्स का प्रयोग करके, वैज्ञानिकों ने तुलसी की फसल कटाई से पहले पैदावार का बहुत सटीक अनुमान (R^2 ~0.88) लगाया और चाय की फसल में शुरुआती दौर में ही रोगों का पता लगाने में 90 प्रतिशत से ज्यादा सटीकता हासिल की। ये उपलब्धियां हिमालयी क्षेत्रों में सतत खेती के लिए ड्रोन–आधारित, बिना नुकसान पहुँचाने वाली और व्यापक पैमाने पर प्रयोग की जा सकने वाली स्मार्ट खेती की तकनीकों में संस्थान की बढ़ती क्षमताओं को दिखाती हैं।

संस्थान ने पश्चिमी हिमालय के ज्यादा उच्च तुंगता वाले ठंडे रेगिस्तानी क्षेत्रों में खतरे में पड़े और आर्थिक रूप से महत्वपूर्ण औषधीय पौधों पर बड़े पैमाने पर पारिस्थितिक और संरक्षण संबंधी अध्ययन किए। हिमाचल प्रदेश में उच्च तुंगता वाले

और इकोलॉजिकल आवासों में *एलियम कैरोलिनियानम, एलियम नेगियानम* और *एरेमुरस हिमालयकस* जैसी प्रजातियों की क्षेत्र संख्या का विस्तृत आकलन किया गया। इससे उनके वितरण, प्रभुत्व के पैटर्न और प्राकृतिकवास की पसंद के बारे में महत्वपूर्ण जानकारी मिली। सीहैब में पौधशाला और फील्ड जीन बैंक में महत्वपूर्ण औषधीय प्रजातियों (जैसे कि *आर्नीबिया यूक्रोमा* और *पॉलीगोनेटम सिरिफोलियम*) की प्रतिनिधि क्षेत्र / संख्या और रोपण सामग्री तैयार करके 'एक्स–सिटू' (ex-situ) संरक्षण की दिशा में भी उल्लेखनीय प्रगति हुई है। इसके साथ ही, लाहौल और स्पीति में बेहतर किस्मों की पहचान करने और औषधीय पौधों के बीजों का जीन बैंक बनाने के प्रयास भी किए गए। प्राकृतिक वास को बहाल करने और 'रीवाइल्डिंग' (वनस्पतिजात को वापस लाने) के प्रयासों में सहायता के लिए, राज्य वन विभाग को संकटापन्न औषधीय पौधों के 3.9 किलोग्राम अच्छी गुणवत्ता वाले बीज दिए गए। यह RET (दुर्लभ, लुप्तप्राय और खतरे में पड़े) पौधों की प्रजातियों के संरक्षण और उनकी संख्या बढ़ाने की दिशा में एक सार्थक कदम है।

संस्थान के मुख्य ध्येय, उद्योगों की आवश्यकताओं और बायोमैन्युफैक्चरिंग पर भारत सरकार के रणनीतिक / योजनायुक्त पहल को ध्यान में रखते हुए, इस वर्ष संस्थान में नए "किण्वण और फाइटोफार्मिंग प्रभाग" की शुरुआत हुई। आधारभूत जीवविज्ञान शोध को सतत औद्योगिक प्रक्रियाओं और धरातल स्तर की तकनीकों से जोड़ने के उद्देश्य से स्थापित इस प्रभाग ने 2025–26 में अपने शोध कार्य को तेजी से बढ़ाया।

संस्थान ने *पिक्रोराइजा कुरोआ* और *नार्डोस्टैकस जटामांसी* के लिए उच्च दक्षता वाले प्रोटोप्लास्ट विलगन और रूपांतरण प्रणालियों के विकास, हींग (*फेरुला एस्सा फोएटिडा*) के एआई–सहायता प्राप्त सूक्ष्मप्रसार, *फिलोस्टैचिस प्यूबसेन्स* के लिए सूक्ष्मप्रसार प्रोटोकॉल और उच्च पीएच सहिष्णु ब्लूबेरी किस्मों के लिए रोगाणुरोधी संवर्ध की स्थापना के माध्यम से अपनी जैव प्रौद्योगिक क्षमताओं को मजबूत किया। हाइड्रोपोनिक्स, कैम्बियम मेरिस्टेमैटिक सेल कल्चर और एलिसिटेशन विधियों के साथ एरोपोनिक खेती जैसी एप्लाइड बायोलॉजिकल प्रोडक्शन प्रणालियों ने औषधीय पौधों में बायोमास, पिक्रोसाइड की मात्रा और सगंध तेल की पैदावार को काफी बढ़ा दिया है। उल्लेखनीय है कि पिक्रोसाइड्स और वैलेपोट्रिएट्स के *इन–विट्रो* उत्पादन के लिए पेटेंट फाइल किए गए, और '*आर्नीबिया यूक्रोमा*' की एडवेंटिशियस रूट कल्चर से नैफ्थोक्विनोन पिगमेंट बनाने की एक पेटेंटेड सतत प्रौद्योगिकी को व्यवसायीकरण के लिए उद्योगों को हस्तांतरित किया गया।

प्रकम नवोन्मेष के माध्यम से बड़े पैमाने पर प्रयुक्त किए जा सकने वाले और उपयोगी जैवप्रौद्योगिकीय समाधान विकसित करने के लिए माइक्रोबियल विविधता का भरपूर प्रयोग किया गया। इन प्रयासों के परिणामस्वरूप महत्वपूर्ण औद्योगिक परिणाम सामने आए हैं जिसमें कि 'बायोलैक्सी एंजाइम्स प्राइवेट लिमिटेड' को एल–एस्पैराजिनेज (हिम अषनेश) प्रौद्योगिकी का सफल हस्तांतरण, और 'आयोडोबैक्टर sp. PCH 194' से पॉलीहाइड्रॉक्सीब्यूटायरेट और वियोलासीन निष्कर्षण की नई जैवप्रक्रम तकनीक के लिए भारत और इंग्लैंड में पेटेंट मिलना शामिल है।

सामुदायिक विकास के लिए, सीएसआईआर–आईएचबीटी राष्ट्रीय स्तर पर सीएसआईआर के 14 अन्य संस्थानों के साथ मिलकर सीएसआईआर के नए ''स्मार्ट विलेज'' मिशन आधारित परियोजनाओं में सहयोग कर रहा है। इस परियोजना के अंतर्गत देश के विभिन्न क्षेत्रों के गांवों में मधुमक्खी पालन, सूखे फूलों से बनी कलाकृतियां और कुपोषण रोकथाम के उपाय जैसी संस्थागत तकनीकें लागू की जाएंगी, जिससे जमीनी स्तर पर लोगों को सशक्त बनाने और गांवों को आत्मनिर्भर बनाने में सहायता मिलेगी।

संस्थान ने वर्ष भर सतत विकास, नवोन्मेष और सामाजिक समरसता / सहभागिता को बढ़ावा देने के लिए कई वैज्ञानिक और आउटरीच कार्यक्रम आयोजित किए। हिमालयी जैवसंपदा के सतत विकास और संरक्षण पर आयोजित एक राष्ट्रीय संगोष्ठी में शोधकर्ताओं, छात्रों और विशेषज्ञों को संरक्षण, बायोप्रोस्पेक्शन और जैव–आर्थिकी को बढ़ावा देने पर चर्चा हेतु एक मंच पर लाया गया, इसमें वैज्ञानिक प्रस्तुतियाँ, प्रौद्योगिकी हस्तांतरण समझौते और प्रदर्शनियाँ शामिल थीं। संस्थान ने "चंबा सशक्तिकरणः सीएसआईआर–आईएचबीटी की अत्याधुनिक तकनीकों से सतत विकास को बढ़ावा देना" विषय पर एक सम्मेलन भी आयोजित किया। इसमें किसानों, स्टार्ट–अप्स, उद्योगों, स्वयं–सहायता समूहों, वैज्ञानिकों और छात्रों ने सक्रिय रूप से भाग लिया, जो ग्रामीण सशक्तिकरण और प्रौद्योगिकी के प्रसार के प्रति संस्थान की प्रतिबद्धता को दर्शाता है। सीएसआईआर का 84वां स्थापना दिवस और संस्थान का 43वां स्थापना दिवस बहुत उत्साह के साथ मनाया गया। इस अवसर पर कई जाने–माने वैज्ञानिक और शिक्षाविद शामिल हुए, जिन्होंने सतत जीवनशैली, स्वास्थ्य क्षेत्र में नवोन्मेष, हिमालयी जैवसंपदा के संरक्षण और विज्ञान–आधारित सामाजिक परिवर्तन के महत्व पर जोर दिया।

इस वर्ष संस्थान को कई प्रतिष्ठित गणमान्य व्यक्तियों के आतिथ्य का सौभाग्य प्राप्त हुआ, जिन्होंने अपने बहुमूल्य दृष्टिकोण और अनुभवों से वैज्ञानिक समुदाय को समृद्ध किया। विशिष्ट गणमान्यों में भारत सरकार के कपड़ा मंत्री श्री गिरिराज सिंह, INSA के अध्यक्ष प्रो. शेखर सी. मांडे, पंजाब केंद्रीय विश्वविद्यालय के कुलपति प्रो. आर.पी. तिवारी, जवाहरलाल नेहरू विश्वविद्यालय के पूर्व कुलपति प्रो. एस.के. सोपोरी, सीएसआईआर–उत्तर पूर्व विज्ञान एवं प्रौद्योगिकी संस्थान के निदेशक डॉ. वी.एम. तिवारी, नीति आयोग के सदस्य डॉ. वी.के. पॉल, भारतीय विज्ञान शिक्षा एवं अनुसंधान संस्थान, मोहाली के निदेशक डॉ. ए.के. त्रिपाठी, नेशनल प्रोफेसर और भारतीय कृषि अनुसंधान परिषद के पूर्व उप

महानिदेशक डॉ. टी.आर. शर्मा, और सीएसआईआर–इनोवेशन कॉम्प्लेक्स, मुंबई के प्रमुख और जाने–माने वैज्ञानिक डॉ. रविकृष्ण चेबोलु शामिल थे। उनके दौरों ने वार्ता, व्याख्यानों और वैज्ञानिक चर्चाओं के माध्यम से शोधकर्ताओं और छात्रों को बहुत प्रेरित किया।

इस वर्ष सीएसआईआर–आईएचबीटी परिवार में अलग–अलग स्तरों और पदों पर 31 नए कर्मचारी शामिल हुए, जिससे संस्थान की वैज्ञानिक और तकनीकी क्षमताएं और सुदृढ़ हुईं। संस्थान ने जैवप्रौद्योगिकी विभाग, विज्ञान एवं प्रौद्योगिकी विभाग, अनुसंधान नेशनल रिसर्च फाउंडेशन, राष्ट्रीय औषधीय पादप बोर्ड, नेशनल मिशन ऑन हिमालयन स्टडीज, भारतीय चिकित्सा अनुसंधान परिषद (आईसीएमआर) और सूक्ष्म, लघु और मध्यम उद्यम मंत्रालय जैसी एजेंसियों से प्राप्त वित्तीय सहायता से 21 नई परियोजनाएं प्रारंभ की। इसके अलावा, थीम डायरेक्टोरेट को अलग–अलग थीम के अंतर्गत 47 प्रस्ताव (FTT/FTC/NCP/FBR/CSIR&FIRST/RDSF) भेजे गए।

हमारे वैज्ञानिकों ने प्रतिष्ठित पीयर–रिव्यू जर्नल में 216 शोध लेख प्रकाशित किए, जो संस्थान की बढ़ती शोध उत्कृष्टता और वैज्ञानिक प्रभाव को दर्शाते हैं। संस्थान ने इनक्यूबेट्स के साथ 02 समझौते, आवश्यकता–आधारित 02 समझौते, 01 कंसल्टेंसी समझौता, 146 सामग्री हस्तांतरण समझौते और 30 समझौता ज्ञापन किए।

संस्थान ने बाजार में अच्छी संभावना वाली 12 प्रौद्योगिकी भी विकसित कीं और 20 प्रौद्योगिकी को उद्योगों को सफलतापूर्वक हस्तांतरित किया, जो ट्रांसलेशनल रिसर्च, नवोन्मेष और औद्योगिक पहुंच के प्रति इसकी दृढ़ प्रतिबद्धता को दर्शाता है। इस वर्ष जिन विशेष प्रौद्योगिकियों को हस्तांतरित किया गया, उनमें फैटी लिवर (वसामय यकृत) और उससे जुड़े रोगों से निपटने के लिए फाइकोबिलिप्रोटीन और उनसे बने फॉर्मूलेशन का व्यवसायिक उत्पादनय मोंक फ्रूट के संवर्धन और उसकी खेती के कृषि प्रौद्योगिकीय और प्राकृतिक रंग (नेचुरल कलरेंट) के तौर पर नैफ्थोक्विनोन पिगमेंट (शिकोनीन डेरिवेटिव) पर्यावरण–अनुकूल (सतत) उत्पादन शामिल है। ये उपलब्धियां आत्मनिर्भरता, जैवसंपदा में मूल्य–वर्धन, स्वदेशी तकनीकों को बढ़ावा देने और देश की जैव–आर्थिकी को सुदृढ़ करने की दिशा में महत्वपूर्ण कदम हैं।

इस वर्ष, अलग–अलग सामाजिक वैज्ञानिक दायित्व (SSR) गतिविधियों से कुल 12,399 विद्यार्थियों और फैकल्टी सदस्य लाभान्वित हुए। इसमें सीएसआईआर–जिज्ञासा कार्यक्रम के अंतर्गत 10,539 स्कूली विद्यार्थियों और शिक्षक, तथा 9 राज्यों और केंद्र–शासित प्रदेशों के विश्वविद्यालय, संस्थानों और कॉलेजों के 1,860 विद्यार्थी और फैकल्टी सदस्य शामिल थे। इसके अलावा, अलग–अलग कौशल विकास कार्यक्रमों (SDPs) के तहत 708 लोगों ने प्रशिक्षण प्राप्त किया, जिनमें अलग–अलग राज्यों और केंद्र–शासित प्रदेशों के 273 रिसर्च इंटर्न और ट्रेनी शामिल थे। इस वर्ष, 16 फैकल्टी सदस्यों को नेशनल स्किल्स क्वालिफिकेशन्स फ्रेमवर्क (NSQF) के अनुरूप एग्रीकल्चर स्किल काउंसिल ऑफ इंडिया (ASCI) के विभिन्न कोर्स के लिए ''मास्टर ट्रेनर'' के तौर पर मान्यता दी गई। इसके अतिरिक्त, संस्थान में NSQF के अनुरूप 11 कोर्स चलाए गए और हमने अलग–अलग कौशल विकास कार्यक्रमों के लिए कई शैक्षणिक संस्थानों और स्टेकहोल्डर्स के साथ साझेदारी भी की है।

कुल मिलाकर, यह वर्ष ट्रांसलेशनल रिसर्च, नवोन्मेष और स्टेकहोल्डर की भागेदारी पर विशेष जोर देने वाला रहा। इन सामूहिक प्रयासों ने सतत विकास को बढ़ावा देने, क्षेत्रीय जैव–आर्थिकी को सुदृढ़ करने और वैज्ञानिक उत्कृष्टता तथा सामाजिक प्रभाव के एक प्रमुख केंद्र के तौर पर संस्थान की भूमिका को और मजबूत करने में विशिष्ट योगदान दिया।

संस्थान के सभी सदस्यों के अटूट समर्पण, निरंतर सहयोग और मिलजुलकर काम करने की भावना के लिए मैं उनका दिल से आभार व्यक्त करता हूँ। हमारे वैज्ञानिकों, शोधकर्ताओं और तकनीकी व प्रशासनिक कर्मियों के सामूहिक प्रयासों ने संस्थान के अनुसंधान लक्ष्यों को आगे बढ़ाने और समाज के कल्याण/उत्थान के लिए विज्ञान का उपयोग करने की हमारी प्रतिबद्धता को सुदृढ़ करने में महत्वपूर्ण भूमिका निभाई है। नई पहलों के सफलतापूर्वक क्रियान्वयन और इस रिपोर्ट को तैयार करने में उनके अथक परिश्रम, रचनात्मकता और दृढ़ता ने अहम भूमिका निभाई है। मैं सीएसआईआर के महानिदेशक, परिषद मुख्यालय और अनुसंधान परिषद (रिसर्च काउंसिल) के सदस्यों का भी उनके निरंतर मार्गदर्शन और प्रोत्साहन के लिए हार्दिक आभार व्यक्त करता हूँ। मैं केंद्र और राज्य सरकारों, शिक्षा जगत, उद्योग तथा सार्वजनिक व निजी क्षेत्रों में हमारे सहयोगियों के समर्थन और सहयोग के लिए आभार व्यक्त करता हूँ। मैं अपने सहयोगियों, ग्राहकों, शुभचिंतकों और मीडिया का भी उनके सतत विश्वास और सहयोग के लिए धन्यवाद देता हूँ। इन सबके मिले–जुले योगदान के फलस्वरूप ही सीएसआईआर–आईएचबीटी वैज्ञानिक उत्कृष्टता और सामाजिक उत्थान के लिए समर्पित एक जीवंत, नवोन्मेषी और प्रभावशाली अनुसंधान संस्थान के तौर पर आगे बढ़ पाया है।

जय हिंद!

(सुदेश कुमार यादव)

FROM THE DIRECTOR'S DESK

It is my privilege and pleasure to present the Annual Report of CSIR-Institute of Himalayan Bioresource Technology (CSIR-IHBT) for the period 2025-26. This report highlights the institute's significant contributions in frontier areas of research and development, made possible through the continued support of CSIR and our valued stakeholders, including Central and State Governments, public and private sector industries, and academia. The report presents key achievements and recognitions earned during the year, along with high-impact publications and intellectual property generation. It also documents the major scientific activities, outreach programs, and capacity-building initiatives undertaken during the reporting period.

During the third year of CSIR Aroma Mission (Phase-III), CSIR-IHBT covered an additional area of 685 ha in thirteen states and two union territories. About 25.9 tons of essential oil was produced resulting in a revenue generation of 8.22 crores. Ten lakh rooted plants and 950 kg of seeds were generated for distribution to the farmers. Three new clusters of lemongrass were developed in Himachal Pradesh. Linkages were established with the Industry for the direct purchase of essential oil from the farmers. During the year, Himachal Pradesh retained its position as the top producer of Aromatic marigold oil in the country with production of 3.5 tonnes of oil.

A breakthrough was achieved in Heeng cultivation in the country when flowering initiated for the first time in Heeng plants in field at CSIR-IHBT, Palampur in May 2025 and subsequently in July 2025 at Centre for High Altitude Biology (CeHAB), Ribling, Lahaul & Spiti (Research Centre of CSIR-IHBT, Palampur). Similarly, flowering of Heeng plants has also been obtained in fields of a farmer, at Village Salgran, Lahaul and Spiti.

CSIR-IHBT also promoted cultivation of medicinal plants viz., *Inula racemosa, Picrorhiza kurrooa* and Heeng under CSIR-Phytopharmaceutical mission. Apart from these, five lakh planting material of other medicinal plants such as *Valeriana jatamansi, stevia, bacoppa* and *ocimum* were distributed to the farmers. Agrotechnologies of medicinal and aromatic plants black turmeric (*Curcuma caesia)* and clary sage (*Salvia sclarea*) were also developed by the Institute. Under the CSIR "Bioresource Conservation and Prospection" Mission, a dedicated conservation garden, 'Jaivsampada Udyan', was established for the preservation and promotion of Himalayan bioresources, encompassing more than 50 species of medicinal, aromatic, dye-yielding, spice, edible, and ornamental plants. This year, CSIR Aroma Mission Team was conferred the prestigious Rashtriya Vigyan Puraskar 2025 in the Agricultural Science category. Among the participating institutions, CSIR-Institute of Himalayan Bioresource Technology played an active and significant role as a key member of the mission team.

Under our new research and agri-innovation initiatives, the Institute successfully introduced high-value exotic crops such as Avocado, Blueberry and Dragon Fruit. These strategic interventions mark an important step toward diversification of Himalayan horticulture and the promotion of climate-resilient, high-income farming systems. Such initiatives reflect the Institute's continued commitment to translating scientific research into sustainable socio-economic impact.

The institute made significant advances in biotechnology, artificial intelligence, plant sciences, and sustainable materials research during the year. Scientists developed novel copper-chelating fluorescent carbon dots capable of reducing protein aggregation and restoring lipid homeostasis, offering promising therapeutic potential against neurodegenerative diseases. In the area of computational biology, an explainable generative AI-based platform, PTF-Vāc, was developed for ab initio discovery of plant transcription factor binding sites, overcoming major limitations of existing motif-finding tools and opening new avenues in genomic annotation and regulatory biology. Important breakthroughs were also achieved in saffron biology, where key regulators controlling temperature-mediated flowering were identified, providing critical insights for genetic improvement and enhanced yield in this high-value crop. The institute further strengthened its contributions toward sustainable and eco-friendly technologies through the development of biodegradable active packaging films based on natural biopolymers. Novel sodium

alginate and κ-carrageenan composite films enriched with natural bioactive compounds demonstrated improved mechanical strength, antioxidant and antibacterial properties, enhanced food preservation efficiency, and rapid biodegradability, highlighting their potential as sustainable alternatives to conventional plastic packaging.

This year institute achieved significant progress in biomass valorization, green chemistry, natural products, and process innovation. Lignocellulosic biomass was successfully converted into value-added chemicals such as vanillin, vanillic acid, and acetovanillone. An innovative catalyst-based strategy was developed for transforming biomass-derived furfural into 2,5-furandicarboxylic acid (FDCA), a key monomer for polyethylene furanoate (PEF). The institute isolated and characterized several bioactive natural products, including a new sesquiterpenoid from *Nardostachys jatamansi* and novel compounds from *Thalictrum* and *Swertia*. NABL accreditation (ISO/IEC 17025:2017) was achieved, seven Certified Reference Materials (CRMs) were developed, and a patent was filed for Atisinium Chloride. Collaborative research led to the development of a tannin-enriched tea extract for leather applications. Additional achievements included greener analytical methodologies, NADES-based extraction processes, a patented hydro-distillation process for citrus essential oils, and a novel catalytic route for vinyltrifluoromethylated derivatives.

In the area of nutrition and nutraceutical technologies, the institute focused on the development of sustainable functional foods and bioactive interventions targeting malnutrition and chronic diseases. Millet-based probiotic soup mixes enriched with Himalayan floral waste, optimized kodo millet beverages, and sustainably processed Himalayan legumes demonstrated enhanced nutritional quality, improved bioactive composition, better digestibility, and high consumer acceptability. Indigenous bioresources such as *Prunus cerasoides*, microalgae, and wild Himalayan foods were identified as valuable sources of antioxidants, proteins, and health-promoting compounds, while millet-based products integrated under POSHAN Abhiyaan contributed toward nutritional security. The institute also developed advanced delivery systems, including cyclodextrin nanosponges, liposomal nanofibers, biodegradable packaging films, Ayurveda-based sports nutrition products, and herbal formulations for improved health management. Emerging technologies such as cold plasma processing and 3D food printing were explored for enhancing food functionality, personalization, and sustainability. Significant progress was also achieved in plant and diet-based therapeutic interventions, where extracts of *Urtica dioica* showed neuroprotective effects, medium-chain triglycerides reduced seizure severity and depressive-like behavior, *Linum usitatissimum* demonstrated anti-inflammatory activity in rheumatoid arthritis, and *Ophiocordyceps indica* exhibited renoprotective potential in IgA nephropathy. Studies on malnutrition-induced liver injury further highlighted disruptions in lipid metabolism and the gut-liver axis associated with metabolic dysfunction-associated steatotic liver disease (MASLD).

Field-based botanical surveys conducted in the Himalayas have significantly contributed to documenting its rich biodiversity. In this context, our taxonomists have described two new species. *Cremanthodium kalaiselviae Vik. Kumar & Rahul Kumar* was discovered from the Dibang Valley, while *Taraxacum diluculorum Vik. Kumar, Kirschner & Štěpánek* was documented from Tawang district of Arunachal Pradesh. Furthermore, during the exploration of fieldwork in the Sairag Valley, district Kinnaur, Himachal Pradesh, a new distributional record of *Allium rosenbachianum* Regel was recorded from India. These findings further enrich the floristic diversity of the region.

The institute made significant contributions toward climate-resilient ecosystem management and precision agriculture in the Western Himalayas. Comprehensive assessments of climate-driven landscape changes provided critical insights for sustainable policy planning and ecosystem conservation. A geo-tagged digital platform, *HimMedCrop*, was developed for systematic mapping, monitoring, and conservation of medicinal crops in the Himalayan region. Leveraging AI/ML-enabled hyperspectral analytics, scientists achieved highly accurate pre-harvest yield prediction in basil (R^2 ~0.88) and over 90% accuracy in early disease detection in tea. These advancements demonstrate the institute's growing capabilities in drone-based, non-destructive, and scalable smart agriculture technologies for sustainable Himalayan farming systems.

The institute carried out extensive ecological and conservation studies on threatened and economically important medicinal plants in the high-altitude cold desert regions of the Western Himalayas. Detailed population assessments of species such as *Allium carolinianum, Allium negianum, and Eremurus himalaicus* were conducted across diverse altitudinal ranges

and ecological habitats in Himachal Pradesh, providing valuable insights into their distribution, dominance patterns, and habitat preferences. Significant progress was also made toward ex-situ conservation through the establishment of representative populations and planting materials of important medicinal species, including *Arnebia euchroma* and *Polygonatum cirrihifolium*, in nurseries and field gene banks at the CeHAB Ribling Centre. Concurrently, efforts were undertaken for elite accession identification and development of a medicinal plant seed gene bank repository in Lahaul & Spiti. To support habitat restoration and rewilding initiatives, 3.9 kg of quality seeds of threatened medicinal plants were supplied to the State Forest Department, marking an important step toward conservation and recovery of RET (Rare, Endangered, and Threatened) plant species.

In alignment with the institute's core vision, pressing industrial requirements and the Government of India's strategic focus on biomanufacturing, this year marked with the inception of the new "Fermentation and Phytofarming Division" at CSIR-IHBT. Established with a mandate to bridge fundamental biological research with sustainable industrial processes and grassroots technologies, the division rapidly accelerated its research portfolio in 2025-26.

The institute strengthened its biotechnology capabilities through development of high-efficiency protoplast isolation and transformation systems for *Picrorhiza kurrooa* and *Nardostachys jatamansi*, AI-assisted micropropagation of *Ferula assa-foetida*, micropropagation protocols for *Phyllostachys pubescens*, and establishment of aseptic cultures for high-pH tolerant blueberry varieties. Applied biological production systems, including hydroponics, cambium meristematic cell cultures, and aeroponic cultivation with elicitation strategies, significantly enhanced biomass, picroside content, and essential oil yield in medicinal plants. Notably, patent filings were made for in vitro production of picrosides and valepotriates, and a patented sustainable technology for production of naphthoquinone pigments from *Arnebia euchroma* adventitious root cultures was transferred to industry for commercialization.

Process innovations further harnessed extreme microbial diversity to develop scalable and application-oriented biotechnological solutions. These efforts resulted in significant industrial outcomes, including the successful technology transfer of L-asparaginase (HimAsnase) to Biolaxi Enzymes Private Limited, as well as the grant of Indian and UK patents for an innovative bioprocess for the extraction of polyhydroxybutyrate and violacein from *Iodobacter* sp. PCH 194. On a societal level, CSIR-IHBT is partnering with 14 other CSIR institutes at national level in a new CSIR "Smart Village" Mission Mode Project, where institutional technologies such as apiculture, dry flower artefacts and malnutrition interventions will be deployed in villages across geographical region of the country, driving grassroots empowerment and rural self-reliance.

The institute organized several scientific and outreach programmes during the year to promote sustainable development, innovation, and societal engagement. A National Symposium on Sustainable Development and Conservation of Himalayan Bioresources brought together researchers, students, and experts to deliberate on conservation, bioprospection, and bioeconomy generation, featuring scientific presentations, technology transfer agreements, and exhibitions. The institute also organized a conference on "Empowering Chamba: Driving Sustainable Growth with CSIR-IHBT's Cutting-edge Technologies," which witnessed active participation of farmers, start-ups, industries, self-help groups, scientists, and students, highlighting the institute's commitment to rural empowerment and technology dissemination. The 84th CSIR Foundation Day and the institute's 43rd Foundation Day were celebrated with great enthusiasm, featuring distinguished scientists and academicians who emphasized the importance of sustainable lifestyles, healthcare innovation, Himalayan bioresource conservation, and science-driven societal transformation.

During this year, the institute was privileged to host several renowned dignitaries who enriched the scientific community with their valuable insights and experiences. Distinguished visitors included Shri Giriraj Singh, Union Cabinet Minister of Textiles in the Government of India, Prof. Shekhar C. Mande, President INSA, Prof. R.P. Tiwari, Vice Chancellor of Central University of Punjab, Prof. S.K. Sopory, former Vice Chancellor of Jawaharlal Nehru University, Dr. V. M. Tiwari, Director of CSIR-North East Institute of Science and Technology, Dr. V.K. Paul, Hon'ble Member, NITI Aayog, Dr. A. K. Tripathi, Director of Institute of Science Education and Research (IISER) Mohali, Dr. T. R. Sharma, National Professor and former DDG, ICAR, and Dr. Ravikrishna Chebolu, Distinguished Scientist and Head of the CSIR-Innovation Complex, Mumbai. Their visits greatly inspired researchers and students through interactions, lectures, and scientific discussions.

During the year, 31 new staff members joined the CSIR-IHBT family across various levels and positions, further strengthening the institute's scientific and technical capabilities. The institute initiated 21 new projects funded by agencies such as Department of Biotechnology, Department of Science and Technology, Anusandhan National Research Foundation, National Medicinal Plants Board, National Mission on Himalayan Studies, Indian Council of Medical Research, and Ministry of Micro, Small and Medium Enterprises. In addition, 47 proposals (FTT/FTC/NCP/FBR/CSIR-FIRST/RDSF) were submitted under various themes to the Theme Directorate.

Our scientists published 216 research articles in the peer reviewed journals of high repute, reflecting the institute's growing research excellence and scientific impact. The institute signed 02 agreements with incubates, 02 need-based agreements, 01 consultancy agreement, 146 Material Transfer Agreements, and 30 MoUs, including an international agreement with National Research Institute of Chinese Medicine under the Ministry of Health and Welfare, Taiwan, for academic and R&D cooperation.

The institute also developed 12 technologies with significant market potential and successfully transferred 20 technologies to industries, underscoring its strong commitment to translational research, innovation, and industrial outreach. Notable technologies transferred during the year included commercial manufacturing of phycobiliproteins and derived formulations for combating fatty liver and related disorders, agro-technology for the multiplication and cultivation of monk fruit, and sustainable production of naphthoquinone pigments (shikonin derivatives) as natural colorants. These accomplishments mark important strides toward self-reliance, value addition to bioresources, promotion of indigenous technologies, and strengthening of the nation's bioeconomy.

This year, a total of 12399 students and faculty members were benefited through different Social Scientific Responsibility (SSR) Activities. This included 10539 school students and teachers under CSIR-JIGYASA program and 1860 students and faculty members from universities, institutes, and colleges across 9 states and union territories. Additionally, under the different Skill Development Programs (SDPs), 708 individuals received training, including 273 research interns and trainees from different states and UTs. This year, 16 faculty members were recognized as "Master Trainer" of National Skills Qualifications Framework (NSQF) aligned different Agriculture Skill Council of India (ASCI) courses. Furthermore, 11 NSQF aligned courses were conducted at the Institute and also we have established partnerships with various academic institutions and stakeholders for different SDPs.

Overall, the year was marked by a strong emphasis on translational research, innovation, and stakeholder engagement. The collective efforts contributed significantly to promoting sustainable development, strengthening regional bioeconomy, and reinforcing the institute's role as a key center for scientific excellence and societal impact.

I take great pleasure in expressing my heartfelt gratitude to all members of CSIR-IHBT for their unwavering dedication, continued support, and collaborative spirit. The collective efforts of our scientists, students, and technical and administrative staff have been instrumental in advancing the institute's research goals and strengthening our commitment to leveraging science for societal benefit. Their hard work, creativity, and resilience have played a pivotal role in successfully implementing new initiatives and in the compilation of this report. I also extend my sincere appreciation to the Director General of CSIR, CSIR Headquarter and the members of the Research Council for their constant guidance and encouragement. I gratefully acknowledge the support and cooperation of our partners across Central and State Governments, academia, industry, and both public and private sectors. I further thank our collaborators, clients, well-wishers, and the media for their continued trust and engagement. These collective contributions have enabled CSIR-IHBT to grow as a vibrant, innovative, and impactful research institution dedicated to scientific excellence and societal advancement.

Jai Hind !

(Sudesh Kumar Yadav)

TECHNOLOGIES AVAILABLE AND ROLLED OUT

TECHNOLOGY TRANSFER AGREEMENTS

S. No.	Title of Agreement	Name of Party	Date of signing
	AGROTECHNOLOGY		
1	New Gerbera cultivars "Him Kumud, Him Prabha and Him Aruna" and standardized its micro propagation protocol for mass multiplication	M/s Sashanka Agrotech Pvt. Ltd. Morabadi, Ranchi, Jharkhand - 834008	15.05.2025
2	Artifact making using dry flowers	M/s Komal Innovation and Wellness Initiatives (KIWI), Kangra, H.P - 176047	24.05.2025
3	Agro-technology of Monk Fruit for multiplication and cultivation	M/s The Squirrels, Sector 32-A, Ward No. 10 , Chandigarh Road, Ludhiana-141 010 (Pb.)	08.10.2025
4	Agro-technology of Monk Fruit for multiplication and cultivation	M/s Rami Hortitech Pvt. Ltd., Khata Sadar, Muzaffarnagar, Uttar Pradesh- 251001	19.11.2025
5	Tulip Agro- technology	M/s Red Mirchi Associates, Jind, Haryana	06.03.2026
6	Agro-technology of Gerbera	M/s Madan Lal Tissue Culture Lab, Jaisinghpur	06.03.2026
7	Making flower based resin encapsulated products	M/s Harsh Enterprises, Patiala, Punjab	06.03.2026
	BIOTECHNOLOGY		
8	Aeroponic production of Brahmi, Jatamansi, Thyme and Basil	M/s Suraj Shree Chemicals Ltd., Dwarka New Delhi-110077	02.07.2025
	CHEMICAL TECHNOLOGY		
9	Making herbal incense cones and sticks from temple waste flowers	M/s Dharma Kisan Vikas Committee Village Khall Nadal, Salooni District Chamba (H.P.)- 176325.	15.05.2025
10	Making (i) Aromatic/ non aromatic floral wax and (ii) aromatic floral wax candle	M/s Mountleaf Pvt Ltd, Ghurkari, Distt Kangra 176001, Himachal Pradesh	08.10.2025
11	Making herbal soaps (bars)	M/s Softbio Pharma Pvt. Ltd., J-1/144, Khirkee Extension, Adjoining Krishna Temple, Malviya Nagar, South Delhi, Delhi, 110017, India	08.10.2025
12	Herbal incense cones and sticks from temple waste flowers	M/s Trimurti Udyog Palampur, Himachal Pradesh	06.03.2026
	DIETETICS AND NUTRITION		
13	Manufacturing/processing of i) Bee Pollen Based Ready to use products like Bars, Beverages ii) Flavoured Honey (Aroma Infused Honey), iii) Honey Based Jam Products	M/s Himalaya Apiaries, Distt Una- 177208 (H.P.)	02.07.2025
14	Manufacturing/ processing of (i)Ragi banana porridge mix powder, (ii)Ragi carrot beetroot porridge mix powder, (iii)Rice apple and banana porridge mix powder, (iv)Ragi green gram porridge mix powder, and (v) Multi grain porridge mix powder	M/s Tashvika India Food Pvt. Ltd., Third Floor, Plot No. 34, Sector 3, Dwarka, New Delhi-110075	02.09.2025
15	Protein bar chocolate	M/s Tashvika India Food Pvt. Ltd., Dwarka, New Delhi-110075	02.09.2025
16	Commercial manufacturing of phycobiliproteins and derived formulations for combating fatty liver and other related disorders	M/s Vyoum Biotech Pvt. Ltd. No.77, Rani Bagh, Kasturbgram, Indore- 452020 (M.P.)	15.05.2025
17	Manufacturing/processing of Multigrain Porridge Mix	M/s Godhan Masala Foods Limited, Haryana-131029	18.02.2026
18	Ready to eat Seera in the convenience package	M/s Behatar Himachal, Village Ghulan, P.O Kithera, Tehsil Ghumarwin, Distt Bilaspur-147026 (H.P.)	06.03.2026
	FERMENTATION AND PHYTOFARMING TECHNOLOGY		
19	Production of Naphthoquinone pigment (Shikonin Derivatives) as natural colorants on sustainable basis	M/s Phytopulse Unit of AB Scientific Solutions, B2, Gurukunj, Kesar Bagh Colony, Palampur- 176061 (H.P.)	02.07.2025
20	Development of L-Asparaginase for Pharma and Food Processing Application	M/s Biolaxi Enzymes Pvt Ltd., Thane, Maharashtra	06.03.2026

MATERIAL TRANSFER AGREEMENTS (MTA)

S. No.	Title of Agreement	Name of Party	Date of signing
	AGROTECHNOLOGY		
1	MTA for rosemary (10,000.00 Nos) provided free of cost) under "**CSIR Aroma Mission Phase- III**"	Mr. Jitha Ajay, Co-Founder, Gan Eden Biotic Pvt. Lt., 618, Muniyellappa Garden, Kodihalli, Bengaluru, Karnataka560008	**09.04.2025**
2	MTA for Stevia seeds (100 gm) provided free of cost under project **GAP-0293**	Mr. Munish Data, H.No. 2468, Sri Guru Har Rai Sahib Complex Sector 67, Mohali (Pb)- 160062	**16.04.2025**
3	MTA for Heeng (20 plants) (*Ferula assa-foetida*) plants for trial purpose	Mr. A. C. Katoch, R/o village Rajehar (Kandwadi), Tehsil, Palampur, Distt. Kangra, (H.P.)	**21.04.2025**
4	MTA for *Valeriana jatamansi* plant (100 Nos.) on payment basis provided under project **MLP-0202**	Dr. Sukhbir Singh, Mehar Organic Agro Herbal Farms, Village Kukar Post Office Chaplah Tehsil Rakkar Distt. Kangra 177043 (H.P.)	**24.04.2025**
5	MTA for *Tagetes minuta* seeds (200 g) variety "Him Swarnima" provided free of cost under "**CSIR Aroma Mission Phase- III**"	Dr. Yash Pal Sharma, Principal Scientist & Head, AICRP on Medicinal & Aromatic Plants & Professor & Head Dept of Forest Products, Dr. Y S Parmar University of Horticulture & Forestry, Nauni, Solan-173230 (H.P.)	**27.05.2025**
6	MTA for Wild Marigold seeds (*Tagetes minuta*) (500 gm) variety "Him Swarnima" provided free of cost under "**CSIR Aroma Mission Phase- III**"	Sh. Pankaj Surender Vasudeva S/O Sh. Village Chowki Khalet, Tehsil Palampur, Distt. Kangra (H.P.)	**28.05.2025**
7	MTA for Heeng (50 plants) (*Ferula assa-foetida*) provided free of cost for trial purpose under "**Phytopharmaceutical Mission Phase-III**, Seabuckthorn (50 plants) provided free of cost under "**NMPB Project**" and Lavender (2100 plants) provided free of cost & Lavender (400 plants) @ Rs. 13/- provided under "**CSIR Aroma Mission Phase- III**"	Sh. Ashish Gautam S/O Sh. Tota Ram Village Chamora, Sarahan, Distt. Sirmaur (H.P.)	**30.05.2025**
8	MTA for Tagetes minuta seeds (15 kg) variety "Him Swarnima" and Palmarosa seed (15 kg) provided free of cost under "**CSIR Aroma Mission Phase-III**"	Institute of Natural Resources, (Meghalaya Basin Development Authority) Upper Nongrim Hills Shillong- 793002	**04.06.2025**
9	MTA for Stevia seed (50 gm), Stevia plant (500 nos.), Brahmi (5000 nos.) provided free of cost under **Project GAP-0293** and Rosemary plants (150 nos.) free of cost and Rosemary plants (150 nos.) @Rs. 16 per plant provided under "**CSIR Aroma Mission Phase- III**"	Smt. Asha Devi W/o Sh. Deval Kumar, VPO Paddar, The. Dharamshala, (H.P.) 176052	**05.06.2025**
10	MTA for Chrysanthemum cuttings (500 nos.) provided free of cost under "**CSIR-Floriculture Mission Phase-II**"	Sh. Raj Veer V.P.O Saliana Tehsil Palampur Distt. Kangra (H.P.) 176061	**05.06.2025**
11	MTA for Chrysanthemum cuttings (500 nos.) provided free of cost under "**CSIR-Floriculture Mission Phase-II**"	Sh. Mandeep Mandhotra Village Chudherer, Saliana, Palampur Distt. Kangra (H.P.) 176103	**05.06.2025**
12	MTA for Stevia Plants (2000 Nos.) Bramhi Plants (Bacopa monnieri Variety: CIM- Jagtiti) (1500 Nos.), Palmarosa seeds (1.5Kg), Tulsi seeds (100gm), and Wild Marigold seed Variety "Him Swarnima" (2 Kg) provided free of cost under project "**GAP-0293**" and Rosemary plants (100 Nos.) (Rosemary (50 Nos.) provided free of cost and Rosemary (50 Nos.) provided under "**CSIR-Aroma Mission Phase-III)**	HP Shiva Kisan Sabha, Sh. Govind Singh, Dhanag Tehsil Baijnath Distt. Kangra (H.P.)	**05.06.2025**
13	Material Transfer Agreement (MTA) for aromatic marigold seed Variety "Him Swarnima" (4 Kg) provided free of cost under "**CSIR- Aroma Mission Phase-III**"	Sh. BBL Butail, Bandla Tea Estate Palampur Distt. Kangra- 176061 (H.P.)	**25.06.2025**

S. No.	Title of Agreement	Name of Party	Date of signing
14	MTA for *Valeriana jatamansi* plant (10,000 Nos) provided free of cost under **"GAP-0293"**	Sh. Arun Kumar, S/o Shari Chuni Lal, Ward No.03, Dayala (19) Village- Dayala, Post Office- Jiya, Tehsil- Palampur, Kangra, (H.P.) 176059	**16.07.2025**
15	MTA for *Valeriana jatamansi* Seeds (100 gm) provided free of cost under **"GAP-0293"**	Sh. Ghanshyam Sharma, S/o Sh. Seth Ram Village Jagat Ranuh Kothi Bharmour District Chamba (H.P.)	**16.07.2025**
16	MTA for *Valeriana jatamansi* plant (200 Nos) and Stevia plant (200 Nos) provided free of cost under "GAP-0293"	Sh. Kulwant Kumar S/o Milkhi Ram, Ward No. 01, V.P.O- Bhawarna Tehsil- Palampur, Distt. Kangra (H.P.) -176083	**21.07.2025**
17	MTA for *Ginkgo biloba* plants (05 Nos.) provided under project "MLP-0202"	Ms. Pooja Ridhal, Ph.d Scholar, Supervisor Prof. Priyanka Siwach, Chaudhary Devi Lal University, Sirsa (Haryana)	**24.07.2025**
18	MTA for *Picrorhiza kurroa* plants (5000 Nos.) and German Chamomile seed (100 g) provided free of cost under "MMP075201"	Mr. Trilok Chand S/o Sh. Nank Chand, President, Van Durga Herbal and Medicinal Sangathan, Village Osan, Post Office Diyar, Tehsil Bhunter, Distt Kullu (H.P.)- 175141	**24.07.2025**
19	MTA for carnation rooted cuttings (3000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Ms. Anchal Chauhan PO Janedghat, Bhalawag, Solan, (H.P.) 173218	**17.09.2025**
20	MTA for carnation rooted cuttings (5000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Amit Chauhan PO Janedghat, Bhalawag, Solan, (H.P.) 173218	**17.09.2025**
21	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Anil Kumar S/O Baldev Singh, Damdar, Tehsil Kandaghat, Solan, Himachal Pradesh- 173217	**17.09.2025**
22	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Anirudh Sharma S/O Rajender Krishan Sharma, Chohra (476), Jhjha, Solan, (H.P.) 173217	**17.09.2025**
23	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Anuj Kumar S/O Balak Ram, Village Kot, Tehsil Ghumarwin, Bilaspur, (H.P.) 174028	**17.09.2025**
24	MTA for carnation rooted cuttings (3000 Nos.) provided " **CSIR Floriculture Mission Phase-II".**	Sh. Balwinder Singh S/O Bhadur Singh, Village Naili, PO Mundkhar, Bhoranj, Hamirpur, (H.P.) 176044	**17.09.2025**
25	MTA for carnation rooted cuttings (4000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Champat kala PO Janedghat, Bhalawag, Solan,(H.P.) 173218	**17.09.2025**
26	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Chhavinder Sharma S/O Harinand Sharma, VPO Dhanain, Tehsil and District Shimla, (H.P.) 171007	**17.09.2025**
27	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Dharmender Singh Kanwar S/O Laxmi Singh, VPO Mashobra, Tehsil and District Shimla, (H.P.) 171007	**17.09.2025**
28	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Ms. Diksha C/O Om Prakash, Chohra (476), Jhjha, Solan, (H.P.) 173217	**17.09.2025**
29	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Dinesh Kumar S/O Bhagwan Singh, Hukal, PO Nagali , Tehsil Kandaghat, Solan, (H.P.) 173217	**17.09.2025**
30	MTA for carnation rooted cuttings (5000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Dinesh Kumar S/O Surender Kumar, Village Jhajha, Solan, (H.P.) 173217	**17.09.2025**
31	MTA for carnation rooted cuttings (3000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Ms. Ganga Devi W/O Surender Singh, Sub Tehsil Junga, Kumhali, Shimla, (H.P.) 173217	**17.09.2025**
32	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh.Hari Mohan S/O Het Ram, Village Banehr, Jhajha (451), Tehsil Kandaghat, Solan, (H.P.) 173217	**17.09.2025**
33	MTA for carnation rooted cuttings (5000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Harish Thakur S/O Surender Kumar, Village Jhajha, Solan, (H.P.) 173217	**17.09.2025**

S. No.	Title of Agreement	Name of Party	Date of signing
34	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Hemant Kumar S/O Krishan Dutt, Chohra (476), Jhjha, Solan, (H.P.) - 173217	**17.09.2025**
35	MTA for carnation rooted cuttings (4000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Kamal Kishore S/O Om Prakash, Tikri (433), PO Kawarag, Solan, (H.P.) - 173215	**17.09.2025**
36	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Ms. Kanta Devi W/O Krishan Dutt, Chohra (476), Jhjha, Solan, (H.P.) 173217	**17.09.2025**
37	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Kapil Dev S/O Puran Das, Village Bagna, PO Mashobra, Tehsil and District Shimla, (H.P.) 171007	**17.09.2025**
38	MTA for carnation rooted cuttings (2000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Kesar Singh S/O Ramanand, Village Thada Jubbar, PO Janedghat, Tehsil Jungha, Shimla, (H.P.) 173217	**17.09.2025**
39	MTA for carnation rooted cuttings (5000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Kshma Nand S/O Ram Rattan, PO Nagali, Kanauri, Chail, Solan, (H.P.) 173217	**17.09.2025**
40	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Kuldeep Singh S/O Man Singh, Sakog, Jhajha, Kandaghat Solan, (H.P.) 173217	**17.09.2025**
41	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Man Singh S/O Sukh Ram, Sakog, Jhajha, Kandaghat Solan, (H.P.) 173217	**17.09.2025**
42	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Manmohan Thakur S/O Bhopal Singh Thakur, VPO Mashobra, Tehsil and District Shimla, (H.P.) 171007	**17.09.2025**
43	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Munoo Ram Verma S/O Lobhi Ram Verma, Banjani, PO Janedghat , Tehsil Junga, Shimla, (H.P.) 173217	**17.09.2025**
44	MTA for carnation rooted cuttings (5000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Narender Kumar S/O Rajinder, Tehsil Junga, Janedghat, Shimla, (H.P.) 173217	**17.09.2025**
45	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Neeraj Kumar S/O Babu Ram Thakur, Village Banjani, PO Chail, Tehsil Kandaghat, Solan, (H.P.) 173217	**17.09.2025**
46	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Ms. Niti Bhardwaj S/O Deep Ram, Banehr, Jhajha, Solan,(H.P.) 173217	**17.09.2025**
47	MTA for carnation rooted cuttings (5000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Om Prakash S/O Chain Singh, Shamror, Solan, (H.P.) 173223	**17.09.2025**
48	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Om Prakash S/O Krishan Lal, Chohra (476), Jhjha, Solan, (H.P.) 173217	**17.09.2025**
49	MTA for carnation rooted cuttings (2000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Parmod Singh PO Loharli, Dhatwal, Hamirpur, (H.P.) 176039	**17.09.2025**
50	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Pradeep Kumar S/O Suresh Kumar, Village Ramahan, PO Gumma, Tehsil Sunni, Shimla, (H.P.) 171018	**17.09.2025**
51	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Pradeep Kumar S/O Hari Mohan, Village Banehr, Jhajha (451), Tehsil Kandaghat, Solan, (H.P.) 173217	**17.09.2025**
52	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Praveen Kumar S/O Late Hem Raj, Village Sadhraian, Tehsil Bhoranj, Hamirpur, (H.P.) 176045	**17.09.2025**
53	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Ms. Priya C/O Pradeep Kumar, Village Sakori, PO Chail, Solan, Himachal Pradesh-173217	**17.09.2025**
54	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Ms. Priyanka Verma W/O Sunder SIngh, Village Racholi, PO Khaneri, Rampur, Shimla, (H.P.) 172001	**17.09.2025**

S. No.	Title of Agreement	Name of Party	Date of signing
55	MTA for carnation rooted cuttings (2000 Nos.) provided under " **CSIR Floriculture Mission Phase-II**".	Ms. Pushpa W/O Sanjeev Kumar , Village Sakog Jhajha, Solan, (H.P.) 173217	**17.09.2025**
56	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Raj Verma C/O Om Prakash, VPO Jhajha, Tehsil Kandaghat, Solan, (H.P.) 173217	**17.09.2025**
57	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Rajiv Rajput S/O Jagardeep Rajput, Tehsil Palampur, PO Rajpur, Kangra (H.P.) 176085	**17.09.2025**
58	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Rakesh Thakur S/O Prakash Chand, Bud, Shimla, (H.P.) 173217	**17.09.2025**
59	MTA for carnation rooted cuttings (5000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Rattan Chand S/O Nikka Ram, Village Bahal Arjun, PO Chakmoh, Hamirpur, (H.P.) 176039	**17.09.2025**
60	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Ms. Rekha Verma W/O Susheel Kumar, Tehsil Solan, Jarai, (H.P.) 173214	**17.09.2025**
61	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Rohit Kumar Thakur S/O Yogender SIngh, VPO- Dhanain, Tehsil and District Shimla,(H.P.) 171007	**17.09.2025**
62	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Rohit Kumar S/O Ratan Singh, VPO Dhatikanda, Tehsil and District Shimla, (H.P.) 171007	**17.09.2025**
63	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sahil S/O Ram Gopal , Village Tikri, Kaurag, Solan,(H.P.) 173215	**17.09.2025**
64	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Sandeep Kumar S/O Roop Singh Thakur, VPO Nagali, Tehsil Kandaghat, Solan, (H.P.) 173217	**17.09.2025**
65	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Sandeep S/O Ram Swaroop, PO Nagali, Tikker, Kandaghat, Solan, (H.P.) 173217	**17.09.2025**
66	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Sanjeev S/O Thandi Ram, PO Nagali, Tikker, Kandaghat, Solan, (H.P.) 173217	**17.09.2025**
67	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Ms. Seema W/o Lokender Singh, Banjani, PO Chail, Tehsil Kandaghat, Solan, (H.P.) 173217	**17.09.2025**
68	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Ms. Shakuntla W/o Man Singh, Sakog, Jhajha, Kandaghat Solan, (H.P.) 173217	**17.09.2025**
69	MTA for carnation rooted cuttings (4000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Shali, Hills Farmers Producer Co. Ltd. C/O Manmohan Thakur, VPO Mashobra, Tehsil And District Shimla, (H.P.) 171007	**17.09.2025**
70	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Sudheer S/O Jai Prakash, Jhethna, Tikker, Solan, (H.P.) 173217	**17.09.2025**
71	MTA for carnation rooted cuttings (2000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Sunil Kumar S/O Baldev Singh, Damdar, Tehsil Kandaghat, Solan, (H.P.) 173217	**17.09.2025**
72	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Suresha Nand S/O Chet Ram, Hukal, PO Nagali , Tehsil Kandaghat, Solan, (H.P.) 173217	**17.09.2025**
73	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Vikram Thakur C/O Ruder Dutt, Jhajha (451), Solan,(H.P.) 173217	**17.09.2025**
74	MTA for carnation rooted cuttings (1000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Vikul Verma S/O Geeta Ram, Jhajha Solan, (H.P.) 173217	**17.09.2025**
75	MTA for carnation rooted cuttings (5000 Nos.) provided under " **CSIR Floriculture Mission Phase-II".**	Sh. Virender Kumar Verma S/O Late Daya Ram Verma, Village kanori, Tehsil Kandaghat, Solan, (H.P.) 173217	**17.09.2025**

S. No.	Title of Agreement	Name of Party	Date of signing
76	MTA for *Picrorhiza kurroa* plant (9500 Nos.) provided free of cost under "**CSIR Phytopharmaceutical Mission Phase-III**".	Sh. Ashok Kumar S/O Sh. Dhuni Chand, Village Khangsar, Post Office Ghondhla The Lahoul, Dist Lahaul & Spiti, H.P. 175140	**23.09.2025**
77	MTA for chrysanthemum rooted cuttings (10,000 Nos.) provided under "**CSIR Floriculture Mission Phase-II**"	Sh. Som Dutt, S/o Dhuni Chand, VPO Chakmoh, Barsar, Hamirpur, (H.P.) 176039	**29.09.2025**
78	MTA for chrysanthemum rooted cuttings (15,000 Nos.) provided under "**CSIR Floriculture Mission Phase-II**"	Sh. Ashwani Kumar, VPO Dharer, Tehsil Bajnath, Kangra,(H.P.) 176125	**29.09.2025**
79	MTA for chrysanthemum rooted cuttings (6,000 Nos.) provided under "**CSIR Floriculture Mission Phase-II**"	Sh. Ashok Kumar, VPO Bhattu Samula, Tehsil Palampur, Distt Kangra (H.P.)	**29.09.2025**
80	MTA for chrysanthemum rooted cuttings (5,000 Nos.) provided under "**CSIR Floriculture Mission Phase-II**"	Sh.Pramod Singh, PO Loharli, Dhatwal, Hamirpur, (H.P.)- 176039	**29.09.2025**
81	MTA for chrysanthemum rooted cuttings (5,000 Nos.) provided under "**CSIR Floriculture Mission Phase-II**"	Sh. Pankaj Kumar, VPO Chakmoh, Barsar, Hamirpur, (H.P) 176039	**29.09.2025**
82	MTA for chrysanthemum rooted cuttings (6,000 Nos.) provided under "**CSIR Floriculture Mission Phase-II**"	Sh. Virender Kumar, VPO Bhattu Samula, Tehsil Palampur, Kangra (H.P.)- 176064	**29.09.2025**
83	MTA for chrysanthemum rooted cuttings (10,000 Nos.) provided under "**CSIR Floriculture Mission Phase-II**"	Sh. Pawan Kumar, Village Kalohan, PO Bumbloo, Tehsil Barsar, Distt Hamirpur, (H.P.) 177119	**29.09.2025**
84	MTA for chrysanthemum rooted cuttings (10,000 Nos.) provided under "**CSIR Floriculture Mission Phase-II**"	Sh. Rajender Kumar, Village Kot Kufri, Shogi (95), Shimla (H.P.) 171219	**29.09.2025**
85	MTA for chrysanthemum rooted cuttings (10,000 Nos.) provided under "**CSIR Floriculture Mission Phase-II**"	Sh. Sandeep S/o Madan Lal Chandoli (120), PO Anandpur, Distt Shimla (H.P.) 171219	**29.09.2025**
86	MTA for chrysanthemum rooted cuttings (15,000 Nos.) provided under " **CSIR Floriculture Mission Phase-II**"	Sh. Nitin Kumar, Village Dehlu, PO Dohag, Tehsil Jogindernagar, Mandi, (H.P.) 176120	**29.09.2025**
87	MTA for chrysanthemum rooted cuttings (15,000 Nos.) provided " **CSIR Floriculture Mission Phase-II**"	Sh. Rajesh Kumar, Village Jol, PO Pandol, Tehsil Ladbharol, Mandi, (H.P.) 176126	**29.09.2025**
88	MTA for chrysanthemum rooted cuttings (20,000 Nos.) provided under " **CSIR Floriculture Mission Phase-II**"	Sh. Ajay Kumar, Village Pokhr, PO Gwal Pathar, Tehsil Nadaun, Hamirpur, (H.P.) 177041	**29.09.2025**
89	MTA for Clary sage seed (*Salvia sclarea* L.) (01 kg) provided free of cost under " **CSIR Aroma Mission Phase-III**".	Sh. Manish Chauhan M/s TGG Research Private Limited, Village Kunana, Kot-Chori Road, Kut, Hamirpur (H.P.)- 177027	**24.10.2025**
90	MTA for Heeng (100 plants) (*Ferula assa-foetida*) plants for trial purpose provided free of cost under "**Phytopharmaceutical Mission Phase-III**"	Dr. Kunzes Angmo, Scientist, School of Agriculture Science and Technology, University of Ladakh, Stakna, Leh (UT Ladakh)	**30.10.2025**
91	MTA for Tuberose bulbs (32,200 Nos.) provided under **"CSIR Floriculture Mission Phase-II"**.	Sh. Ghanshyam S/O Besar Ram, PO Devdar, Tehsil Chachyot, Kharsi (147), Mandi, (H.P.)	**31.10.2025**
92	MTA for Tuberose bulbs (20,700 Nos.) provided under **"CSIR Floriculture Mission Phase-II".**	Sh. Lalit Sharma S/O Ramesh Sharma, H. No. 1185 B-1, Near Old Well, VTC Colony, PO- Pinjore, Panchkula, Haryana - 134102	**31.10.2025**
92	MTA for Tuberose bulbs (11,500 Nos.) provided under **"CSIR Floriculture Mission Phase-II".**	Sh. Pritam Chand S/O Late Kirpa Ram, Village Chakmoh (34/8), Hamirpur, (H.P.)	**31.10.2025**
94	MTA for Tuberose bulbs (41,400 Nos.) provided under **"CSIR Floriculture Mission Phase-II"**.	Sh. Sahil S/O Suresh Kumar, Nimar (61), Charkhi Dadri, Haryana - 127308	**31.10.2025**
95	Material Transfer Agreement MTA) for Tuberose bulbs (41,400 Nos.) under **"CSIR Floriculture Mission Phase-II"**.	Sh. Satyander S/O Madan Lal, Nandha(53), Bhiwani, Haryana - 127308	**31.10.2025**
96	MTA for Tuberose bulbs (4,600 Nos.) provided under **"CSIR Floriculture Mission Phase-II**	Sh. Jagraj Jit Singh Binepal C/O Maninder Jit Singh Binepal, Machhian Kalan, Ludhiana, Punjab 141126	**11.11.2025**

S. No.	Title of Agreement	Name of Party	Date of signing
97	MTA for Damask Rose Plant (Jwala variety) (70 Nos.) provided free of cost under "**CSIR Aroma Mission Phase-III**"	Sh. Pawan Kumar, Presiden, Pragati Kisan Kalian Samiti, Sihunta, Chamba	**20.11.2025**
98	MTA for Russian variety of Seabuckthorn mother-stock (50 Nos.) provided free of cost under "**GAP-0293**"	Dr. Komal, Industrial Area, Shed No. 4, Phase II, Nagrota Bagwan, Distt Kangra (H.P.)-176047	**02.12.2025**
99	MTA for Gypsophila plants (500 No.) provided under **"CSIR Floriculture Mission Phase-II".**	Sh. Anil Kumar S/O Brij Lal, Village Majwas, PO Devdhar, Tehsil Chachyot, Mandi -175029, Himachal Pradesh	**17.12.2025**
100	MTA for Gerbera plants (200 No.) and Gypsophila plants (170 No.) provided under **"CSIR Floriculture Mission Phase-II".**	Ms. Anu Devi W/O Rajneesh Kumar, PO- Bumbloo, Tehsil Barsar, Hamirpur, Himachal Pradesh, 174312	**17.12.2025**
101	Material Transfer Agreement MTA) for Gerbera plants (200 No.) and Gypsophila (170 No.) provided under **"CSIR Floriculture Mission Phase-II".**	Sh. Dharam Chand S/O Late Santu Ram, Village Kalohan, PO- Bumbloo, Tehsil Barsar, Hamirpur, Himachal Pradesh, 177119	**17.12.2025**
102	MTA for Gerbera plants (400 No.) and Gyosophila (200 No.) provided under **"CSIR Floriculture Mission Phase-II".**	Sh. Hari Om Sharma S/O Gian Chand Sharma, VPO Sunhi, Tehsil Baroh, Kangra, Himachal Pradesh - 176037	**17.12.2025**
103	MTA for Gerbera plants (600 No.) and Gypsophila plants (340 No.) provided under **"CSIR Floriculture Mission Phase-II".**	Sh. Harish Kumar S/O Dina Nath, Village Tiar, PO Khurwain, Tehsil Bangana, Una, Himachal Pradesh - 174321	**17.12.2025**
104	MTA for Gerbera plants (450 No.) provided under **"CSIR Floriculture Mission Phase-II".**	Sh. Kartar Singh S/O Balwant Singh, PO - Chakmoh, Tehsil Barsar, Hamirpur, Himachal Pradesh - 176039	**17.12.2025**
105	MTA for Gerbera plants (340 No.) provided under **"CSIR Floriculture Mission Phase-II".**	Sh. Manjeev Singh S/O Dharam Chand, PO Thunag , Mandi, Himachal Pradesh -175048	**17.12.2025**
106	MTA for Gerbera plants (550No.) and Gypsophila plants (400No.) provided under **"CSIR Floriculture Mission Phase-II".**	Sh. Manjinder Singh Grewal S/O Karnail Singh, Malakpur, PO- Malakpur, District Ludhiana, Punjab-142027	**17.12.2025**
107	MTA for Gerbera plants (340 No.) provided under **"CSIR Floriculture Mission Phase-II".**	Sh. Mohar Singh S/O Veer Singh, PO Thunag , Mandi, Himachal Pradesh -175048	**17.12.2025**
108	MTA for Gerbera plants (450 No.) provided under **"CSIR Floriculture Mission Phase-II".**	Sh. Mohinder Kumar S/O Saran Dass, Village Ghiana Khurd PO- Jheol, Tehsil Dharamshala, Kangra, Himachal Pradesh - 176001	**17.12.2025**
109	MTA for Gerbera plants (450 No.) provided under **"CSIR Floriculture Mission Phase-II".**	Sh. Narender Singh S/O Ajit Singh, Village Samaila, PO - Maharal, Tehsil Barsar, Hamirpur, Himachal Pradesh - 176049	**17.12.2025**
110	MTA for Gerbera plants (450 No.) provided under **"CSIR Floriculture Mission Phase-II".**	Sh. Rakesh Kumar S/O Rattan Chand, Village Kallar PO Bankhandi, Tehsil Dehra, Kangra, Himachal Pradesh - 177114	**17.12.2025**
111	MTA for Gerbera plants (500No.) and Gypsophila plants (400 No.) provided under **"CSIR Floriculture Mission Phase-II".**	Ms. Reena Devi W/O Rajeev Kumar, Village Makteri, PO- Bhakreri, Tehsil Barsar, Hamirpur, Himachal Pradesh -174305	**17.12.2025**
112	MTA for Gypsophila plants (340 No.) provided under **"CSIR Floriculture Mission Phase-II".**	Sh. Manjeev Singh S/O Dharam Chand, PO Thunag , Mandi, Himachal Pradesh -175048	**17.12.2025**
113	MTA for Gerbera plants (200 No.) and Gypsophila plants (680 No.) provided under **"CSIR Floriculture Mission Phase-II".**	Ms. Sheela Devi W/O Bahadur Singh, Village Naily, PO- Mundhkhar, Tehsil Bhoranj, Hamirpur, Himachal Pradesh, 176044	**17.12.2025**
114	MTA for Gerbera plants (200 No.) provided under **"CSIR Floriculture Mission Phase-II".**	Sh. Suresh Kumar S/O Madan Lal, Village Narwana PO Yol, Tehsil Dharamshala, Kangra, Himachal Pradesh - 176052	**17.12.2025**
115	MTA for Bacopa Monnieri (4,000 Nos.) provided under project "**MLP-0202**"	Sh. Zahid Hussain, Inhydro Private Ltd., Village Siamipur Taprian, Tehsil- Kharar, SAS Nagar, Punjab, 140301	**23.12.2025**
116	MTA for Gypsophila plants (200 No.) provided under "**CSIR Floriculture Mission Phase-II"**	Sh. Chain Singh S/O Naranu Ram, Kot, Solan, Himachal Pradesh -173217	**29.12.2025**

S. No.	Title of Agreement	Name of Party	Date of signing
117	MTA for Gypsophila plants (200 No.) provided under **"CSIR Floriculture Mission Phase-II"**	Sh. Durga Dutt S/O Harnam Singh, PO Kawaraag, Solan, Himachal Pradesh -173215	**29.12.2025**
118	MTA for Gypsophila plants (200 No.) provided under **"CSIR Floriculture Mission Phase-II"**	Sh. Chain Singh S/O Durga Singh, Village Shamror, Solan, Himachal Pradesh -173221	**29.12.2025**
119	MTA for Gypsophila plants (200 No.) provided under **"CSIR Floriculture Mission Phase-II"**	Sh.Harish Thakur S/O Surender Kumar, Jhajha, Solan, Himachal Pradesh -173217	**29.12.2025**
120	MTA for Gypsophila plants (200 No.) provided under **"CSIR Floriculture Mission Phase-II"**	Ms. Hera Devi W/O Ajay Kumar, Village Samol, Garkhal, Solan, Himachal Pradesh 173201	**29.12.2025**
121	MTA for Gypsophila plants (200 No.) provided under **"CSIR Floriculture Mission Phase-II"**	Sh. Jeevan Mehta S/O Pushpender Singh, Village Bhulra, Daghil (485), Solan, Himachal Pradesh -173217	**29.12.2025**
122	MTA for Gypsophila plants (200 No.) provided under "CSIR Floriculture Mission Phase-II"	Sh. Joginder S/O Babu Ram Hokal (493) Nagali, Solan, Kandaghat, Himachal Pradesh -173217	**29.12.2025**
123	MTA for Gypsophila plants (200 No.) provided under **"CSIR Floriculture Mission Phase-II"**	Ms. Kusum C/O Om Prakash, Village Shamror, Solan, Himachal Pradesh -173221	**29.12.2025**
124	MTA for Gypsophila plants (200 No.) provided under **"CSIR Floriculture Mission Phase-II"**	Ms. Madhu W/O Netar Singh, Jhajha, Solan, Himachal Pradesh -173217	**29.12.2025**
125	MTA for Gypsophila plants (200 No.) provided under **"CSIR Floriculture Mission Phase-II"**	Ms. Kusum W/O Durga Singh, Village Samol, Garkhal, Solan, Himachal Pradesh 173201	**29.12.2025**
126	MTA for Gypsophila plants (200 No.) provided under **"CSIR Floriculture Mission Phase-II"**	Ms. Meenakshi C/O Tek Chand, VTC Bayla Balahu, PO Nayagram, Solan, Himachal Pradesh - 173220	**29.12.2025**
127	MTA for Gypsophila plants (200 No.) provided under **"CSIR Floriculture Mission Phase-II"**	Sh. Mohit Thakur C/O Ram Gopal Thakur, Village Chabri, PO Jhaja, Solan, Himachal Pradesh -173217	**29.12.2025**
128	MTA for Gypsophila plants (200 No.) provided under **"CSIR Floriculture Mission Phase-II"**	Sh. Narender Kumar Thakur S/O Om Prakash Thakur, PO Maniyat Deora, Solan, Himachal Pradesh -1732078	**29.12.2025**
129	MTA for Gypsophila plants (200 No.) provided under **"CSIR Floriculture Mission Phase-II"**	Sh. Nitika W/O Rajesh Kumar, Village Brahmna, PO Jobri, Solan, Himachal Pradesh -173221	**29.12.2025**
130	MTA for Gypsophila plants (200 No.) provided under **"CSIR Floriculture Mission Phase-II"**	Sh. Om Prakash S/O Deep Ram, Village Karadug, Tehsil Kasauli, Koti, Solan, Himachal Pradesh -173209	**29.12.2025**
131	MTA for Gypsophila plants (200 No.) provided under **"CSIR Floriculture Mission Phase-II"**	Ms. Parveen Kumari W/O Parveen Kumar, Kaba Kalan, Solan, Himachal Pradesh - 173229	**29.12.2025**
132	MTA for Gypsophila plants (200 No.) provided under **"CSIR Floriculture Mission Phase-II"**	Sh. Pawan Mehta S/O Pushpender Mehta, Tehsil Kandaghat Dangheel Solan, Himachal Pradesh -173217	**29.12.2025**
133	MTA for Gypsophila plants (200 No.) provided under **"CSIR Floriculture Mission Phase-II"**	Sh. Praveen Kumar S/O Muni Lal, Kaba Dhar Gora, Solan, Himachal Pradesh - 173229	**29.12.2025**
134	MTA for Gypsophila plants (200 No.) provided under **"CSIR Floriculture Mission Phase-II"**	Ms. Priya C/O Pradeep Kumar, Sakori, PO Chail, Solan, Himachal Pradesh -173217	**29.12.2025**
135	MTA for Gypsophila plants (200 No.) provided under **"CSIR Floriculture Mission Phase-II"**	Sh. Puran Chand S/O Krishan Lal, Bayla Balahu, PO Nayagram, Solan, Himachal Pradesh - 173220	**29.12.2025**
136	MTA for Gypsophila plants (200 No.) provided under **"CSIR Floriculture Mission Phase-II"**	Ms. Radha W/O Hem Ram, Village Samol, Garkhal, Solan, Himachal Pradesh 173201	**29.12.2025**
137	MTA for Gypsophila plants (200 No.) provided under **"CSIR Floriculture Mission Phase-II"**	Sh. Rajat Thakur S/O Pratap Singh, Mahog, PO Chail, Solan, Himachal Pradesh -173217	**29.12.2025**
138	MTA for Gypsophila plants (200 No.) provided under **"CSIR Floriculture Mission Phase-II"**	Sh. Rajneesh S/O Puran Chand, Village Shamror, Solan, Himachal Pradesh -173223	**29.12.2025**

S. No.	Title of Agreement	Name of Party	Date of signing
139	MTA for Gypsophila plants (200 No.) provided under **"CSIR Floriculture Mission Phase-II"**	Sh. Ravinder Kumar S/O Om Prakash, Palech, Kandaghat, Solan, Himachal Pradesh -173215	**29.12.2025**
140	MTA for Gypsophila plants (200 No.) provided under **"CSIR Floriculture Mission Phase-II"**	Ms. Ruchi W/O Gurcharan Singh,Village Bhuira, Danghil (485), Dangheel, Solan, Himachal Pradesh -173217	**29.12.2025**
141	MTA for Gypsophila plants (200 No.) provided under **"CSIR Floriculture Mission Phase-II"**	Sh. Sahil S/O Ram Gopal,Village Tikkri, Kuarag (435),Solan, Himachal Pradesh -173215	**29.12.2025**
142	MTA for Gypsophila plants (200 No.) provided under **"CSIR Floriculture Mission Phase-II"**	Ms. Savitri Devi W/O Sohan Lal, Tehsil Arki, Jiawala, Khararhatti, Solan, Himachal Pradesh 173207	**29.12.2025**
143	MTA for Gypsophila plants (200 No.) provided under **"CSIR Floriculture Mission Phase-II"**	Sh. Sumit Kumar S/O Sohan Lal Tehsil Solan, Himachal Pradesh -173214	**29.12.2025**
144	MTA for Gypsophila plants (200 No.) provided under **"CSIR Floriculture Mission Phase-II"**	Sh. Sunil Mehta S/O Surender Mehta, Sub Tehsil Junga, Kumhali, Shimla, Himachal Pradesh -173217	**29.12.2025**
145	MTA for Gypsophila plants (200 No.) provided under **"CSIR Floriculture Mission Phase-II"**	Ms.Teena D/O Sohan Lal, Tehsil Arki, PO Khararhatti, Solan, Himachal Pradesh -173207	**29.12.2025**
146	MTA for Stevia seeds (100 gm) provided under project **MLP-0202.**	Sh. Praveen Kumar S/o Sh. Hans Raj, Village Jaral, Post Office Chakmoh, Tehsil Barsar, Distt Hamirpur (H.P.) 176093	**16.01.2026**

MISCELLANEOUS MOUs

S. No.	Title of Agreement	Name of Party	Date of signing
	AGROTECHNOLOGY		
1	MoU for joint collaboration in the area of Floriculture	Box and Pots Pvt Ltd, Village Ambari, Tikka Panther,Ward No. 7 Post Office MalanTehsil Nagrota Bagwan Distt. Kangra, Himachal Pradesh- 176047	**15.05.2025**
2	MoU for area of products based on CSIR-IHBT Technology and essential oils	Sh. Gurinder Kumar Vashist, Prop. Himagrow Herbs, V.P.O Banuri, Tehsil Palampur, District Kangra, (H.P) 176061	**26.05.2025**
3	MoU for Joint collaboration in the area of aromatic crops, essential oils, floriculture, tissue culture and/or any other area	Him Agro Farmer Producer Company Ltd. Saklana Tehsil Dharampur, District Mandi, (H.P.) 175040	**24.07.2025**
4	MoU for R&D Cooperation in the area of floricutlure and/or any other area	Florance Flora, 383/A, Rajiv Gandhi Nagar, NTI Housing Society, 2nd Phase, Bangalore-560097, Karnataka, India	**27.09.2025**
5	MoU for R&D Cooperation in the area of floricutlure and/or any other area	Darjeeling Gardens Pvt. Ltd., 3rd Floor, Janpath House, Seth Srilal Market, Sevoke More, Siliguri- 734001, West Bengal, India	**27.09.2025**
6	MoU for R&D cooperation in the area of Tulip early flowering using AI tools, and/ or any other area	Future AG, 4/640, 12th Link, 3rd Cross St, Venkateswara Colony, Nehru Nagar, Perungudi, Chennai, Tamil Nadu 600096, India	**08.10.2025**
7	MoU for install distillation unit for extraction of essential oils under "**CSIR Aroma Mission Phase-III**'	Mehar Singh Foundation, Village Kukahar, Tehsil Rakkad, Distt Kangra- 177043 (H.P.)	**11.11.2025**
8	MoU for installation of distillation unit for extraction of essential oils under "**CSIR Aroma Mission Phase-III**'	Nagrota Surian Farmers producer Company Ltd., Tiukari Mawa Jawali, Jawali, Distt kangra - 176023 (H.P.)	**19.11.2025**
	BIOTECHNOLOGY		
9	Tri Party MoU for biochar from local bioresources	HIM AGRO Farmer Producer Company Limited,VPO Saklana, Tehsil Dharampur, District Mandi, Himachal Pradesh – 175040 Corporate Office: 50, Morthikri, Tehsil Dera Bassi, District Mohali, Punjab – 140506 and Vishal Himachal Mahasangh, Registered Office: 1343 (Basement), Sector 26, Panchkula, Haryana–134116	**10.12.2025**

S. No.	Title of Agreement	Name of Party	Date of signing
	CHEMICAL TECHNOLOGY		
10	MoA for advanced technical textile Solution (Joint Project Proposals)	Vijya Wellness and Biosciences LLP, 46/17, Plumeria, Dera Mandi, New Delhi- 110074	**24.05.2025**
11	Confidentiality Agreement for Herbal formulations from Aescin as anti-inflammatory vasprotective, anti-edematous for varicose veins: (ointment/ capsules/tablets).	M/s Himalayan Herbs & Products, Prabhu Chhaya Bhawan, Baijnath Road, Palampur-176061 (H.P.)	**11.11.2025**
12	Confidentiality Agreement for "Process for 5-HMF Production".	M/s Dhampur Sugar Mills, Dhampur, Distt Bijnor, Uttar Pradesh 246761	**19.01.2026**
	DIETETICS & NUTRITION TECHNOLOGY		
13	MoU for Value addition/processing of cannabis and hemp for industrial and medicinal purpose	Vijya Wellness and Biosciences LLP. 46/17, Plumeria, Dera Mandi Greens, New Delhi 110074 Regional office- Joginder Nagar, District Mandi (H.P.)	**15.05.2025**
	ENVIRONMENTAL TECHNOLOGY		
14	Mou for mapping and value added services in fields using RS-GIS	M/s Excel Geomatics Pvt. Ltd., A-67, SF, Parsvnath Paradise, Mohan Nagar, Ghaziabad Uttar Pradesh- 201007	**01.05.2025**
	FERMENTATION AND PHYTOFARMING		
15	Confidentiality Agreement for upscaling/ commercializing above technologies and for joint project to develop other technologies	Human Healers, Opposite Base Hospital gate Srikot Ganganali Srinagar Garhwal - 246174 Distt Pauri, Uttarakhand, India	**03.07.2025**
16	Confidentiality Agreement for Sustainable sourcing of valepotriates usin Valeraian Jatamansi adventitious roots	M/s Netrasetu Eyecare LLP, 3rd Floor, Hilife Premises Soc, PM Road, Mumbai- 400054, India	**29.11.2025**
17	Tri Party NDA (Non Disclosure Agreement) for analytical testing of the HIMASNASE enzyme	M/s Biolaxi Enzymes Pvt. Ltd., Babosa Industrial Park, A-2/110, Mumbai Nashik Highway, Saravali Village, Behind Hotel Vatika, Kalyan, Bhiwandi- 421302, Maharashtra, India and National Research Development Corporation (NRDC), Anusandhan Vikas, 20-22, Zamroodpur Community Centre, Kailash Colony Extension, New Delhi-110048, India	**22.12.2025**
18	Confidentiality Agreement for Production of Bioactives using Plant Cell and Tissue culture	M/s Tangerine Biosciences (Unit Shree Shyam Pipes Pvt Ltd), Farm 2, 8th Avenue, Bandh Road, New Delhi 110047	**09.01.2026**
	MISCELLANEOUS		
19	MoU for facilities and service to the employees, Officers/officials of the industry to her people connected with CSIR-IHBT (adventure activities)	H.P Tourism Development Corporation Ltd., RITG, Annexe, Shimla 171001, represented by its AGM HPTDC Hotel Tea Bud Palampur	**16.06.2025**
20	MoU for promotion and facilitation of "Development of Pharmacopoeial Monographs, Botanical, Phytochemical Reference Standards and Pharmacological studies"	Pharmacopoeia Commission for Indian Medicine and Homoepathy (PCIM&H), Raispur, Ghaziabad, Uttar Pradesh	**02.07.2025**
	ACADEMICS		
21	MoU for R&D and Academic Collaborations	Laureate Institute of Pharmacy, Jawalaji-Kangra (H.P.) – 176031 (H.P.)	**03.04.2025**
22	MoU for R&D and Academic Collaborations	ICMR- Regional Research Centre, Gorakhpur (U.P.) - 273013	**26.05.2025**
23	MoU for R&D and Academic Collaborations	Dr. Deepak Sharma, Registrar, Tripura University, Suryamaninagar, Tripura (W) Pin- 799022	**02.07.2025**
24	MoU for R&D and Academic Collaborations	Pandit Sant Ram Govt. Degree College, Baijnath, kangra (H.P.) - 176125	**03.04.2025**
25	MoU for Research and Academic activities	Goswami Ganesh Dutt Sanatan Dharam College (GGDSD), Rajpur (Palampur) 176067	**25.04.2025**
26	MoU for Research and Academic activities	SCVB Govt. Degree College, Palampur, Kangra (H.P.) 176061	**16.05.2025**

S. No.	Title of Agreement	Name of Party	Date of signing
27	MoU for R&D Cooperation in the area of bioinformatics and computational biology research	Genomic Valley Bharat Pvt. Ltd. (GVBPL), 2nd Floor G74, Pushkar Enclave, Paschim Vihar, New Delhi, India- 110063	09.10.2025
28	MoU for Academic and R&D Co-operation	National Research Institute of Chinese Medicine (NRICM), Ministry of Health and Welfare, Taiwan	19.11.2025
29	MoU for R&D and Academic Collaborations	National Institute of Pharmaceutical Education and Research (NIPER), S.A.S Nagar, Punjab 160062	**26.02.2026**
30	MoU for R&D and Academic Collaborations	Chitkara University, SCO 160-161, Sector 9-C, Chandigarh- 160009, India	**06.03.2026**

AGREEMENTS WITH INCUBATEES

S. No.	Title of Agreement	Name of Party	Date of signing
	INCUBATEES		
1	Agreement for infrastructure and facility for plant tissue culture (vitro propagation of potato and apple.	Plant Hub Biotech Pvt. Ltd., Village Chamyowal, P.O. Sujhaila, Tehsil Arki, Distt Solan- 173208, (H.P.)	**02.07.2025**
2	Agreement for production Osyter mushrroom per batch capacity (100 kg fresh Oyster mushroom) (Facility use)	M/s. Neugal Farms, Ward No. 11, Rajpur Chowk, Tehsil Palampur District Kangra (H.P.) 176 061	**08.10.2025**
	Need Based Agreement		
1	Outsourced Service Agreement for Testing and Evaluation of Microalgae-Based Biostimulant Product	Sahyadri Farms Post Harvest Care Limited, Gat No. 314/1, 314/2/1, A/P. Mohadi, Taluka- Dindori, District- Nashik- 422207, Maharashtra	**20.06.2025**
2	Need Based Agreement for R&D Bioefficacy evaluation of malt based food products as nutrition supplement (GrowVita product range)	Mahalaxmi Malt Products Pvt Ltd., Village Rehrana, Tehsil and Distt Palwal, Haryana-121102	**02.09.2025**
	CONSULTANCY		
1	Consultancy Agreement for "Utilization of pine needle into biochar, compost and other waste resource (only dry leaves and kitchen waste)"	Vaseeyat Eco Foundation, Unit Industrial Area Har, V.P.O Bani, Tehsil Barsar, Distt Hamirpur (H.P.) 174304	**10.02.2026**

CSIR MISSION PROJECTS

CSIR-AROMA MISSION

Nodal: Dr. Sanjatsujat Singh

Co-Nodal: Dr. Rakesh Kumar

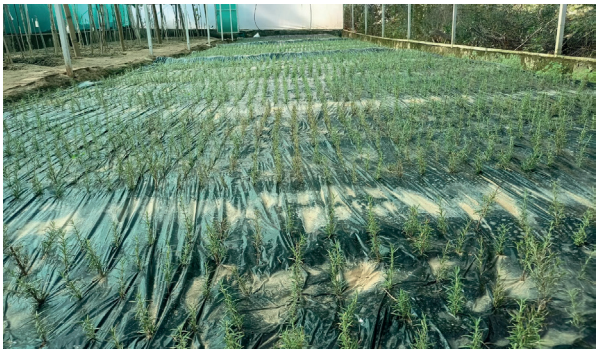
CSIR-IHBT INTERVENTIONS UNDER CSIR-AROMA MISSIONCSIR-AROMA MISSION

Generation of quality planting material:

High-quality planting materials of selected aromatic crops were successfully developed at CSIR–IHBT, Palampur and distributed to farmers with the objective of promoting the cultivation of aromatic crops on degraded and waste lands. This initiative aimed to enhance the utilization of underproductive land resources while providing farmers with a sustainable livelihood option. The planting materials were supplied as part of a broader effort to promote aromatic crop-based agro-economy in rural areas. Detailed information regarding the quantity and type of planting material distributed during the period from April 2025 to March 2026 is presented in Table 1.

Table 1. Generation of planting material under CSIR-Aroma Mission Phase III

S. No.	Crops	Planting material generated	Planting material distributed
1	Aromatic marigold seeds	1000 kg	46 kg
2	Damask rose	25000 plants	3037 plants
3	Rosemary	26000 plants	12000 plants
4	Rose-scented Geranium	26000 plants	11000 plants
5	Chamomile seeds	100 kg	20 kg
6	Lavender	25000 plants	750 plants
7	Tulsi seed	100 kg	30 kg
8	Lemongrass slips	10 lakh	5 lakh



Rose-scented Geranium **Rosemary**

Lemon grass **Damask rose**

Fig. 1 Generation and distribution of quality planting material of aromatic crops.

Training and awareness programmes for skill development: 18

Between April 2025 and March 2026, a total of twenty-two awareness-cum-training programs were conducted to educate farmers on improved agro-technologies and processing methods related to aromatic crops (**Table 2**). These programs aimed to build the capacity of farmers by offering in-depth, practical knowledge on key areas such as land preparation, field layout, nutrient and weed management, pest and disease control, post-harvest handling, essential oil extraction, value addition, marketing strategies and establishing linkages with the fragrance and flavor industry.

Table 2. Awareness cum training programs conducted during April 2025 to March 2026 on cultivation and process technologies of aromatic crops

S. No.	State/U.T	District	Location of trainings	Date	Total Men	Total Women	Total
1	Himachal Pradesh	Chamba	Vill. Samra, Bharmour	16/06/2025	25	19	44
2	Himachal Pradesh	Kullu	Kullu	19/06/2025	12	0	12
3	Himachal Pradesh	Lahaul Spiti	Lahaul Spiti	20/06/2025	33	21	54
4	Himachal Pradesh	Lahaul Spiti	Lahaul Spiti	21/06/2025	15	17	32
5	Himachal Pradesh	Lahaul Spiti	Lahaul Spiti	22/06/2025	10	4	14
6	Himachal Pradesh	Kangra	CSIR-IHBT	26/09/2025	15	08	23
7	Meghalaya	East Khasi Hills	Vill. Phlangwanbroi, Meghalaya	02/11/2025 - 04/11/2025	50	50	100
8	Himachal Pradesh	Kangra	CSIR-IHBT	10/11/2025	2	1	3
9	Himachal Pradesh	Kangra	CSIR-IHBT	13/11/2025	39	1	40
10	Himachal Pradesh	Kangra	CSIR-IHBT	01/12/2025	17	3	20
11	Himachal Pradesh	Kangra	CSIR-IHBT	12/12/2025	8	9	17
12	Himachal Pradesh	Kangra	CSIR-IHBT	07/01/2026	14	12	26
13	Himachal Pradesh	Kangra	CSIR-IHBT	13/01/2026	5	10	15
14	Himachal Pradesh	Kangra	CSIR-IHBT	21/01/2026	35	13	48
15	Himachal Pradesh	Kangra	CSIR-IHBT	06/02/2026	26	0	26
16	Himachal Pradesh	Chamba	Vill. Talla, Chamba	10/02/2026	10	0	10
17	Punjab	Barnala	Vill. Rure ke Kalan	14/02/2026	5	0	5
18	Himachal Pradesh	Kangra	CSIR-IHBT	11/03/2026	48	0	48
Total					**369**	**168**	**537**

Skill Development Programmes: 4

Table 3. Skill development programs conducted by CSIR-IHBT

S. No.	State/U.T	District	Location of training	Date	Total Men	Total Women	Total
1	Himachal Pradesh	Kangra	CSIR-IHBT	06/10/2025 - 07/10/2025	32	0	32
2	Himachal Pradesh	Kangra	CSIR-IHBT	28/10/2025	17	01	18
3	Himachal Pradesh	Kangra	CSIR-IHBT	19/11/2025 -20/11/2025	100	50	150
4.	Tripura	Agartala	Tripura University and the NB Institute for Rural Technology (NBIRT), West Tripura	04/01/2026- 06/01/2026	40	20	60
Total					**189**	**71**	**250**

Fig. 2 Training and awareness activities for farmers were conducted across tribal areas of Kullu, Chamba, and Lahaul & Spiti in June 2025 under Aroma Mission Phase III.

Fig. 3 Training program for students and army officers at IHBT Chandpur farm.

Fig. 4 Training and awareness activities for farmers of Reasi district, J&K.

Fig. 5 Exposure visit by NABARD, Punjab and Horticulture Department, Kullu.

Fig. 6 Exposure visit by Agriculture students of Banaras Hindu University.

Fig. 7 Promoting cultivation of aromatic crops through field exposure and technical training for farmers from Mandi, Chamba and Jammu and Kashmir.

Fig. 8 CSIR IHBT organized a two-day training session on “Helping Jammu Farmers Turn Challenges into Fragrant Profits” held on 6–7 October 2025.

Fig. 9 CSIR-IHBT Palampur, organized a one-day workshop on “Value Addition of Himalayan Essential Oils and Their Marketing Regulation" in association with the Himalayan Phytochemical and Growers Association (HIMPA) on October 28, 2025 under CSIR AROMA Mission Phase III.

Fig. 10 CSIR-IHBT, Palampur extended support to farmers of Meghalaya to promote aromatic crops and enhance livelihoods, as Dr. Sudesh Kumar Yadav, Director, CSIR-IHBT, along with scientists visited the state from 2–4 November 2025 to monitor CSIR–Aroma Mission Phase III activities and explore collaborations.

Fig. 11 CSIR-IHBT organized a two-day Marketing Linkage and Skill Development Workshop on "Empowering Chamba (Aspirational District)" on 19–20 November 2025, focusing on sustainable growth through advanced technologies for agriculture, rural livelihoods, health, and nutritional security.

Fig. 12 CSIR-IHBT Explores Collaboration and Promotes Aromatic Crops in Tripura under CSIR-Aroma Mission Phase III.

Fig. 13 Field visits and training program were conducted at Vill. Talla and Vill. Kamla, District Chamba (Himachal Pradesh) on February 10, 2026 and at Vill. Rure ke kalan, District Barnala, Punjab under Aroma Mission Phase III.

Fig.14 Farmers developed a range of value-added products using technologies transferred by CSIR–IHBT, enhancing both product diversity and market potential.

CSIR FLORICULTURE MISSION

Nodal: Dr. Bhavya Bhargava

Co-Nodal: Dr. Poonam Kumari

The CSIR Floriculture Mission aims to enhance farmers' incomes and promote entrepreneurship through high-value floriculture, leveraging CSIR-developed technologies. CSIR–IHBT is implementing the mission across six verticals. The vertical-wise progress for the period April 2025 to March 2026 is summarized below:

To support the large-scale expansion of floriculture, the institute focused on generating quality planting material. During the reporting period, approximately 50.72 lakh planting materials were produced.

A total area of 161.50 hectares was brought under floricultural cultivation. Crop-wise area coverage included: Marigold (139.77 ha), Chrysanthemum (5.22 ha), Gladiolus (5.10 ha), Lilium (0.32 ha), Gypsophila (0.31 ha), Gerbera (0.32 ha), Carnation (1.53 ha), Tuberose (0.17 ha), Cut rose (0.53 ha), Loose rose (3.12 ha), Limonium (3.30 ha), Sunflower (0.50 ha), Eustoma (0.11 ha), Tulip (0.75 ha), Calla Lily (0.33 ha), and Orchid (0.12 ha).

In addition, around 68.29 lakh units of quality planting material were distributed to farmers across Himachal Pradesh, Punjab, Haryana, Uttarakhand, and Ladakh (UT), benefiting approximately 1,290 farmers.

A total of 38 awareness-cum-training programs on floriculture, including bulbous crops, were organized. These programs trained more than 930 participants, including unemployed youth, rural women, and farmers.

Under urban floriculture initiatives, CSIR–IHBT, Palampur, established 49 floriculture gardens and 10 vertical gardens at prominent public locations during 2025–26.

Under Vertical D (Post-harvest and Value Addition), several technologies were developed, including:

- Microencapsulation of marigold carotenoids
- Edible flower-enriched fruit bars and pasta
- Flavor-infused honey products
- Aromatic and non-aromatic floral wax

These innovations have applications in nutraceutical, food, cosmetic, pharmaceutical, and coating industries.

Under the Floriculture Mission Phase II (2025–2026), efforts were made to strengthen collaborations. A total of 163 Material Transfer Agreements (MTAs) were signed with farmers and schools across different states, along with 5 Memoranda of Understanding (MoUs). Additionally, 5 Pushp Krishi Melas were organized, facilitating direct interaction with farmers on various floriculture practices.

Under **Varietal Development**, four novel chrysanthemum lines-CSIR-IHBT-CH-14-9, CSIR-IHBT-CH-14-12, CSIR-IHBT-CH-18-1, and CSIR-IHBT-CH-18-6 were developed through hybridization and clonal selection. Of these, three entries have been submitted to AICRP trials, while one has been submitted to PPV&FRA for registration. In Lilium, clonal multiplication of selection **CSIR-IHBT-LH-3-4** is currently in progress.

Plant material distribution of Tuberose to Panchkula, Haryana farmers

Training to college students of KLB Government College, Kangra

Carnation field of farmers of Bilaspur, HP

Planting of lilium bulbs at farmers field, Solan

Carnation and Gypsophila field of farmers of Shimla and Solan H.P.

Packaging of carnations at farmers field, Hamirpur

Farmer, Industry, Startup meet at Palampur, H.P, 25.05.2025

On-site field trainings and awareness programs on lilium cultivation at Drass, Ladakh

WASTE TO WEALTH: COMPREHENSIVE SOLUTIONS TOWARDS CIRCULAR ECONOMY AND SUSTAINABILITY

Theme: CSIR Mission Mode Project

Principal Investigator: Dr. Sarita Devi and Dr. Aparna Maitra Pati

The CSIR Waste-to-Wealth Mission aims to promote sustainable waste management by converting waste into valuable resources, supporting the vision of a zero-waste, zero-landfill nation. Under the aegis of the Council of Scientific and Industrial Research (CSIR), all 38 laboratories are contributing to this mission through innovative technologies. In this context, the CSIR–Institute of Himalayan Bioresource Technology (CSIR-IHBT) is developing microbial and process-based solutions tailored to the Himalayan region, particularly focusing on low-temperature waste degradation.

A major research focus at CSIR-IHBT is the development of psychrotrophic microbial consortia for efficient anaerobic digestion of organic waste. A laboratory-scale study was conducted over 16 weeks using four 50 L anaerobic digesters to evaluate the performance of a hydrolytic microbial consortium. The treatment reactors (T1 and T2), supplemented with a consortium of 14 hydrolytic bacterial strains, showed significantly improved performance compared to control reactors (C1 and C2). Total solids reduction was highest in T1 (49.89%) and T2 (32.93%), compared to minimal reductions in controls. Similarly, volatile solids reduction reached 47.04% in T1 and 41.23% in T2, indicating enhanced degradation of organic matter. The carbon-to-nitrogen (C/N) ratio remained within an optimal range in treatment reactors, ensuring process stability. Volatile fatty acid (VFA) degradation was also higher in T1 (43.85%) and T2 (29.86%), reflecting improved metabolic activity. Biogas production was significantly enhanced, with T1 producing the highest cumulative volume (1757 L), followed by T2 (1044.2 L). Methane content reached approximately 65% in T2, indicating efficient methanogenesis. However, challenges such as pH drop and VFA accumulation were observed, which affected process efficiency and highlighted the need for further optimization, especially under cold climatic conditions.

In addition to biomethanation, CSIR-IHBT is developing technologies for converting fecal sludge into nutrient-rich compost through co-composting with kitchen waste. An in-vessel composting system was established to evaluate different substrate ratios with and without microbial consortia. The inoculated treatments demonstrated enhanced thermophilic activity, faster decomposition, and improved compost stabilization. Nutrient analysis revealed enrichment of nitrogen, phosphorus, and potassium, making the compost suitable for agricultural use. Compost maturity was assessed through indicators such as reduction in total organic carbon, stabilization of C/N ratio, and neutral pH. Electrical conductivity remained within safe limits, and heavy metal concentrations were found to be within permissible standards. Pathogen analysis confirmed the absence of harmful microbes such as coliforms and Salmonella, ensuring biosafety. Phytotoxicity tests using Solanum lycopersicum seeds showed 100% germination and high vigor in optimized treatments, confirming compost maturity and safety. Further validation through pot experiments with *Triticum aestivum* and *Coriandrum sativum* demonstrated enhanced plant growth when compost was fortified with plant growth-promoting rhizobacteria. Additional trials using *Tagetes erecta* confirmed significant improvements in root and shoot development. Overall, the work at CSIR-IHBT demonstrates the potential of microbial consortia-based technologies for integrated waste management, renewable energy generation, and sustainable agriculture in Himalayan regions.

EMPOWERING FARMERS THROUGH CULTIVATION OF LOW-CHILLING VARIETIES OF APPLE IN NORTH EASTERN STATES

Project Investigation: Dr. Rakesh Kumar

Research Group: Dr. Vipin Hallan and Dr. Kiran Singh Saini

Apple (*Malus domestica* Borkh.), a deciduous fruit tree native to western Asia, is widely cultivated across temperate regions worldwide. Traditional apple varieties require extended chilling periods, limiting their cultivation to colder climates. However, low-chilling varieties that require only 250–300 chilling hours present a viable opportunity for apple cultivation in non-traditional areas like Manipur and Mizoram. CSIR-IHBT is carrying out two DBT-funded projects entitled "Surveillance, multiplex virus diagnostics, raising quality rootstocks for promotion of low-chilling varieties of apple (*Malus domestica* Borkh.) in Manipur to improve the livelihood of local farmers" and "Inter-institutional program support on the development and sustainable utilization of bio-resources of Mizoram Sub project 3: Introduction of low-chilling varieties of apple (*Malus domestica* L.) in Mizoram to improve the livelihood of tribal farmers".

This year, as part of our project to promote apple cultivation in Northeast India, the team CSIR-IHBT, in collaboration with MISTIC Mizoram and IBSD Manipur, monitored the growth of already planted apple trees and recorded their growth data. The performance of low-chilling apple varieties (Anna and Dorsett Golden) was monitored across locations in Mizoram and Manipur. Plants exhibited healthy vegetative growth, canopy development and produced fruits of good taste, appearance and quality, indicating good adaptability to local agro-climatic conditions. CSIR-IHBT in collaboration with IBSD (Institute of Bioresources & Sustainable Development), Manipur organized a capacity-building program on agro-technology of low chill apples to support its cultivation in various villages including, Hiyangthang, Jhogju, Makhel, Wangoi and Yumnam Huidrom. Farmers received hands-on training in plantation techniques, orchard maintenance, nutrient management, pruning, and disease control, with a specific focus on low-chilling apple varieties. Another capacity building program in collaboration with MISTIC (Mizoram Science, Technology & Innovation Council) was conducted at Chandpur farm, CSIR-IHBT, Palampur to demonstrate plant propagation techniques in apple.

Furthermore, evaluation of the biochemical composition of low-chilling apple varieties grown at Manipur, Mizoram and CSIR-IHBT was carried out according to the standard protocol to determine key quality parameters, *viz.*, total sugars, titratable acidity, ascorbic acid content, TPC (Total Pheolic Content) in peel & pulp, and TFC (Total Flavonoid Content) in peel & pulp (Table 1). Glimpses of the project activities are shown in Fig. 1.

Table 1. Analytical report on biochemical composition of apple samples

Parameters	Location				
	Manipur		Mizoram	CSIR-IHBT	
	Anna	Dorsett Golden	Anna	Anna	Dorsett Golden
Total sugars (g/100g)	3.84 ± 0.03	3.69 ± 0.11	3.52 ± 0.01	4.19 ± 0.02	3.08 ± 0.00
Titratable acidity (%)	0.134 ± 0.02	0.192 ± 0.01	0.17 ± 0.02	0.22 ± 0.02	0.31 ± 0.01
Ascorbic acid (mg/100g)	9.17 ± 1.44	6.67 ± 1.17	10.00 ± 0.00	11.25 ± 1.77	10.00 ± 0.00
TPC in peel (mg/100g)	131.36 ± 0.56	181.38 ± 0.96	94.60 ± 0.27	197.64 ± 1.66	279.55 ± 0.89
TPC in pulp (mg/100g)	51.45 ± 0.42	102.57 ± 0.41	33.89 ± 0.54	96.64 ± 0.47	166.29 ± 0.89
TFC in peel (mg/100g)	223.41 ± 0.99	276.77 ± 0.29	289.27 ± 1.54	114.86 ± 0.47	160.90 ± 0.91
TFC in pulp(mg/100g)	134.10 ± 2.09	222.19 ± 1.04	65.17 ± 1.54	63.71 ± 1.04	128.20 ± 1.52

Capacity building program at IBSD, Manipur

Capacity building program at CSIR-IHBT in collaboration with MISTIC (Palampur)

Demonstration of training and pruning techniques in apple (Manipur)

Demonstration of tongue grafting in apple (Palampur)

Fig. 1 Glimpses of project activities.

REGION-SPECIFIC SMART AGROTECHNOLOGIES FOR ENHANCING PLANT AND SOIL HEALTH

Project investigation: Dr. Rakesh Kumar

Research group: Er. Amit Kumar, Dr. Poonam and Dr. Sanatsujat Singh

The Region-Specific Smart Agro-technologies project is a joint initiative across several CSIR labs, designed to harness diverse expertise in creating innovative solutions for smart agricultural management. By incorporating modelling, predictive analytics, indigenous drone-based surveillance and spraying, IoT-based measurement systems, and controlled environment agriculture using grow lights, the project aims to tackle region-specific challenges in improving plant and soil health sustainably. Capacity-building workshops at the participating CSIR labs will facilitate knowledge sharing and provide training for stakeholders, including agro-industries, startups, agricultural universities, and farming communities.

Spatial Variability and Precision Nutrient Management in Apple (Malus domestica Borkh.) Varieties Grown in the Western Himalayas: A two-year study was conducted in a farmer-managed apple orchard at Ghordhor, Naggar, Kullu, Himachal Pradesh,(32°6.0010'N Latitude; 77°9.3960'E Longitude; 1637 m amsl Altitude) to assess soil health, planting systems, and precision organic nutrient management. SoilOptix® mapping revealed moderate spatial variability with low N and K, high P, high organic carbon (1.46%), normal EC, and moderate micronutrient status (Fig.1).

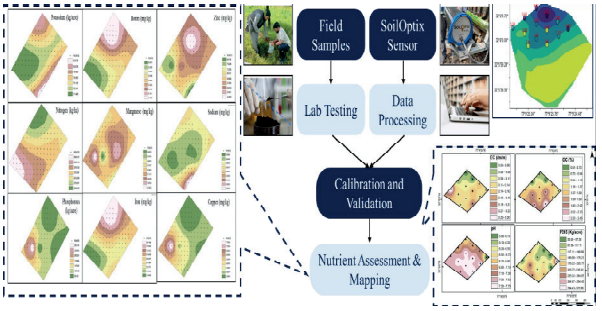


Fig. 1 High Resolution Soil Nutrient Mapping using Soil Optix.

High-Density Plantation (HDP) showed vigorous vegetative growth without fruiting due to juvenility, whereas Low-Density Plantation (LDP) exhibited balanced canopy structure and consistent fruiting. A factorial experiment comprising of two plantation system, (HDP & LDP) and three organic nutrient treatments (control, 100% FYM, 50% FYM + 50% vermicompost) indicated enhanced vegetative growth in HDP treatments (T3, T6) without fruiting, while LDP treatments (T9, T12) recorded better vegetative efficiency, active fruiting, and highest chlorophyll content (T12), reflecting superior physiological performance and nutrient response (Fig. 2).

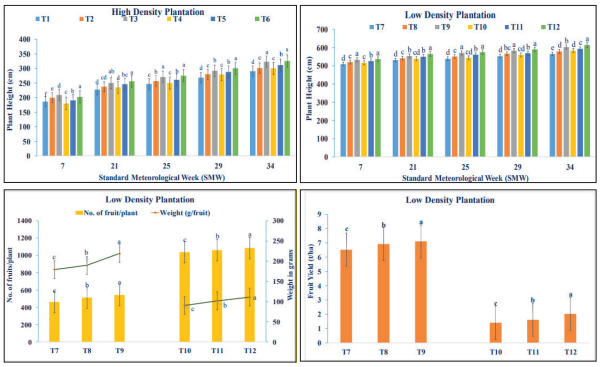


Fig. 2 Growth parameters of Apple varieties.

Smart Sensor based Growth Assessment of Paddy (*Oryza sativa* L.) Varieties Grown in Acidic Soils of Western Himalayas: A two-year field study was conducted at Kandwari, Palampur (Kangra valley; 32°6′816″ N, 76°34′62″ E; 1461 m amsl) in the acidic soils of the Western Himalayas to compare the growth and productivity of a high-yielding paddy variety (HYV) and a traditional local landrace (LV) under organic cultivation. The experiment was laid out in a Randomised Block Design with ten plots and three replications per variety, transplanted at 20 × 15 cm spacing with 4 cm depth, and amended with FYM @ 20 t/ha. Soil diagnostics using SoilOptix® indicated acidic soil (pH 5.7) with low P and K but adequate micronutrients. Continuous meteorological monitoring showed high cumulative rainfall, humidity (77–82%), and variable photosynthetic efficiency (13–26%) due to cloudy and waterlogged conditions. Higher DVR coefficients in the local variety enabled faster phenological progression and better stress escape. While HYV attained greater final height under stable conditions, it suffered high grain sterility and reduced yield in 2025 due to excess rainfall during reproductive stages (Fig. 3). In contrast, the local variety demonstrated superior resilience and produced higher yield under high-rainfall, saturated soil conditions, highlighting its suitability for Himalayan agro-ecosystems (Fig. 4).

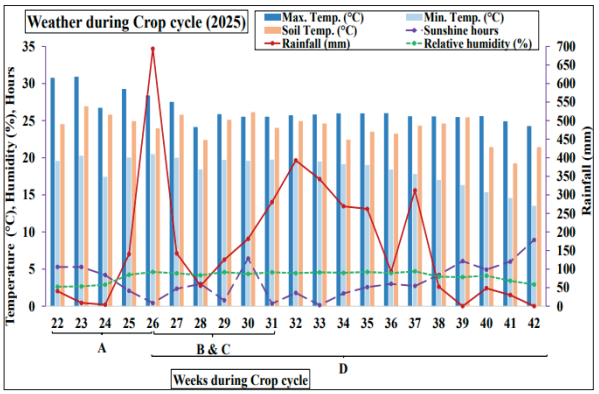


Fig. 3 Weather parameters recorded using Agri Environmental Station.

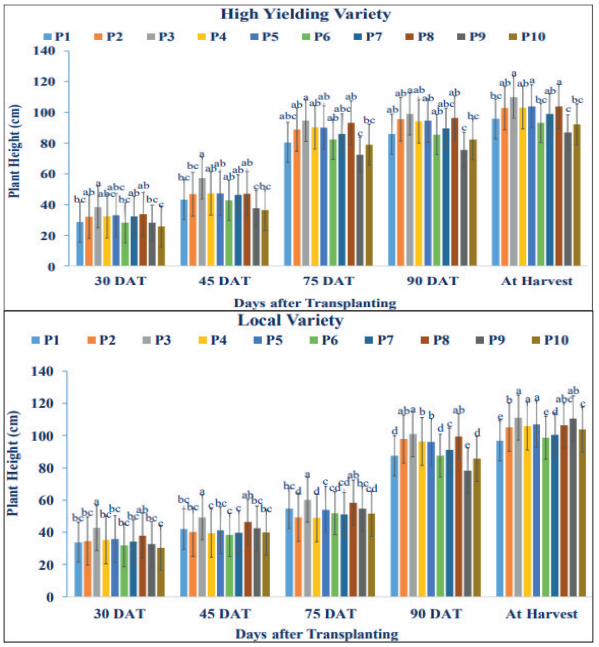


Fig. 4 Growth parameters recorded for paddy varieties.

Monitoring Growth, Physiology and Yield Performance of Gerbera Varieties under Controlled Polyhouse Conditions: The experiment was conducted at the CSIR-Institute of Himalayan Bioresource Technology campus under controlled polyhouse conditions to evaluate the performance of different gerbera varieties. Growth and morphological parameters, including plant height, number of leaves, leaf area, days to bud initiation, flower diameter, stalk length, and flower yield, were systematically recorded to assess varietal performance (Fig. 5). Abiotic and biotic stress responses were continuously monitored using handheld smart sensors for measuring chlorophyll content, photosynthetic efficiency, temperature, humidity, and plant stress indices. In addition, microscopic analysis of gerbera leaf and floral samples was carried out to detect and confirm disease infestation, enabling early diagnosis and precise management of pathogens under protected cultivation (Fig. 6).

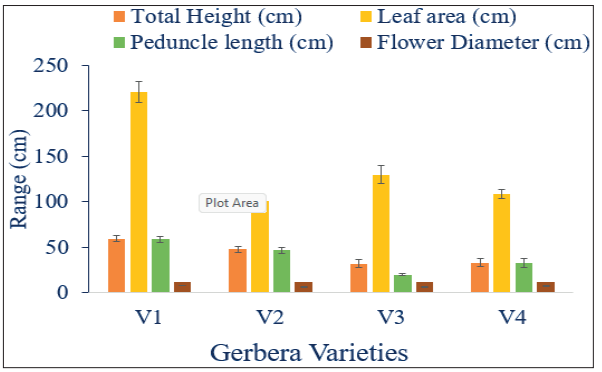


Fig. 5 Growth & morphological parameters of Gerbera varieties.

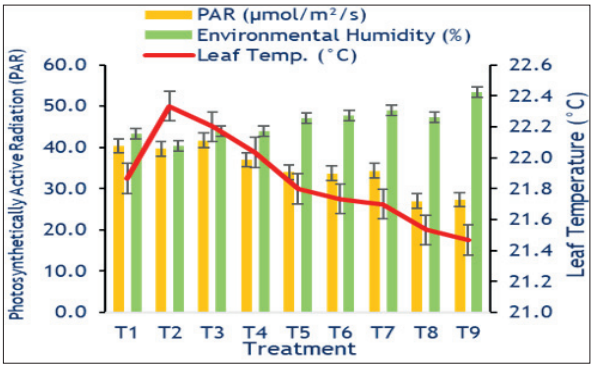


Fig. 6 Stress Monitoring in Gerbera using Smart Sensors.

Drone-Based Multispectral Imaging of Apple for Crop Health Assessment: The multi-temporal drone images were acquired from apple orchards located in Naggar, district Kullu, HP representing its dormant, full bloom, fruit set, fruit development, mature and post-harvest growth stages. The Normalized Difference Vegetation Index (NDVI) derived from these images exhibited significant variation across growth stages (Fig. 7), with the highest values observed during the full bloom growth stage. NDVI was lowest during the dormant phase, increased progressively toward maturity, and subsequently declined as the crop approached the post-harvest stage.

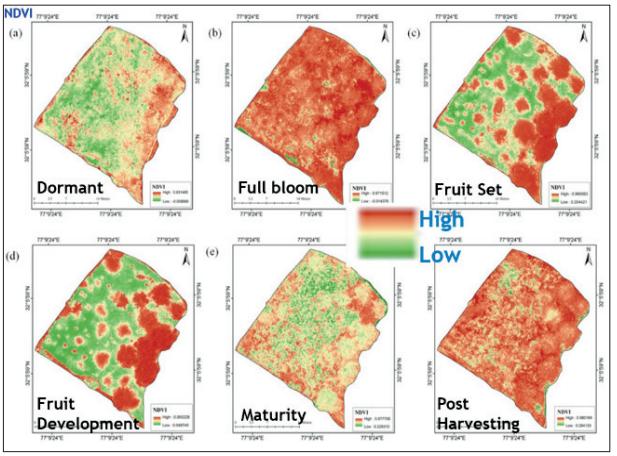
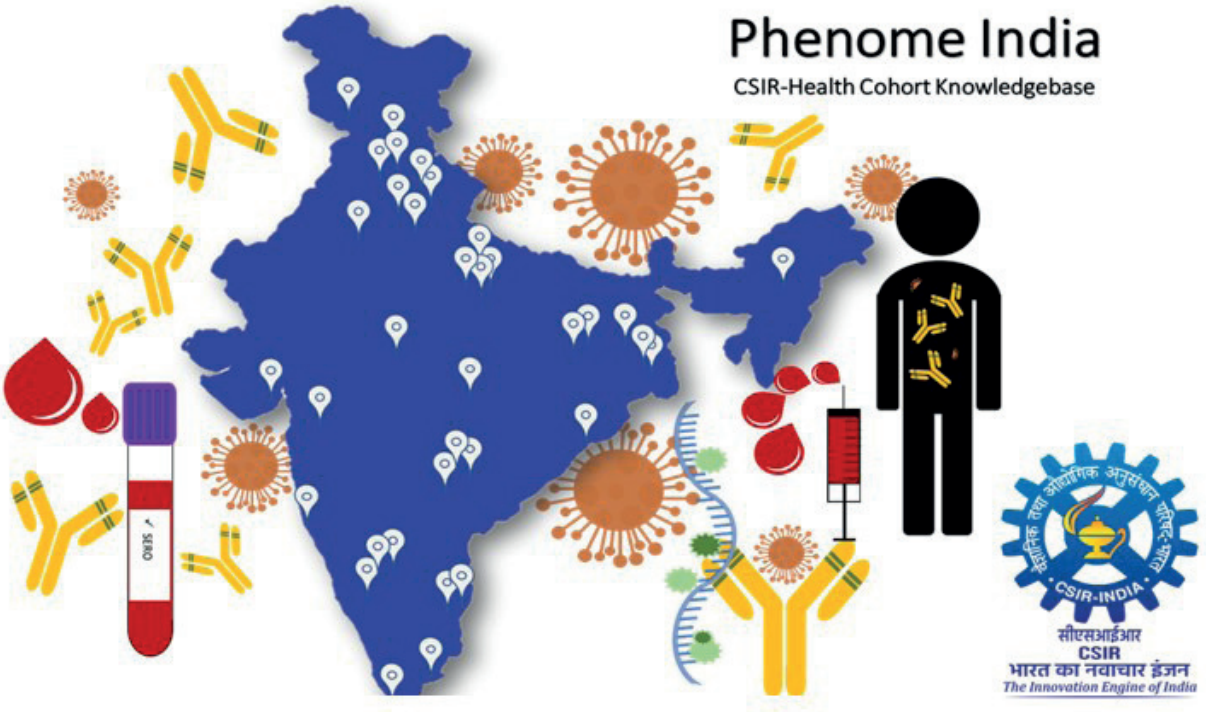


Fig. 7 Temporal Normalized Difference Vegetation Index of Apple field.

PHENOME INDIA- CSIR HEALTH COHORT KNOWLEDGEBASE (PI-CHECK/CSIR COHORT)

Principal Investigator: Dr. Yogendra S. Padwad

A longitudinal population study, comprising of phenotypic measurements at baseline, and long-term follow-up activities are being implemented across CSIR in all the laboratories. This could provide opportunities to understand the complex interrelationships between environmental, genetic and other molecular factors with risk of subsequent disease which is lacking in the Indian population. Study has the advantage of measuring parameters well before the disease onset thereby eliminating selection bias and issues of reverse causality. This phenomics data could help in identifying precise diagnostic and prognostic markers for precision medicine. Such epidemiological data sets are crucial for developing risk prediction tools and play an important role towards establishing precision health and medicine. Currently, most of these risk prediction algorithms are based on epidemiological data from Caucasian population and there is ample evidence that they are inaccurate for the Indian population due to ethnic diversity, varied dietary and lifestyle patterns, and altered risk profiles. It is, therefore, critical that India-specific risk prediction algorithms are developed for communicable and non-communicable diseases. In this context, CSIR-cohort established during the current pandemic is an invaluable resource that can be utilized for developing clinically useful personalized risk prediction scores for various communicable and non-communicable disorders especially cardiometabolic disorders. CSIR-IHBT staff and their spouses has overwhelmingly participated in the two consecutive phases of the sample collection drive at CSIR-IHBT, Palampur under this project. First phase was arranged from April 28, 2024 to May 1, 2024 where 211 no. of samples were collected while second phase of sample collection was carried out from June 20, 2025 to June 23, 2025 and 239 samples were collected. Recently, one publication entitled 'Burden of MASLD and liver fibrosis: evidence from Phenome India cohort' from the project has published in the prestigious journal 'The Lancet Regional Health-Southeast Asia' in which community-based data came out of this study on Metabolic-dysfunction-associated steatotic liver disease (MASLD) was reported. In this, a critical knowledge gap by assessing the prevalence, distribution, and characteristics of MASLD subgroups and fibrosis, leveraging the Phenome India cohort was addressed. Findings revealed that MASLD affected over one-third of participants. Site-specific disparities were observed, which suggest the need for large-scale longitudinal studies to elucidate region-specific risk factors and temporal trends. Community-based awareness and targeted public health interventions across diverse geographical and socio-cultural settings in India may help curb the rising burden.



PHYTOPHARMACEUTICAL MISSION (PHASE-III)

Principal Investigator: Dr. Dinesh Kumar and Dr. Probir Kumar Pal

CSIR-IHBT interventions under Phytopharmaceutical Mission: Under the CSIR–Phytopharmaceutical Mission, CSIR-IHBT is working under two verticals. Within Vertical A, the Institute focuses on developing phytopharmaceutical products derived from *Inula racemosa*. Extensive phytochemical investigations of *I. racemosa* have led to the identification of several novel secondary metabolites along with their diverse biological activities. The plant's remarkable therapeutic potential is primarily attributed to its rich content of sesquiterpene lactones, especially eudesmanolides such as alantolactone (ALT) and isoalantolactone (IALT).

Non-alcoholic fatty liver disease (NAFLD) is a condition where too much fat builds up in the liver, even if a person does not drink much alcohol. It can be mild (just fat in the liver) or more serious, where the liver becomes inflamed and damaged. Over time, this can lead to scarring (fibrosis) and even severe damage (cirrhosis). The main treatment is improving lifestyle habits, especially by losing weight, eating healthier, and exercising regularly. There is no such medicine available that cures NAFLD; therefore, the current research was focused on developing a photopharmaceutical drug from natural resources, as many drugs are derived from bioresources. Under this Mission programme, a Phytopharmaceutical ingredient (pAPI) was prepared at lab scale and pilot scale from Inula racemosa, and further pure molecules were also isolated from the pAPI. pAPI was standardized and analyzed in accordance with phytopharmaceutical regulations and found suitable for pharmaceutical product development. A prepared batch of pAPI and pure molecules was submitted to CSIR-CDRI for evaluation against NAFLD. The results were found effective in preclinical animal model validation. Further, work is underway on detailed studies of product development and validation.

Under vertical B, the main activities are the generation of Quality Planting materials (QPM) and the promotion of captive cultivation of Picrorhiza kurroa, I. racemosa, and Heeng (*Ferula asafoetida*). Approximately 18.0 kg of *I. racemosa* seeds were distributed to farmers in Lahaul & Spiti, Chamba, Kullu, and Kinnaur districts to cover 18 ha of land under this crop. Likewise, 9100 Heeng plants have been distributed to the farmers of the district. Kinnaur, Chamba, Kullu, Mandi, and Lahaul & Spiti of HP, Leh (Khimi, Ayee, Kargil), Jammu & Kashmir (Doda, Atholi, Kishtwar, Gulabgarh), and Uttarakhand (Joshimath, Chamoli) to cover an area of about 1.5 ha. Moreover, more than 6 ha of land has been covered under P. kurroa in HP and UK.

A total of 26 on-farm training programs and field visits were organized during 2025-2026 across farmers' fields in the high altitude regions of Himachal Pradesh, J & K, and the UK. These capacity-building activities were designed to disseminate the improved agronomic practices for the targeted m plants, with the aim of enhancing crop productivity and sustainability. Emphasis was also placed on post-harvest handling and sustainable harvesting techniques, particularly important for high-value medicinal plants cultivated in fragile mountain ecosystems.

Kargil

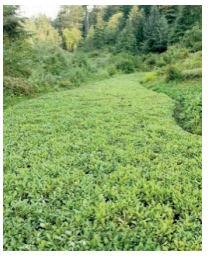
Khimmi

Ayee

Awareness-cum-training program on Heeng in Leh-Ladakh

Training and Heeng plant distribution program in Jammu and Kashmir

Distribution of QPM of *P. kurroa* to the farmers of District Kullu, HP



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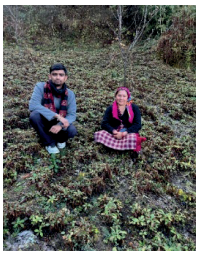


Harvesting of Picrorhiza plants in the farmer's field at District Chamoli Uttarakhand

Interaction with farmers and data collection of heeng in different villages of Mandi

Distribution of seeds of Inula racemosa and Heeng plantation in Lahaul & Spiti

SPECIALTY CHEMICALS FOR UPHOLSTERY APPLICATIONS: TANNINS FROM REGENERABLE PARTS OF PLANTS FOR VEGETABLE TANNING

Principal Investigators: Dr. Upendra Sharma and Er. Mohit Sharma

Brief Overview

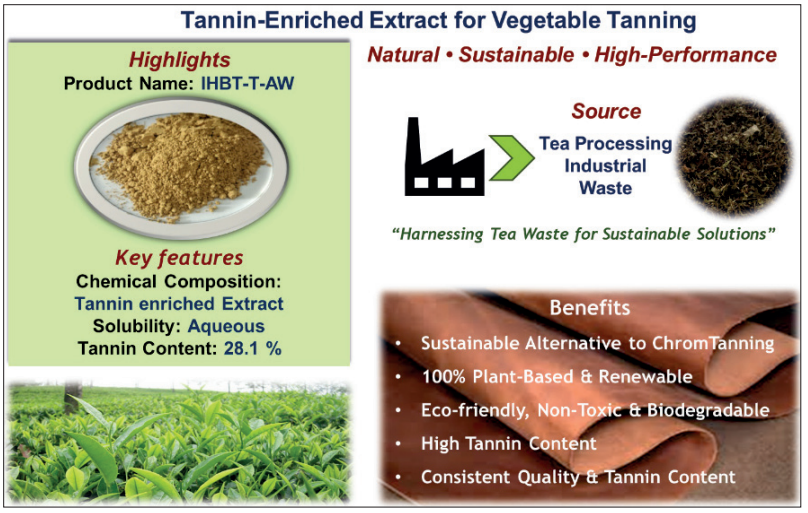
The leather industry plays a vital role in the Indian economy, with a total valuation of USD 17.85 billion—comprising USD 5.85 billion in exports and USD 12 billion in domestic sales. Despite growing demand for leather products, the industry faces mounting criticism due to its significant environmental footprint. Chromium-based tanning, widely used for its efficiency and versatility, produces hazardous waste such as chromium sludge and chrome-tanned leather shavings, posing serious environmental threats. In response, natural tannins—plant-based compounds are being explored as eco-friendly alternatives. However, identifying reliable and regenerative sources of plant material for tannin extraction and a pilot-scale process for standardized tannin-enriched extract remains a key challenge. The project's vertical aims to identify plant species with the highest tannin content and develop an efficient lab-scale extraction process from selected plants. Extracted tannins will be characterized using modern spectroscopic techniques and evaluated for their effectiveness in the leather tanning process. Based on these findings, a pilot-scale tannin extraction process will be established for potential industrial application.

Progress and significant achievements:

Three tannin-enriched extracts (T1, T2, and T3) were prepared from *Camellia sinensis* leaves. A comparative analysis was conducted to estimate the tannin and non-tannin content in each extract, which revealed the highest tannin content (28.1 %) in T1. Based on CLRI inputs, the aqueous solubility of the T1 extract was optimized and improved (T1A), and the resulting extract was sent to CLRI for performance analysis. Further, T1A was prepared on a kilogram scale, and a 1 kg sample was sent to CLRI for performance evaluation of the scale-up sample in leather tanning application. In parallel, tannin content was estimated in various proposed plant species, including *Quercus leucotrichophora*, *Pyrus pashia*, *Terminalia chebula*, *Acacia catechu*, and *Aesculus indica*, to evaluate their potential as sustainable tannin sources. Additionally, tannin levels were analyzed in tea waste samples to assess their viability as an alternative input biomass for the preparation of tannin-enriched extract.

Tasks to be achieved in the next year:

- Further enrichment of tannins in T1A-extract from industrial tea waste and its testing for leather vegetable tanning.
- MS-based characterisation of different classes of tannins in lead tannin-enriched sample.



FERMENTATION SCALE UP AND TECHNOLOGY DEVELOPMENT OF LEAD INDUSTRIAL ENZYMES FOR BIOFUEL, FOOD, FEED, AGRICULTURE AND VACCINE APPLICATIONS

Theme: CSIR Mission Mode Project

Principal Investigator: Dr. Arun Kumar

Co- Principal Investigator: Dr. Dharam Singh and Dr. Upendra Sharma

The global shift from relying on natural resources to utilizing products derived from biological waste has accelerated in response to the urgent demand for sustainable energy solutions. LPMOs have emerged as promising enzymes for enhancing the biomass deconstruction process. These enzymes utilize monocopper ions at their active sites to oxidatively cleave the C1 and C4 positions of glycosidic bonds in polysaccharide chains. This oxidative cleavage disrupts the crystalline structure, thereby increasing the accessibility of glycosyl hydrolases to the substrate. Therefore, synergistic interaction significantly improves the conversion of complex polysaccharides into simple fermentable sugars. An LPMO encoding gene (referred as LPMOBl) was identified from the genome of Bacillus spp. PCH94 through genome mining. LPMOBl was successfully cloned and expressed in E. coli BL21 cells. The purified LPMOBl exhibited monooxygenase and peroxygenase activities, with optimal activity at pH 7.0 and 30°C (Fig. 1). The kinetic parameters Km and Vmax were 2.31 ± 0.25 mM and 20.36 ± 0.5 Units/mg respectively. LPMOBl displayed high thermal stability with a melting temperature (Tm) of 74.4± 0.85. Furthermore, enzyme resulted in oxidative cleavage of chitin and PASC. Additionally, a pilot-scale production process for LPMOBl was developed using 15L fermentor. A patent has been filed for the same (0058NF2026).

GENOME-EDITING FOR CROP IMPROVEMENT (GE-CROPS)

Principal Investigator: Dr. Shiv Shanker Pandey

Under the CSIR-Genome-editing mission project, three important crops *Camellia sinensis* (Tea), *Crocus sativus* (Saffron) and *Stevia rebaudiana* were selected for genome editing. *Camellia sinensis* was targeted for editing of Polyphenol oxidase (*PPO*) and Caffeine synthase (*TCS*) genes to enhance tea quality and improve its health-promoting attributes. In *Crocus sativus* (saffron), flowering repressor genes *TFL1-3* (earlier identified as *TFL1-2*) and *SVP* were selected for silencing to achieve increased flowering and higher productivity. For *Stevia rebaudiana*, the *UGT74G1* gene (encoding UDP-glycosyltransferase 74G1) was edited to enhance steviol glycoside content, particularly Rebaudioside A, thereby reducing the characteristic bitter aftertaste.

In the case of *Camellia sinensis*, using the previously established somatic embryo transformation and regeneration protocols, more genome edited plants of tea cv. Him Sphurti and cv. Kangra Asha were generated. Molecular characterization of generated plants was performed by confirming Cas9 presence and editing in the target genes through sequencing. Cloning of the target genes from genome edited plants followed by sequencing of several clones was also done to confirm the efficient editing. As the generated plants were in early growing stage therefore biochemical analysis of some of the genome edited plants (having sufficient samples) were done that could confirm the reduced caffeine, theobromine content (in case of *TCS* edited plants) and reduced PPO activity (in case of *PPO* edited plants). RNP mediated protoplast editing was also established and confirmed through sequencing of the target genes. In the case of protoplast regeneration, the micro and mass calli formation from RNP transfected protoplast was established. In addition, to develop Cas9 free genome edited plants (with minimal regulatory constraints), a process of nanomaterial mediated RNP transfection of tea is being also established.

In the case of genome editing of *Crocus sativus,* the earlier developed CRISPR constructs for editing in *TFL1-3* and *SVP2* was used for *Agrobacterium* mediated transformation of callus. Few transformed callus were regenerated into plantlets which were tested for Cas9 presence and were found Cas9 positive, showed successful transformation. Using the saffron cell suspension culture the protoplast isolation, purification and PEG-mediated protoplast transformation were also successfully optimized (Fig. 1).

In the case of genome editing of *Stevia rebaudiana,* in-planta stevia seeds transformation was done using the *Agrobacterium* having CRISPR construct of the target gene *UGT74G1*, and transformed plants were raised. Regenerated plants were tested for Cas9 presence through PCR, were found Cas9 positive and confirmed successful transformation. Agrobacterium mediated transformation of nodal explants and callus were also done, and plants are being regenerated. VIGS constructs for *SrUGT* genes and *SrPDS* were also developed to further test the transformation and successful CRISPR mediated editing. Stevia protoplast transfection with RNP complex (UGT74G1 sgRNAs-cas9) was also optimized and editing in the target gene was also confirmed through genomic cleavage detection kit and sequencing. Regeneration of protoplast is being optimized.

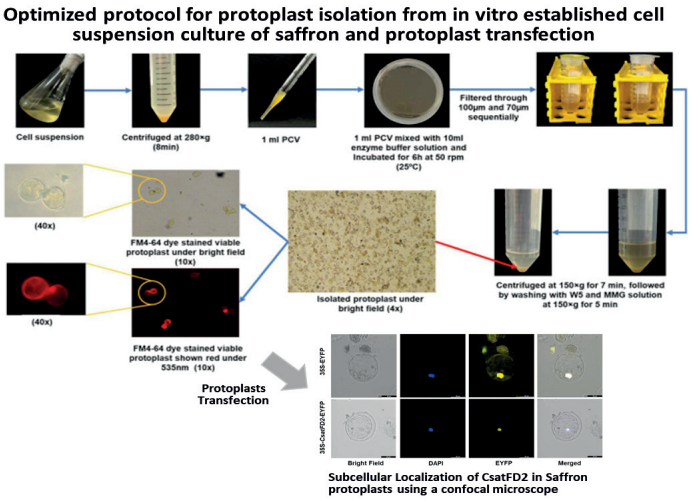


Fig. 1 Optimized protocol for protoplast isolation from in-vitro established cell suspension culture of saffron and protoplast transfection.

BIORESOURCE CONSERVATION AND PROSPECTION (BIOCAP)

Principal Investigator: Dr. Sanjay Kumar Uniyal

India represents 4 of the 36 biodiversity hotspots and nearly all the representative global ecological zones of South Asia. The vast resource pool offers significant opportunities for exploration, economic growth, development, and discoveries. However, today, the pace of species loss is 1000 times higher than the natural rate, resulting in the depletion of nearly 60% of the global biodiversity, constraining sustainable development.

Recognizing this, CSIR launched a Mission **Bioresource Conservation and Prospection** (BioCAP) with an aim to Identify, preserve, and value-add natural bioresources for societal, industrial, environmental, and academic benefits. The mission has participation of 9 laboratories, including CSIR-IHBT, which is leading this mission.

The mission has four objectives

- Biodiversity characterization & resource mapping in the target ecosystems/areas/ sites (plants, aquatic animals, microbes)
- Genetic characterization of selected/ prioritized species
- Chemical characterization & value addition of selected/prioritised species
- Conservation (*ex-situ* & *in-situ*), resource management and outreach

Strategy

The mission objectives are designed to enable effective bioprospecting and conservation of resources from the selected study sites. The mission focuses on different ecosystems as described below:

Ecosystem	Partnering laboratories
Mountain ecosystem	
Western Himalayas	CSIR-IHBT, CSIR-CIMAP & CSIR-IIIM
Eastern Himalayas /North East	CSIR-NEIST
Western Ghats	CSIR-CIMAP, CSIR-NIIST & CSIR-CFTRI
Lowland & Plains	CSIR-CIMAP & CSIR-NBRI
Marine/Aquatic ecosystem/ Coast	CSIR-NIO, CSIR-NIIST & CSIR-CSMCRI

BioCAP targets plants (lower and higher), microbes, and ocean bioresources (including invertebrates).

During the reporting period, the mission discovered 9 species new to science (such as *Cyanotis saxicola*, *Fimbristylis hispidigluma*, *Berberis myriovula, Rinodina alpina*), two new additions to the Flora of India (*Solanum nitidibaccatum & Fissidens capitulatus*), along with the identification of hotspots for halophytes. It also developed 38 barcodes for species for ecological and importance, and identified 30 PGPR with promising results. As a part of the mission 9 nutraceutically important plant species were characterized and a conservatory, "Jaivsampada Udyan" was developed for conservation and awareness programmes.

Jaivsampada Udyan developed in the institute under the aegis of BioCAP

CSIR MISSION MODE PROJECT SMART VILLAGE

Principal Investigator: Dr. Shashi Bhushan

Co-Investigator: Dr. Rakesh Kumar, Dr. Mahesh Gupta, Dr. Gireesh Nadda, Dr. Vidyashankar Srivastan, Dr. Bhavya Bhargava and Dr. Poonam Kumari

Smart Village Mission Project is a collaborative initiative led by the Council of Scientific and Industrial Research (CSIR) and its network of 14 laboratories, with a focus on transforming rural India through technology, infrastructure, and sustainable development. The project aims to create model Smart Villages in diverse geographical regions, including Gujarat, Assam, Madhya Pradesh, Odisha and Rajasthan by implementing cutting-edge technologies and eco-friendly solutions that address the unique challenges faced by rural communities. CSIR-Institute of Himalayan Bioresource Technology (CSIR-IHBT), Palampur, Himachal Pradesh, is one of the leading CSIR institutes participating in the 'Smart Village' Mission-Mode Project.

This initiative aligns with the Hon'ble Prime Minister's vision of 'Viksit Bharat' and aims to foster sustainable development and strengthen rural communities into self-reliant hubs using cutting-edge CSIR technologies. Under this mission, villages have been selected from remote and diverse geographical regions across the states like Assam, Madhya Pradesh, Odisha, Gujarat and Rajasthan.

Overall Objectives (Work Package-wise):

- WP-S: To create a sustainable infrastructure framework that supports the development of smart villages.
- WP-M: Incorporating modern technologies and processes to enhance infrastructure development in villages.
- WP-A: To enhance resources availability for strengthening community engagement.
- WP -R: To develop preparedness to address environmental challenges
- WP -T: Augmenting integration and translation of technologies
- WP- K: Project Implementation and Analysis

Project Progress (2025-26)

The CSIR-IHBT project team has made significant progress under the Smart Village Mission project through a structured approach involving need assessment surveys, identification of appropriate technologies, stakeholder collaboration, and initial deployment of interventions across multiple states.

A comprehensive field surveys (Fig. 1) were conducted in Junakimondal (Jorhat, Assam) from December 01–03, 2025; Sawaipura (Pali, Rajasthan) from December 08–10, 2025; Janakpur (Raisen, Madhya Pradesh) from February 06–07, 2026; and Kusunpur (Kendrapara, Odisha) from February 07–10, 2026 to assess socio-economic conditions and identify locally available bioresources for livelihood enhancement. In addition, capacity building program was also organized at Junakimondal (Jorhat, Assam) to provide practical solutions using smart and sustainable technologies (Fig. 2). Based on these assessments, key CSIR-IHBT technologies, including combating malnutrition, value addition of local bioresources, apiculture, fruit cultivation (low-chill apple varieties), agro-flower technology and dry flower technology were identified for village-specific implementation. Further, a Detailed Project Reports (DPRs) have been prepared and submitted for three villages i.e. Junakimondal, Sawaipura and Kusunpur.

CSIR-IHBT team established an active collaboration with stakeholders such as Block Development Officers, the Assistant Commissioner of Titabar (Jorhat, Assam), Panchayat representatives, local government school staff, Anganwadi workers and ASHA workers to ensure effective execution and address grassroots-level challenges. In terms of technology deployment, 200 low-chill apple plants (Anna and Dorsett Golden varieties) were distributed and planted in Junakimondal on January 30, 2026 (Fig. 3), while high-quality marigold seeds (Sonali Orange cultivar) were distributed in Junakimondal (Assam), Janakpur (Madhya Pradesh) and Kusunpur (Odisha) to promote floriculture-based livelihoods. Nutritionally enriched POSHAN MATRI kits were also distributed among women and children in Sawaipura, Janakpur and Kusunpur (Fig.4) to enhance awareness about balanced nutrition and combat malnutrition. Additionally, preliminary laboratory work on jaggery-based value-added products utilizing locally available bioresources such as green gram, dried gram and bajra has been initiated for Sawaipura, Rajasthan. Discussions are also underway with M/S Hexagon Geosystems Services India Pvt. Ltd., Gurugram, Haryana, to explore support through CSR funding, particularly for malnutrition-related initiatives. These activities reflect a comprehensive and integrated approach to sustainable rural development, combining scientific innovation with community participation to improve livelihood opportunities and quality of life in the villages.

Fig. 1 Field survey by CSIR-IHBT team across different identified sites.

Fig. 2 Capacity building program at Junakimondal (Jorhat, Assam).

Fig. 3 Apple plantation drive at Junakimondal (Jorhat, Assam).

Fig. 4 Distribution of fortified food products at Sawaipura (Rajasthan), Janakpur (MP) and Kusunpur Odisha.

FAST TRACK TRANSLATION (FTT),

FUNDAMENTAL INNOVATIVE RESEARCH IN SCIENCE OF TOMORROW (FIRST) PROJECTS

&

R&D SEED FUND (RDSF) PROJECTS

CRM 2-CANDIDATE INDIAN CERTIFIED REFERENCE MATERIALS (CRMS)/ BHARTIYA NIRDESHAK DRAVYA (BND) OF PHYTO & AROMA CHEMICALS FOR QUALITY AND SAFETY ASSESSMENT OF DERIVED PRODUCTS

Principal Investigator & Co-PI: Dr. Upendra Sharma, Er. Mohit Sharma and Mr. Shiv Kumar

Brief Overview

The project aims to develop CRMs/BND specifically for phyto- and aroma-chemicals. These CRMs will play a critical role in ensuring the quality and safety of herbal and aroma-based products, supporting national efforts to establish standardized materials aligned with international quality standards, such as ISO 17034 and ISO 17025. The CSIR-IHBT component of the project involves the isolation of specialized metabolites from four medicinal plants: *Aconitum heterophyllum*, *Trillium govanianum*, *Zanthoxylum armatum*, and *Nardostachys jatamansi*. These plants have high commercial demand and significance; however, the CRMs required for their quality assessment are either unavailable or expensive, often necessitating import from foreign sources.

Progress and significant achievements

The objective of the current project is to develop a reproducible process for the gram-scale isolation of selected marker metabolites from these plants. This includes a comprehensive characterization of the isolated compounds using advanced analytical techniques, along with homogeneity and stability assessments. The stability studies will specifically evaluate the effect of thermal conditions, storage, and transport conditions to ensure the reliability and quality of the compounds when used as CRMs/BND for phytochemical standardization and quality control applications. The process for isolating ten pure CRMs has been successfully developed. These include dioscin, protodioscin, govanoside B, and govanoside D from *Trillium govanianum*, vitexin and isovitexin from *Zanthoxylum armatum*, atisinium and hetisine from *Aconitum heterophyllum*, and valeranone and nerolidol from *Nardostachys jatamansi*. All isolated compounds have been characterized using appropriate analytical techniques, and purity has been assigned. Further, homogeneity and stability studies have been completed for dioscin, protodioscin, vitexin, and isovitexin to ensure consistency and reliability of the CRMs. A patent has been filed for "process for pure crystalline atisinium chloride (Guanfu base H) from plant extract", Ref. no. 0187NF2025. In parallel, the laboratory has been granted ISO/IEC 17025:2017 certification by the National Accreditation Board for Testing and Calibration Laboratories (NABL), making a significant step toward achieving quality and competence in testing and calibration activities.

Work in Progress:

- Lab accreditation as per ISO17034:2016.

HOW DOES HEAT SIGNALING MACHINERY COAX DNA METHYLATION AND GENE EXPRESSION PATTERNS IN PLANTS - CONNECTING THE HEAT WAVES AND GENE WAVES

Principal Investigator: Dr. Gaurav Zinta

Objectives:

Objective 1: Deciphering HSFA2-mediated genome-scale reprogramming of DNA methylation landscape under heat stress in C3 and C4 plants

Objective 2: Linking DNA methylation with heat-responsive gene expression patterns

Objective 3: Genetic validation of the interactions between HSFA2 and DNA methyltransferases and/or demethylases during heat stress

Deliverables:

- Elucidate the role of DNA methylation in plant heat stress responses and stress memory.
- Establish the role of *HSFA2* in heat stress signalling and epigenetic regulation.
- Map *HSFA2*-mediated DNA methylation changes in C3 (*Arabidopsis*) and C4 (amaranth) plants.
- Correlate DNA methylation dynamics with heat-responsive gene expression and regulatory interactions.

Brief Progress:

- Significant progress has been made in understanding the role of DNA methylation dynamics in plant heat stress responses. Expression profiling showed that key DNA methyltransferases (*DRM1, DRM2, MET1,* and *MET2*) and demethylases (*DML1* and *DML2*) are dynamically regulated under moderate (28°C) and severe (38°C) heat stress, as well as during recovery.
- Notably, *DML1* exhibited strong induction (~60-fold) under 38°C, while *DML2* and *DME* displayed distinct temperature-specific expression patterns, indicating functional specialisation during thermal stress adaptation.
- To investigate the role of *HSFA2* in epigenetic regulation under heat stress, homozygous *hsfa2* T-DNA insertion mutants were generated and validated, and three independent *HSFA2* overexpression lines (*HSFA2-OE1, HSFA2-OE2,* and *HSFA2-OE3*) were developed for functional characterisation.
- A standardised heat stress and recovery system was established to enable detailed RNA-based gene expression analyses. Screening of DNA methylation and demethylation mutants further highlighted the importance of epigenetic regulation in thermotolerance, and interaction studies between key DNA methylases/demethylases and *HSFA2* are currently underway.
- In addition, HSF genes from C4 amaranth were identified, characterised, and overexpressed in *Arabidopsis*, resulting in enhanced heat tolerance, improved growth, and better biochemical performance under stress conditions.
- Also, transcriptome and DNA methylome sequencing was performed, and the data is being analysed.

MASS-SCALE PROPAGATION OF MONK FRUIT (*SIRAITIA GROSVENORII*): A NEW INITIATIVE TOWARDS HEALTH AND LIVELIHOOD IMPROVEMENT

Principal Investigator: Dr. Rohit Joshi

Siraitia grosvenorii (Swingle) C. Jeffery (monk fruit), a non-woody perennial vine of the family Cucurbitaceae, is native to southern China and parts of Thailand. The plant is dioecious and highly valued for its fruit, which contains mogrosides—cucurbitane-type triterpene glycosides that provide sweetness several hundred times greater than sucrose without adding calories. Among these, mogrosides IV and V are the principal sweet components. Due to its extensive use in traditional medicine, beverages, and confectionery products, monk fruit has gained significant global attention. Its safety as a natural non-nutritive sweetener has been approved by the European Food Safety Authority and the US Food and Drug Administration.

In vitro propagation offers an effective approach for large-scale multiplication and introduction of this valuable crop into new regions such as India. In the present study, a simple and efficient protocol for direct plantlet regeneration was established by comparatively evaluating light and dark incubation conditions during shoot proliferation. Plants grown under light exhibited significantly improved morpho-physiological and biochemical traits compared with those maintained in the dark after 30 days of culture. Expression analysis revealed higher levels of the auxin signaling gene ARF8 in light-treated plantlets, suggesting light-mediated regulation of shoot development. Genetic fidelity, confirmed by SCoT markers, and successful hardening with 100% survival under polyhouse conditions, demonstrate the reliability of the developed propagation system (Fig. 1).

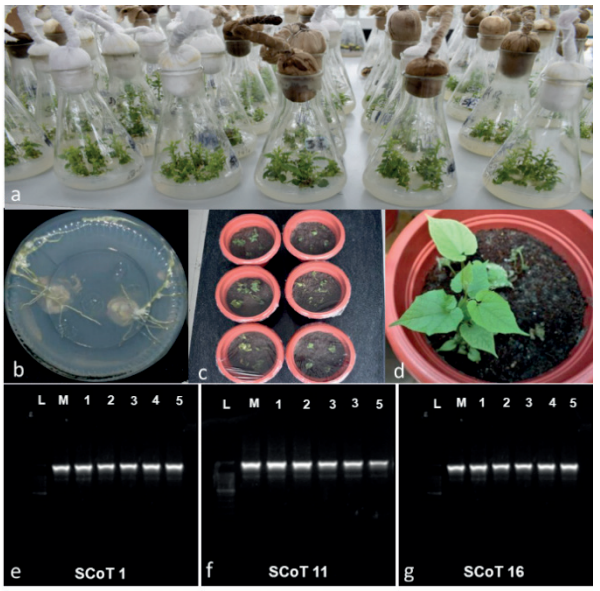


Fig. 1 Effect of variable light and dark incubation on mass-scale propagation of *Siraitia grosvenorii* (monk fruit) under *in vitro* conditions.

The technology reached TRL level 8 and was transferred to M/S The Squirrels, Ludhiana, and M/S Rami Hortitech Pvt. Ltd., Muzaffarnagar, Uttar Pradesh.

UNDERSTANDING EPICOTYL DORMANCY FOR SEED-TO-SEED CYCLE SHORTENING IN KALA JEERA (*BUNIUM PERSICUM*)

Principal Investigator: Dr. Jeremy Dkhar

Kala Jeera takes 3-4 years to complete its life cycle. This lengthy seed-to-seed cycle is attributed, in part, to seed (radicle) dormancy and lack of epicotyl growth. The primary aim of this study was to understand the molecular mechanisms, particularly hormones, regulating epicotyl dormancy in Kala Jeera. Our understanding of the underlying mechanisms may help shorten the seed-to-seed cycle in Kala Jeera. For this purpose, surface- sterilized seeds of Kala Jeera were placed on moist filter paper in Petri plates and incubated at 5 °C for 12 wk. After 12 wk of incubation at 5 °C, the germinated seedlings of Kala Jeera can be seen separated from the seed coat. The seedling length at this stage was recorded at 3.058±0.943 cm. When the seedlings were transferred to Soilrite-containing pots, the hypocotyl and cotyledons, including the root, continued to grow, reaching a final length of 7.867±2.228 cm. However, no epicotyl growth was observed (Fig. 1). Shoot senescence began after the 17th wk. Scanning electron microscopy analysis revealed that the developing shoot of kala Jeera lacked a shoot apical meristem, which is supported by confocal microscopy analysis. Estimation of ABA and GA indicated that epicotyl dormancy in Kala Jeera is associated with high ABA and low GA levels. Treatment with GA failed to release epicotyl dormancy. Although no visible epicotyl growth was observed in the shoot, the root, however, develops a tuber. Future studies will be directed at understanding tuber formation in Kala Jeera. This could facilitate the development of strategies to manipulate tuber formation and reduce the seed-to-seed cycle of the plant.

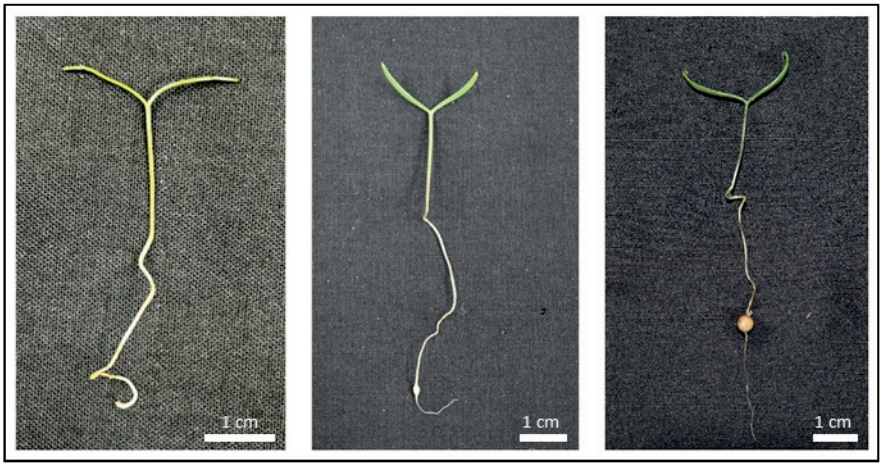


Fig. 1 Different stages of seedling growth in Kala Jeera. No epicotyl growth was observed at the shoot apex.

EVALUATION OF CINNAMON (*CINNAMOMUM VERUM*) IN NON-TRADITIONAL AREAS OF HIMACHAL PRADESH"

Principal Investigator: Dr. Satbeer Singh

Cinnamon (Cinnamomum verum), a highly valued spice crop known for its aromatic bark and essential oil. Recognizing its potential and aiming the diversification of its organized cultivation, the present study was undertaken to evaluate the growth performances of cinnamon germplasm in the non-traditional regions of Himachal Pradesh. For that, a total of 114 genotypes (100 accessions along with two check varieties were planted at CSIR IHBT farm (Fig. 1).

Fig. 1 Field view of the cinnamon plants at CSIR IHBT, Palampur.

Efforts were focused on monitoring plant health, managing field operations, and generating baseline data on morphological traits. Data was recorded after the monsoon season on plant height (PH, cm), trunk diameter (TD, mm), twig diameter (TWD, mm), canopy diameter (CD, cm) leaf length (LL, cm), leaf width (LW, cm), petiole length (PL, cm), which collectively determine the structural and growth characteristics of the plant. Similar to the first year, huge genetic variability was observed, with maximum for canopy diameter and minimum for petiole length (Table 1). Results indicated a diverse genetic pool essentially sufficient for improvement through selection in the region.

Table 1. Average performance of germplasm for all the studied traits

Traits	Ist year	IInd year
Plant height (cm)	76.62	113.6
Trunk diameter (mm)	1.73	27.9
Twig diameter (mm)	0.76	8.5
Canopy dia. (cm)	50.88	92.4
Leaf length (cm)	11.67	13.8
Leaf width (cm)	4.55	5.8
Petiole length (cm)	1.20	1.3

For 12 agronomic treatments under three plants per hill and four nutrient levels, plant height was observed significantly higher with the treatment T10-N4P1, followed by T7-N3P1, T4-N2P1, T5-N2P2, T1-N1P1, T2-N1P2, T12-N4P3, T11-N4P2, T9-N3P3, T8-N3P2, T6-N2P3 and T3-N1P3 (Fig. 2.). Significantly higher canopy diameter was observed with the treatment T12-N4P3, followed by T6-N2P3, T9-N3P3, T11-N4P2, T3-N1P3, T5-N2P2, T7-N3P1, T8-N3P2, T10-N4P1, T2-N1P2, T4-N2P1 and T1-N1P1.

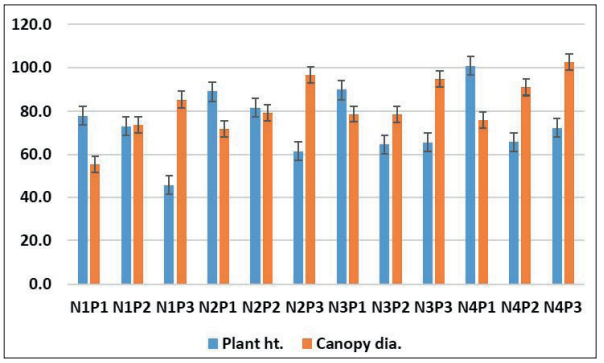


Fig. 2 Plant height and canopy diameter over different agronomic treatments.

MOLECULAR AND CHEMICAL CHARACTERIZATION OF GENUS *CREMANTHODIUM* BENTH.: A HIMALAYAN SUNFLOWER"

Project Investigator: Dr. Vikas Kumar

Project Associate: Rahul Kumar

Progress Summary:

Field Exploration and Taxonomic Characterization: During the period we surveyed Hemkund Sahib (Uttarakhand) and Baralacha and Rohtang Pass (Himachal Pradesh). These explorations resulted in the collection of four species belonging to the genus *Cremanthodium*. Collected specimens were dried, mounted, identified, and deposited in the institutional herbarium. Besides, a new species viz. *Cremanthodium kalaiselviae* Vik.Kumar & Rahul Kumar was discovered, originally collected from Dibang Valley of Arunachal Pradesh.

Molecular and Taxonomic Analysis: Molecular analyses of five species: *C. decaiseni*, *C. ellisii*, *C. dibangii*, *C. arnicoides*, and *C. kalaiselviae* were completed using the rbcL gene. A molecular phylogenetic analysis of *Cremanthodium* spp. with ITS and *trn*C-*pet*N genes was also conducted. During the study, we used sequence data from the nrDNA internal transcribed spacers (ITS) and the chloroplast *trn*C-*pet*N intergenic spacer to determine the molecular identity of 12 *Cremanthodium* species occurring in the Indian Himalayan Region and infer their phylogenetic relationships with other members of the genus. The ITS region exhibited higher sequence divergence (23.23 %) than *trnC–pet*N (2.56 %).

Phytochemical Work: UPLC-based polyphenol analysis of *C. ellisii* and *C. oblanciligulatum* has shown the presence of Protocatechuic acid, Vanillic acid, Caffeic acid, p-coumaric acid, and rutin in their leaves and roots. The GC-MS studies of *C. arnicoides*, *C. rhodocephalum,* and *C. thomsonii* have shown the presence of eremophilene, sesquiterpene, and monoterpenoids in their aerial and root parts.

TRANSCRIPTIONAL ARTISTS OF AMARANTHUS LEAF COLOR: DECIPHERING THE ROLE OF MYB TFS IN BETALAIN BIOSYNTHESIS"

Project Investigator: Dr. Gaurav Zinta

Objectives:

1. Comparative evaluation of betalain-producing and non-producing genotypes of *A. hypochondriacus* based on biochemical analysis
2. Identification of betalain biosynthesis MYBs based on their up-regulation in colored *A. hypochondriacus* genotypes.
3. Gene functional analyses including sub-cellular localization, interaction analysis of MYB-recognition element (MRE) with key target genes (e.g. ADH1, CYP76AD1-1 and DODA1), and validation in Arabidopsis.

Brief Progress:

- Comparative pigment analysis revealed significantly higher betalain accumulation in the red-leaf cultivar AH2, with elevated betacyanin and betaxanthin levels, whereas the green-leaf cultivar AH4 showed negligible pigment accumulation.
- A robust protocol for betalain extraction and quantification was standardised using acidified methanol and spectrophotometric analysis, enabling accurate estimation of pigments in both fresh and dried tissues.
- Genome-wide analysis identified 146 R2R3-MYB transcription factors in *Amaranthus hypochondriacus*. Phylogenetic analysis clustered several MYBs with known betalain-associated regulators from betalain-producing species such as pitaya and onion, and identified conserved R2R3 domains.
- Expression profiling showed significantly higher transcript accumulation of key betalain biosynthesis genes (*ADH, CYP76AD1,* and *DODA1*) and regulatory MYBs (*MYB2, MYB3,* and *MYB6*) in AH2, particularly in stems, petioles, and roots, correlating with enhanced pigment accumulation.
- A virus-induced gene silencing (VIGS) system was successfully established in amaranth using the *PDS* marker gene, which resulted in clear chlorophyll reduction and confirmed the efficiency of the silencing platform.
- VIGS constructs targeting key betalain-associated MYB transcription factors have been developed for functional validation of their role in pigment biosynthesis and regulation.
- VIGS constructs targeting key betalain-associated MYB transcription factors have been developed, and interaction analyses with their downstream target genes are currently underway.

EXPLORING THE POTENTIAL OF ORAL THIN FILMS FOR NUTRACEUTICAL DELIVERY

Principal Investigator: Dr. Ankit Saneja

In this work, we have developed a sustainable, ready-to-brew edible film as an eco-friendly alternative to conventional plastic packaging for instant beverages. The film was formulated using pullulan, Kollicoat® IR, and citric acid. Pullulan provides strong film-forming ability and good oxygen barrier properties, while Kollicoat® IR improves flexibility, mechanical strength, and rapid solubility. Citric acid acts as a safe crosslinker, improving structural stability through hydrogen bonding. To add functionality, we incorporated a phloretin-sulfobutylether-β-cyclodextrin inclusion complex, which improves the solubility and stability of phloretin, a natural antioxidant and antimicrobial compound. The films were prepared by solvent casting and then converted into heat-sealed pouches containing coffee powder. A Quality by Design approach was used to optimize the formulation for balanced strength, solubility, and barrier performance (Fig. 1).

Our results showed that the films had good mechanical strength, thermal stability, and low moisture permeability, while still dissolving rapidly in hot water within about 2 minutes. They also showed uniform appearance, indicating good distribution of the active compound. Functionally, the films exhibited antimicrobial activity (about 47% bacterial reduction) and antioxidant properties, without affecting the taste of the beverage, as confirmed by sensory analysis.

In nutshell, our work presents a practical and sustainable edible packaging system that combines biodegradability, functionality, and consumer convenience, offering a promising alternative to single-use plastic in instant beverages.

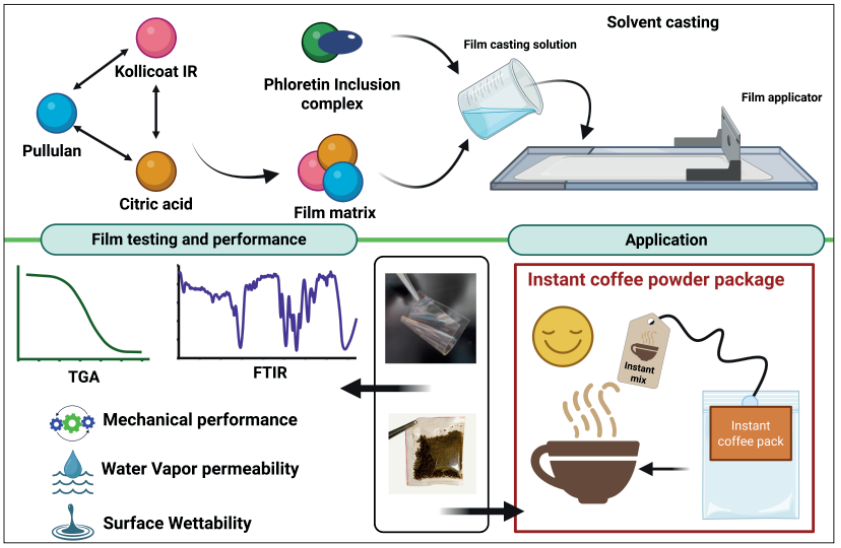
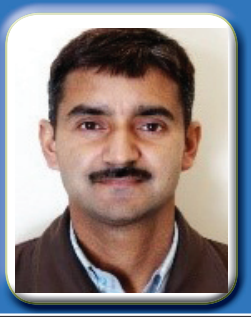


Fig. 1 Schematic illustration for the development of ready-to-brew edible films. Created with Biorender. com.

AGROTECHNOLOGY DIVISION

Sanatsujat Singh, Chief Scientist & Head
sanatsujat.singh@csir.res.in
Plant Breeding



The present research work is focused on breeding efforts for the improvement of aromatic plant, namely clary sage, for the development of new variety under the CSIR-Aroma Mission. Work has also been undertaken to understand the role of endogenous hormones and effect of exogenous hormonal-temperature treatments on seed dormancy and germination in Heeng.

Characterizing trait-specific populations and genetic diversity patterns in clary sage (*Salvia sclarea* L.) using SSR markers

Clary sage (*Salvia sclarea*) is an aromatic and medicinal herb widely grown across Europe, Western Asia, Maghreb, Middle East, and India. The purpose of this study was to assess the genetic diversity of clary sage genotypes from the Western Himalayas to support future breeding efforts. A total of 72 genotypes of clary sage from six distinct populations were examined using 49 simple sequence repeat (SSR) markers (**Fig. 1**). In total, 323 alleles were detected ranging from 1 to 16 with an average of 6.54 alleles per locus. Among these, 78.33% were common alleles, 1.86% were rare, and 19.81 % were frequent alleles. The results revealed an overall polymorphic information content of 93.88%, with an average of 0.71 (range 0.00-0.93) per marker locus, indicating high genetic variability among the studied material. The detected heterozygosity (0.52) was lower than the expected heterozygosity (0.71), pointing to a heterozygote deficit in the population. Analysis of variance showed considerable variability for biomass yield. Molecular analysis of variance (AMOVA) showed that genetic diversity was greater within individuals than among populations. Unweighted neighbour-joining, principal coordinate analysis, and population structure showed that the genotypes from different geographic regions and various biomass yield groups were predominantly admixed across clusters. The cluster-III represented the Bharmour population was the highest biomass performer group. The observed diversity patterns will facilitate plant breeders to make choices for breeding programs aiming for higher biomass yield in this plant.

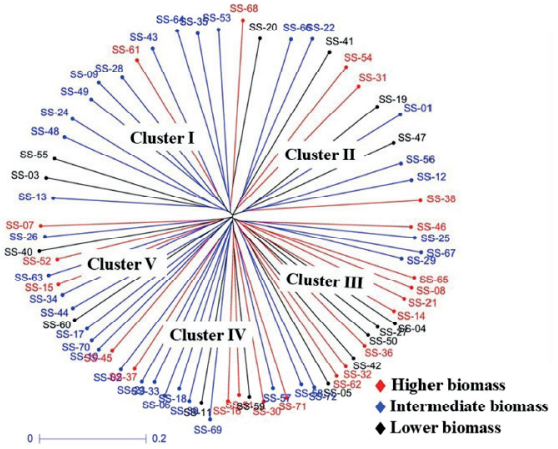


Fig. 1 Clustering patterns of all the 72 genotypes of clary sage based on SSR markers.

Differential role of endogenous hormones and effect of exogenous hormonal-temperature treatments on seed dormancy and germination in Heeng (*Ferula assa-foetida* L.) exotic seed accessions and its wild relative found in India *F. jaeschkeana* Vatke.

Ferula assa-foetida, a herbaceous perennial plant usually found in temperate regions, exhibits persistent dormancy when grown under ambient conditions. To address this, the present study investigated the role of endogenous and exogenous hormones in the germination of *F. assa-foetida* and its wild relative *F. jaeschkeana*. Comparative endogenous hormonal changes were analyzed at different stages of seed germination in both species using ultra-high-performance quadrupole time-of-flight mass spectrometry (UHPLC-MS). For exogenous treatments, seeds of both species were treated with three phytohormones, viz., gibberellic acid (GA_3), 6-benzylaminopurine (BAP), and kinetin (KIN), at three concentrations (50, 100, and 150 ppm) and two temperature conditions (4 °C and 25 °C) to break seed dormancy.

Results showed a significant abrupt change in hormone content during germination. The concentration of GA_3, indole-3-acetic acid (IAA), and jasmonic acid (JA) reduced successively in both species from the dry seed stage till seedling emergence, while abscisic acid (ABA) content increased significantly in imbibed seeds up to seedling emergence in *F. assa-foetida*. Besides, treatment of seeds with exogenous GA_3, BAP, and KIN in both species resulted in a significant

increase in germination percentage at 4 °C compared with 25 °C. Chilling treatment along with 50 ppm GA_3 hormone treatment increased the seed germination up to 94% and 78% in *F. assa-foetida* and *F. jaeschkeana*, respectively (**Fig. 2**). Hence, this study suggests that GA_3 can be used to boost overall seed germination, accelerate seedling development, and overcome seed dormancy in both *Ferula* species. Future investigations should focus on elucidating the molecular mechanisms underlying hormonal regulation during seed dormancy and germination in both species while optimizing synergistic hormonal treatments to accelerate germination and support its large-scale cultivation worldwide.

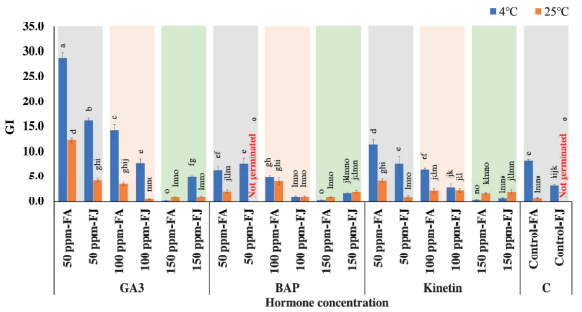


Fig. 2 Mean germination time (MGT) in *F. assa-foetida* (FA) and *F. jaeschkeana* (FJ) at 4°C and 25°C with different concentrations of gibberellic acid (GA_3), 6-Benzylamino-purine (BAP) and kinetin (KIN). Error bars represent the standard error (SE) of the mean, calculated from three replications.

Relevant Publications:

- Journal of Applied Research on Medicinal and Aromatic Plants. (2025), 47: 100646.
- South African Journal of Botany. (2025), 180: 274-285.

Research group: Ravi Kumar, Aniket, Mohar Singh, Niketa Yadav, Amit Rana, Rajni Devi and Ronika Thakur

Rakesh Kumar, Chief Scientist
rakesh.kumar03@csir.res.in
Agronomy

Our group is involved in development of agrotechnologies and generation of high-quality planting material for a variety of aromatic, medicinal, and industrial crops, *viz.*, *Rosa damascena*, *Tagetes minuta*, *Matricaria chamomilla*, *Pelargonium graveolens*, *Cymbopogon spp.*, *Crocus sativus*, *Ocimum spp.*, and *Hypericum perforatum etc.* We are also developing precision farming technologies of paddy and apple crops. Additionally, we assist entrepreneurs and farmers in producing saffron and low-chilling apple varieties in non-traditional places by offering technical guidance and hands-on training. We are also promoting low-chilling apple varieties in the North-Eastern region of India.

Optimization of harvesting period for improved yield and essential oil composition of aromatic marigold (*Tagetes minuta* L.) under acidic soil conditions of the Western Himalaya

Tagetes minuta, commonly known as wild marigold or aromatic marigold, is an aromatic herb of the family Asteraceae, valued for its essential oil (EO) in food, cosmetics, perfume, and medicinal industries. The experiment was conducted in 2025 to study the effect of different harvesting periods on growth, EO yield, and its chemical composition. T_1 (Sept. 15), T_2 (Sept. 30), T_3 (Oct. 15), T_4 (Oct. 30), and T_5 (Nov. 15) were the five harvesting treatments (at intervals of fifteen days) in the present investigation that corresponded to various harvesting dates. The September 15 harvest recorded the highest biomass yield, which is on par with the September 30 and October 30 harvests. Moreover, the October 30 harvest recorded significantly higher EO content and ultimately maximum EO yield than other treatments (**Fig. 1**). Furthermore, *(Z)-β*-Ocimene constituent gradually increased from September 15 harvest to October 30 harvest and was recorded significantly higher on October 30 harvest, *(Z)*-Tagetone followed the reverse trend. Dihydrotagetone and *(Z)*-Ocimenone were recorded comparatively higher at the November 15 harvest (**Fig. 2**).

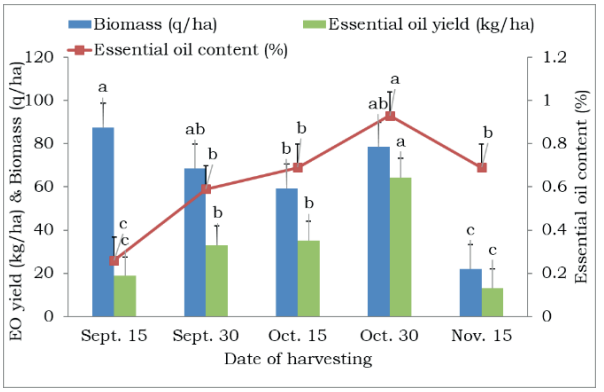


Fig. 1 Effect of different harvesting periods on biomass yield, essential oil content, and essential oil yield of aromatic marigold.

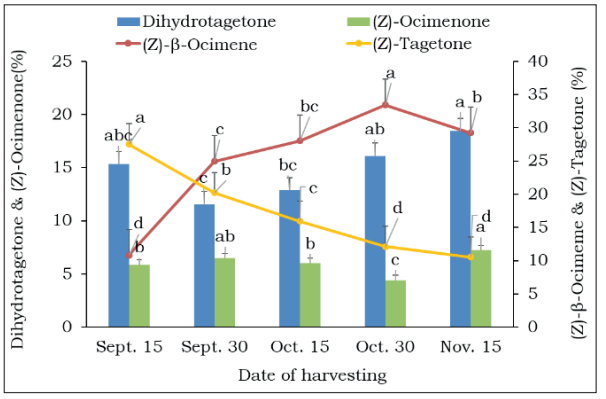


Fig. 2 Effect of different harvesting periods on major constituents of aromatic marigold essential oil.

Relevant Publications:

- Indian Journal of Natural Product Research. (2026), 17(1): 144-154.
- Plant Biosystems. (2026), 160(79).
- BMC Plant Biology. (2026), 26: 489.

Research group: Dr Kiran Singh Saini, Dr Arvind Verma, Surbhi Sharma, Akhilesh Kumar Sharma; Project Fellows: Ayush Paul, Sumedha Thakur, Saizal Jamwal, Priyanka Raj, Swati, Shalini Jariyal, Ankush Garla, Shubham, Nidhi Negi, Dr Neha Thakur, Niharika, Himanshu Saini, Anchal Thakur, Dr Abhinav Rathi and Aditya.

Probir Kumar Pal, Senior Principal Scientist
probir.pal@csir.res.in
Agronomy

India's agricultural research has traditionally focused on staple crops, with comparatively limited attention on medicinal and aromatic plants (MAPs). These crops are rich in essential oils and bioactive compounds and hold significant potential across pharmaceutical, nutraceutical, food, and cosmetic industries. Moreover, MAPs offer a viable pathway for crop diversification, improved land-use efficiency, enhanced farm income, particularly in marginal and rainfed regions. However, the lack of standardized agronomic practices and region-specific agrotechnology continues to constrain their large-scale adaptation. Addressing this gap requires the development of scientifically validated and farmer-friendly production system.

In this context, our research is directed toward developing robust agronomic strategies. The objective is to enhance productivity, ensure quality consistency, and facilitate the translation of research outcomes into practical field-level solutions. Specifically, our group focuses on developing climate-resilience agronomic practices in *Stevia rebaudiana*, a natural non-caloric sweetener rich in steviol glycosides (SGs). Emphasis is placed on improving drought tolerance and reducing dependency on inorganic fertilizers. A pot experiment was conducted to evaluate the effect of seaweed-based bio-stimulant on the growth, yield, and secondary metabolite accumulation in *S. rebaudiana* under moisture stress conditions. Principal component analysis (PCA), network modelling, and k-means clustering elucidated a clear separation between agro-morphological traits and stress-resistance parameters, with NR activity playing as a central link between agronomic traits and SGs biosynthesis (**Fig. 1**). PCA decides a strong agro-physiological and biochemical dichotomy between well-watered and drought situations, suggesting a coordinated swing in growth, metabolism, redox homeostasis, and soil biochemical activity.

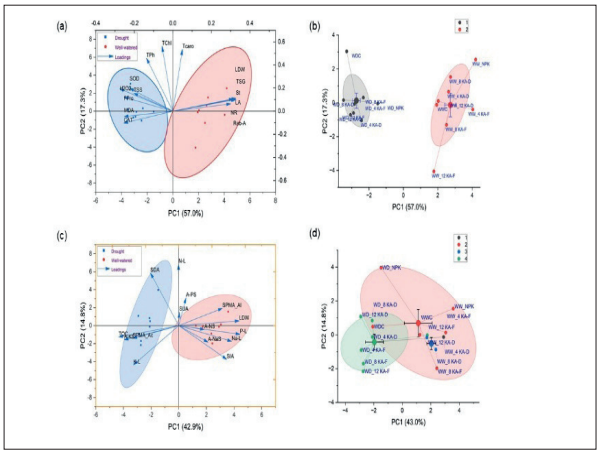


Fig. 1 Principal component analysis and clustering of plant functional, metabolic, ionic, and soil enzymatic traits of stevia.

Valeriana jatamansi Jones is a Himalayan herb, commonly known as Indian valerian. The roots/rhizomes are a rich source of high-value essential oil and valepotriates. A field trial was executed with twelve treatment arrangements involving two cultural practices (CP) (deheading and no-deheading) and six N levels (0-200 kg ha^{-1}) to comprehend how deheading practice and N modulate growth and essential oil biosynthesis.

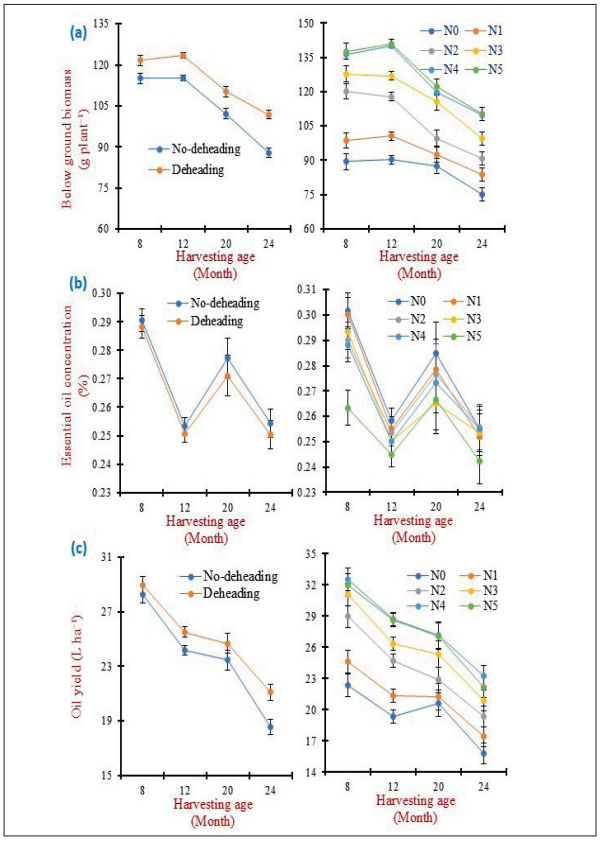


Fig. 2 The changes in (a) fresh below-ground biomass yield, (b) oil concentration, and (c) oil yield of *V. jatamansi* in response to different cultural practices and N levels at different harvested ages.

Irrespective of CP and N levels, the maximum BGB and oil yield were registered at 12 and 8 months after transplanting (MAT), respectively. Deheading increased BGB and essential oil yield by 6-16% and 3-14%, respectively, compared with the no-deheading (**Fig. 2**). Irrespective of the CP, the BGBs and oil yield were significantly ($p \leq 0.05$) increased by around 39-56% and 31-48%, respectively, with N at 200 kg ha^{-1} compared with the control. However, the effects of applying N at 160 and 200 kg ha^{-1} were at par ($p \geq 0.05$).

The data indicate a clear trade-off between growth and secondary metabolite concentration. Deheading and higher nitrogen levels favor biomass accumulation and overall oil yield, while oil concentration is more sensitive to plant developmental stage than to these treatments.

Monk fruit (*Siraitia grosvenorii*) is a unique herbaceous perennial plant. It contains cucurbitane-type triterpene glycosides known as mogrosides. Among them, mogroside-V is extremely sweet. The problem highlights a key physiological constraint in monk fruit, where prolonged dormancy delays sprouting and limits crop establishment and productivity. Dormancy release in monk fruit is likely associated with a metabolic shift. Therefore, monitoring these biochemical changes can serve as a reliable indicator of dormancy status.

Dormancy release is associated with high soluble sugars, low starch, and relatively lower phenolic content, and the observed sex-based differences suggest inherent physiological variation that can be targeted to optimize sprouting and cultivation strategies.

Picrorhiza kurroa Royle ex Benth. commonly called as kutki or kutaki, is an endangered perennial rhizomatous medicinal herb. It contains iridoid glycosides (picroside I and picroside II). The agro-morphological data were collected from different locations under the influence of environmental and edaphic factors on growth. The **Fig. 3** shows that Vaduk showed significantly higher plant height (45.70 cm) and root length (19.30 cm) compared to Shangarh and Ghes.

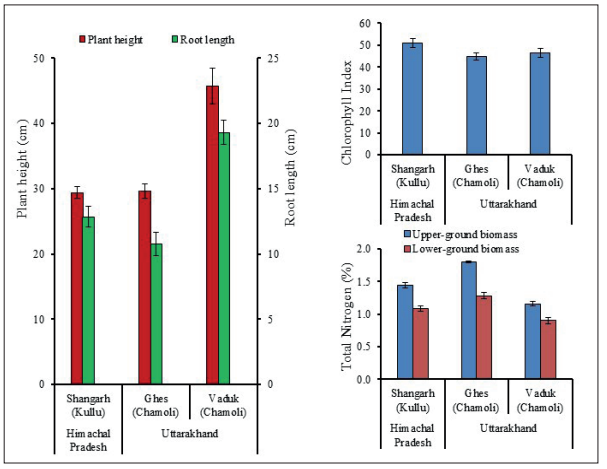


Fig. 3 Plant height, root length, chlorophyll index, and nitrogen concentration of *Picrorhiza kurroa* plants from the different hill regions.

Shangarh recorded the highest chlorophyll index (51.01), followed by Vaduk (46.46) and Ghes (44.90). Nitrogen partitioning (%) was highest in Ghes, followed by Shangarh, and lowest in Vaduk.

Relevant Publications:

- Journal of Soil Science and Plant Nutrition. (2026), 26:1190–1205.
- Pedosphere (2026).
- Chemistry & Biodiversity. (2025), 0:e00413.

Research group (From Left to right): Ashish Kumar, Banish Guleria, Dr. Babit Kumar Thakur, Mr. Ramjee Lal Meena, Mitakshi, Shailja, Shivani, Dr. Neerja Kharwal

Gireesh Nadda, Senior Principal Scientist
gireesh.naada@csir.res.in; training.ihbt@csir.res.in; skill.ihbt@csir.res.in
Entomology and Pest management
Coordinator-JIGYASA; Skill Development Programme; MSME; Trainings and Research Internship; Students' Visit

Development of biopesticides

In the pursuit of identifying potential leads for the development of effective biopesticides, we evaluated native entomopathogenic fungi (EPF) against a range of economically important insect and mite pests. Amongst the tested isolates, *Beauveria bassiana* showed promising insecticidal and acaricidal activities against Diamondback moth (*Plutella xylostella*), aphids (*Aphis craccivora*), and mites (*Tetranychus urticae*).

At a concentration of 1×10^9 conidia/mL, *B. bassiana* resulted 100% mortality in both insects, *P. xylostella* and *A. craccivora*, and 98.89% mortality in *T. urticae*, seven days post-treatment (**Fig. 1**). Furthermore, *T. urticae* was the most susceptible species ($LC_{50}=0.57\times10^6$ conidia/mL), followed by *P. xylostella* ($LC_{50}=0.62\times10^6$ conidia/mL) *and A. craccivora* ($LC_{50}=0.86\times10^6$ conidia/mL).

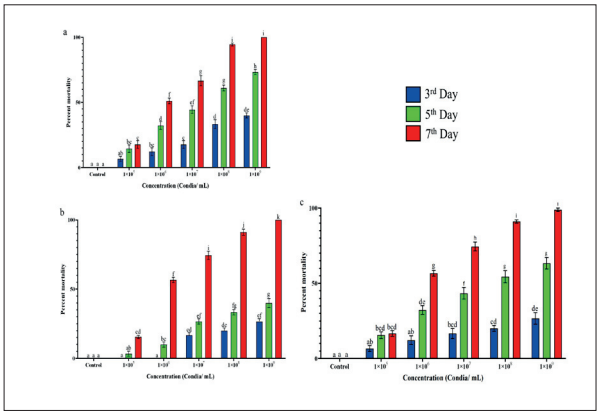


Fig. 1 Percentage mortality exhibited by *Beauveria bassiana* against a) *Plutella xylostella*; b) *Aphis craccivora*; c) *Tetranychus urticae* at different concentrations (1×10^9, 1×10^8, 1×10^7, 1×10^6, 1×10^5 conidia/mL).

First report of *Myzus persicae* infesting *Ferula assa-foetida* (Heeng)

Ferula assa-foetida (Heeng), a historically important spice in India, has only recently been introduced for cultivation in India by CSIR-IHBT. We report the first incidence and identification of *Myzus persicae* infesting *F. assa-foetida* in Himachal Pradesh, India. Aphid infestation was observed under greenhouse conditions, with symptoms including leaf curling, chlorosis, stunted growth, and honeydew secretion (**Fig. 2**). The species was identified based on morphological traits (**Fig. 3**) and DNA barcoding using the cytochrome c oxidase subunit I (*COI*) gene. These findings indicate potential threat to *F. assa-foetida* cultivation and highlight the necessity for developing region-specific integrated pest management (IPM) strategies.

Fig. 2 Infestation of heeng plant (*F. assa-foetida*) by the *Myzus persicae* under greenhouse conditions.

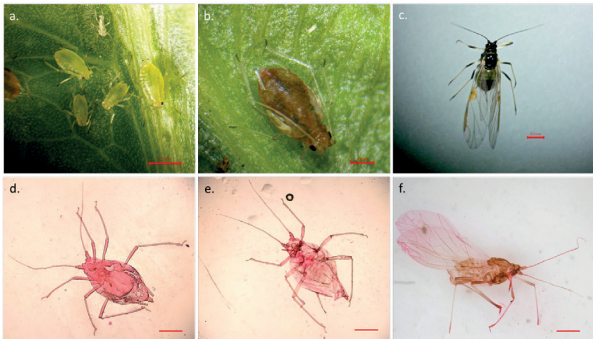


Fig. 3 Infestation and microscopic images of *Myzus persicae* collected from *F. assa-foetida* a) Nymphal stages actively feeding on a leaf; b) Reddish-brown apterous adults on the leaf surface; c) Alate adult; d) Dorsal view of stained adult; e) Ventral view of stained adult showing overall body morphology; f) Stained specimen of a winged adult. (Scale bar: 0.5 mm).

Ophiocordyceps indica from the Indian Himalayas ameliorates the IgA nephropathy in mice

In direction of developing therapeutics from Himalayan bioresources, our research group identified the nephroprotective potential of a newly identified Himalayan Bioresource, *Ophiocordyceps indica*, Gireesh Nadda & Aakriti Sharma 2023. In the present study, hot water extract of *O. indica* demonstrated a profound

ability to modulate the pathogenesis of IgA Nephropathy (IgAN).

The extract significantly lowered the levels of galactose-deficient IgA1 (Gd-IgA1), the primary immune biomarker for the disease, while simultaneously suppressing pro-inflammatory cytokines specifically (TNFα, IL-6, IL-18) indicating its strong anti-inflammatory and immunomodulatory effects. Furthermore, histological and molecular analyses demonstrated a marked amelioration of glomerular hypertrophy and tubular degeneration, alongside the significant downregulation of key fibrotic and kidney injury markers, including TGFβ, αSMA, Nephrin, *WT1, VEGF*, and *Desmin* (**Fig. 4**). Notably, the nephroprotective and anti-inflammatory effects of *O. indica* were found to be comparable to those of *O. sinensis* and dexamethasone. Collectively, these results establish *O. indica* as a promising Himalayan-derived therapeutic candidate for the effective management of IgA Nephropathy.

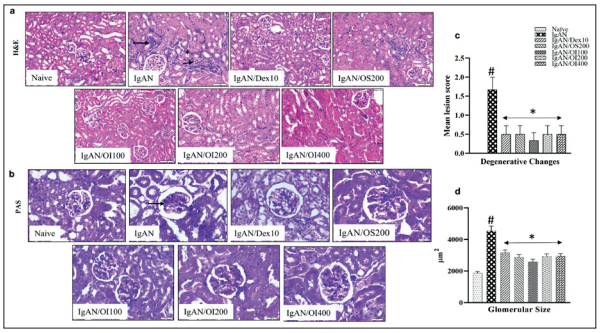


Fig. 4 a) Representative H&E staining images among various groups. Naïve group showing normal glomerulus (*asterisk) and tubules (arrow). IgAN group showing tubulointerstitial nephritis with infiltration of inflammatory cells (arrow) and enlarged glomerulus (*asterisk). Treatment group showing reduced severity of the pathological lesions; b) Representative images of PAS staining showing the mesangial proliferation and expansion in IgAN group (arrow) and reduced severity of mesangial proliferation in treated groups; c-d) Graph representing degenerative changes and glomerular size. # represents p.

Apiculture in SMART villages

Surveyed the proposed four smart villages *viz.* Swaipra, Rajasthan; Junakimondal, Assam; Rajnagar, Madhya Pradesh and Kusunpur, Odisha for motivating farmers to adopt Apiculture in these villages to generate extra income and increasing pollination. Besides, maintained the apiary of CSIR-IHBT and monitored the activities of clusters associated with CSIR-IHBT.

Advisory Services

Provided advisories to the tea planters, and farmers for management of insect and mite pests of tea, floriculture, medicinal, aromatic and other mandate crops for timely management of insect and mite pests.

Social Scientific Responsibility (SSR) Activities

Coordinated and conducted CSIR- JIGYASA, a student-scientist connect programme and other SSR activities of the Institute for students and faculties of schools (JNVs, KVs, Govt. and Public Schools), colleges, universities and different institutes. A total of 12,399 students and faculty members participated and benefitted from different SSR activities during 2025-26.

Year 2026-26	Students and Teachers
School students and teachers (Jigyasa Programme)	10,539
College / University/ Institute students	1,860
Total	**12,399**

"One Day As a Scientist" (ODAS)

As nodal, organized a five-day programme, ODAS from 21-25 July 2025 wherein 454 students from 26 schools across four districts of HP participated.

Skill Development Programmes at CSIR-IHBT

Coordinated different Skill Development Programmes (SDPs) and activities of the Institute including CSIR-Integrated Skill Initiative Programme. A total of 1050 persons were trained in different SDPs, out of which 273 were research interns/ trainees (UG/ PG and PhD. students) from different states and UTs.

16 Faculty members got certification of "Master Trainer" of National Skills Qualifications Framework (NSQF) aligned 16 Agriculture Skill Council of India (ASCI) courses.

This year, 11 NSQF aligned courses were conducted and 14 students successfully passed these courses and got certificates.

Linkages

Established linkages with various stakeholders/ organizations/ departments for different activities and programs, as follows:

Gujarat State Biotechnology Mission (GSBTM)

Academic and research institutions of Pan India (for summer and winter research internship/ training programs for UG, PG, Ph.D. students; Educational and exposure visits of students and faculty members)

Jawahar Navodaya Vidyalayas, Kendriya Vidyalayas and some Govt. and Public Schools of H.P. under JIGYASA programme.

Relevant Publications:

- Applied Biochemistry and Biotechnology. (2026), 1-21.
- International Journal of Tropical Insect Science. (2026), 1-7.
- Archives of Phytopathology and Plant Protection. (2025), 58(17): 947-965.

Research group: Mr. Aditya Singh Ranout, Mr. Rahul Kumar, Ms. Rupinder Kaur, Ms. Kumari Priyanka, Ms. Ritika Chaudhary, Ms. Shakshi Choudhary, Mr. Manthan Sood, Mr. Sahil Sharma, Ms. Trisha Dogra, Ms. Shagun Chambyal, Ms. Ronika Thakur, Mr. Akshit Sood, Ms. Bandana Kumari, Mr. Kapil, Mr. Pankaj Kumar, and Mr. Kashmir Singh.

Bhavya Bhargava, Principal Scientist
bhavya.bhargava@csir.res.in
Smart Cultivation Systems for Floriculture/ Himalayan Wild Ornamentals/ Post-harvest Management of Cut Flowers

Our lab focuses on Smart Cultivation Systems for floriculture and the conservation and utilization of Himalayan wild ornamentals. We also work on postharvest management strategies to enhance the quality and shelf life of cut flowers.

A high-efficiency tissue culture protocol for the domestication and mass propagation of *Incarvillea emodi* (Wallich ex Royle) Chatterjee: a valuable wild ornamental and medicinal plant species

Incarvillea emodi is a valuable wild ornamental and medicinal plant with limited natural propagation, necessitating efficient *in vitro* techniques for its conservation and large-scale multiplication. The present study developed a high-efficiency regeneration protocol using nodal explants for rapid and sustainable propagation (**Fig. 1**). Maximum shoot regeneration (93.33±0.88%) with 4.24±0.76 shoots per explant and shoot length of 4.47±0.84 cm was achieved on MS medium supplemented with 1.0 mg L^{-1} mT + 0.25 mg L^{-1} NAA. Enhanced shoot proliferation (14.45±0.57 shoots; 8.53±1.78 cm length) was observed with the addition of 0.30 mg L^{-1} GA_3. Rooting was highest (94.73±0.37%) on half-strength MS medium with 0.5 mg L^{-1} IBA, while acclimatization resulted in 82.55% survival. *In vitro* plants exhibited higher photopigments, phenolics, flavonoids, antioxidant activity, and volatile compounds, along with improved leaf morphology and photosynthetic efficiency compared to donor plants. Overall, the protocol provides a reliable system for mass propagation, domestication and commercial utilization of *I. emodi.*

Fig. 1 A novel multistep micro-propagation protocol for *I. emodi* (Wallich ex Royle) Chatterjee.

Morphological traits and biochemical and volatile compound composition along with gene expression profiling in *Chrysanthemum morifolium* under soil and soil-less conditions

Chrysanthemum morifolium, a commercially important ornamental crop, faces limitations in conventional soil cultivation, necessitating efficient alternatives, such as soil-less systems. The present study evaluated the impact of Dutch bucket soil-less cultivation on morpho-physiological, biochemical, and molecular traits across different cultivars. Soil-less cultivation, *i.e.,* Dutch bucket soil-less cultivation, showed superior performance compared to soil conditions. Plant height increased up to 70.30 cm, flower diameter reached 10.39 cm, and flowering was accelerated to 77.6 days (**Fig. 2**). Flower biomass improved with fresh weight up to 6.71 g, while chlorophyll content index increased to 45.93. Biochemical traits such as total carbohydrates (2.67 mg/100 g FW) and carotenoids (3.01 mg/mL) were higher

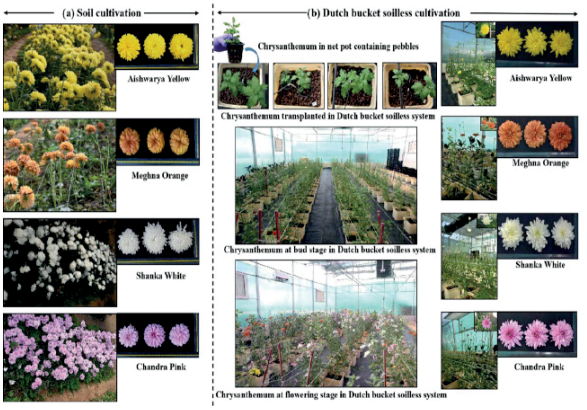


Fig. 2 Pictorial representation of different cultivars of *C. morifolium* cultivated under the soil and Dutch bucket soil-less cultivation system: (a) soil cultivation and (b) soil-less cultivation.

under soil-less systems. A total of 49 volatile compounds were identified, with eucalyptol dominating up to 31.62%, and the expression of differentially expressed genes involved in flavonoid biosynthesis, plant hormone signal transduction, and photosynthesis was higher in flowers cultivated under soil-less conditions compared to soil conditions. Overall, soil-less cultivation demonstrated its potential for high-quality and sustainable chrysanthemum production.

Morphological and biochemical analysis along with gene expression dynamics in Lilium 'Brunello' under supplemented effect of blue and red light treatment in pin tray soil-less cultivation system

Lilium, a facultative long-day plant, can grow under diverse light conditions but requires extended photoperiods for optimal flowering. The integration of LED illumination with automated greenhouse and soil-less cultivation systems offers a promising approach to enhance productivity, resource-use efficiency, and year-round flower production. This study investigated the influence of blue, red, and combined light spectra on growth, biochemical traits, and gene expression in Lilium under a soil-less cultivation system. Combined BL + RL treatment significantly improved plant height (79.59 cm), stem diameter, bud size, and flower diameter, while accelerating flowering. Biochemical attributes, including chlorophyll, carotenoids, phenolics, flavonoids, and antioxidant activity, were also maximized under BL + RL. Postharvest longevity was extended up to 13.2 days. Gene expression analysis revealed upregulation of flowering promoters (*FT*, *CO9*) and downregulation of *FLC*, indicating enhanced floral induction and productivity. Overall, the synergy between optimized light spectra and soil-less cultivation provides an efficient strategy for high-quality and sustainable Lilium production under controlled environments (**Fig. 3**).

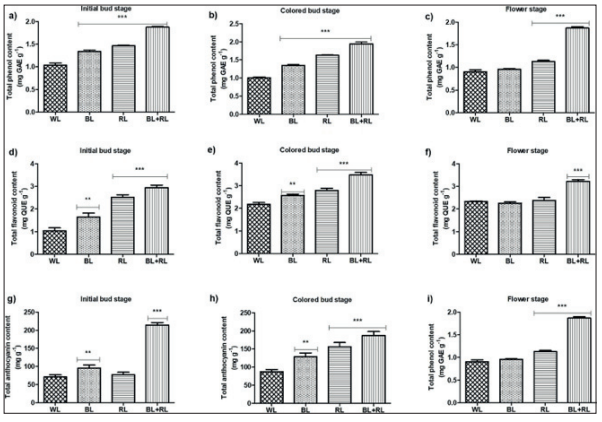


Fig. 3 Estimation of total phenol, flavonoid, and anthocyanin content in lilium cultivar grown in varying light treatments (WL; white light, BL; blue light, RL; red light, BL + RL) under pin-tray soil-less conditions. a) phenol content at initial bud stage; b) phenol content at colored bud stage; c) phenol content at flower stage; d) flavonoid content at initial bud stage; e) flavonoid content at colored bud stage; f) flavonoid content at flower bud stage; g) anthocyanin content at initial bud stage; h) anthocyanin content at colored bud stage; i) anthocyanin content at flower stage.

Evaluating the benzene removal efficiency of *Ficus elastica* in closed-chamber conditions

Indoor air pollution by volatile organic compounds such as benzene poses significant health risks due to their carcinogenicity and persistence in enclosed spaces. Phytoremediation using indoor ornamental plants such as *F. elastica* has emerged as a sustainable and cost-effective alternative to conventional air purification methods. *Ficus elastica*, owing to its large leaf surface and adaptability, demonstrated efficient benzene removal under controlled conditions, with higher plant density significantly enhancing pollutant reduction. A rapid and significant reduction in benzene concentration (up to ~70–80%) was observed within 24 hours, with higher plant density showing enhanced removal efficiency and probable transformation into less toxic compounds. The maximum decline occurred during the initial exposure phase, indicating active uptake and metabolism. The plant also exhibited increased physiological activity, suggesting internal detoxification and possible transformation of benzene into less toxic compounds. These findings highlight *F. elastica* as an effective, low-cost biofilter for improving indoor air quality (**Fig. 4**).

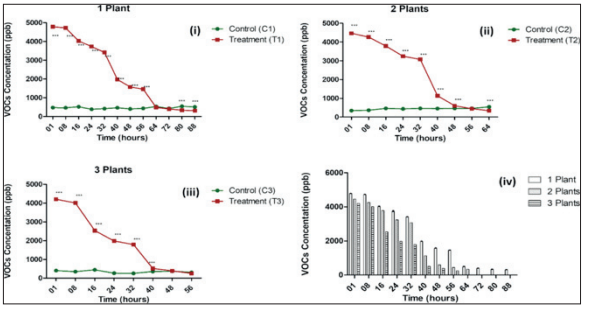


Fig. 4 Reduction in benzene (VOC) concentration over time in a closed chamber with varying plant densities: (i) one plant, (ii) two plants, (iii) three plants, and (iv) comparative analysis showing enhanced benzene removal with increasing plant number.

Silver nanoparticles and graphene oxide synergistically improves the postharvest life of *Narcissus tazetta* L., a wild ornamental flower

Narcissus tazetta L., commonly known as Nargis in India, is a widely recognized wild ornamental plant. It is a perennial, bulbous crop of significant floricultural value and belongs to the Amaryllidaceae family. However, its short blooming period reduces its commercial appeal. Hence, the current study was designed

to develop an efficient nanotechnology-based approach to enhance vase life and postharvest quality of *N. tazetta* through the application of graphene oxide (GO) and silver nanoparticles (SNP). Combined application of GO + SNP (1 µL L^{-1}) significantly extended vase life by ~6 days compared to the control (**Fig. 5**). The treatment improved water uptake and maintained relative fresh weight, while reducing electrolyte leakage, lipid peroxidation, and browning, thereby delaying senescence. Enhanced accumulation of carotenoids, phenolics, flavonoids, and soluble sugars was observed, indicating improved metabolic stability. Additionally, increased antioxidant enzyme activities (APX, POX) and regulation of carotenoid biosynthesis-related genes contributed to oxidative stress mitigation and pigment retention. Overall, the synergistic effect of GO and SNP provides a promising strategy for improving postharvest longevity and quality of ornamental flowers through nanotechnological interventions.

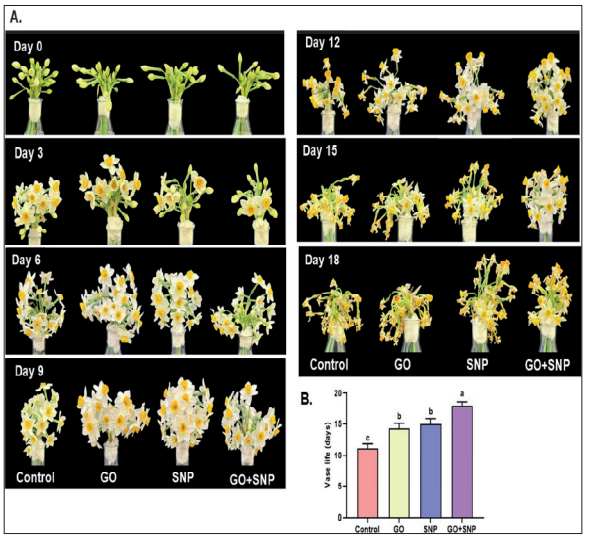


Fig. 5 Effect of different treatments of graphene oxide (GO) and silver nanoparticles (SNP) on vase life of narcissus (A) vase life at 0, 3, 6, 9, 12, 15 and 18 day on cut scapes of *Narcissus tazetta* (B) vase life in days.

Relevant Publications:

- Plant Cell, Tissue and Organ Culture (PCTOC). (2025), 162: 12.
- ACS Agricultural Science and Technology. (2025), 5: 701−713.
- Journal of Photochemistry & Photobiology, B: Biology. (2025), 265: 113168.

Research group: Dr. Vipasha Verma, Dr. Megha Katoch, Dr. Aparna Misra, Dr. Payal Kapoor, Dr. Deekshith HN, Dr. Nishtha Vashishtha, Dr. Kamlesh, Dr. Nitesh Kaushal, Dr. Ragini, Dr. Karthik R., Diksha Thakur, Anjali Chandel, Priti, Diksha Sharma, Himanshi Gupta, Shagun Rana, Gulshan Birsanta, Ujala, Sourabh Kumar, Neeraj Barwal, Deepti, Chhering Youdon, Rahul Bodh

Jeremy Dkhar, Principal Scientist
jeremy.dkhar@csir.res.in
Plant Biology

I work in the area of plant biology, with emphasis on plant evolution and development.

Tuber formation in Kala Jeera (*Elwendia persica*)

Work on understanding the physical and biochemical triggers of tuber formation (**Fig. 1**) in Kala Jeera has been initiated. High temperature affected tuber formation in Kala Jeera.

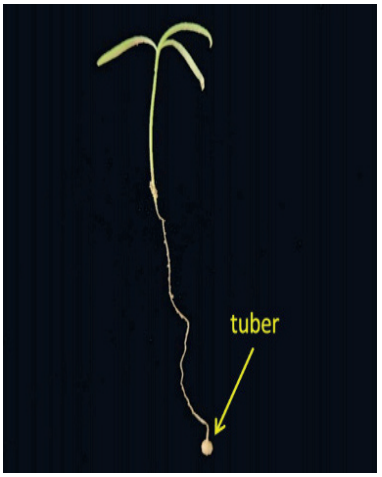


Fig. 1 Kala Jeera seedling showing the tuber formed at the tip of the root.

Seed dormancy in *Carum carvi*

Similar to Kala Jeera, *C. carvi* seeds show underdeveloped embryos (**Fig. 2**). Therefore, cold stratification is required to promote embryo growth. Interestingly, cold treatment in dark condition failed to promote seed germination in *C. carvi*.

Fig. 2 Dissected seed of *Carum carvi* showing an underdeveloped embryo.

A new species of *Cremanthodium* from Arunachal Pradesh, India

Cremanthodium kalaiselviae Vikas Kumar & Rahul Kumar (Asteraceae, Senecioneae) was described and illustrated as a new species from Arunachal Pradesh, India. Molecular phylogenetic analysis of the ITS region revealed that the new species is closely related to a group of species comprising *C. campanulatum* and *C. atrocapitatum* (**Fig. 3**).

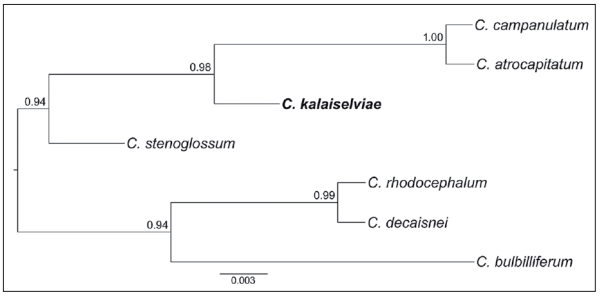


Fig. 3 Midpoint-rooted 50% majority-rule consensus phylogram of 3002 trees, obtained from two runs of Bayesian analysis of the ITS sequences, implementing the SYM+I model. Posterior probability values are indicated at the nodes, and branch lengths denote the number of changes per site.

Relevant Publications:

- Annales Botanici Fennici. (2025), 62: 183–188.
- Botany Letters. (2025), 172: 559-571.

Research group (Left to Right): Yogesh, Foola, Renu, Rakesh, Kiran, Jeremy, Manisha, Shaina, Diksha, Shivangi, Atul

Poonam Kumari, Senior Scientist
poonam.kumari@csir.res.in
Floriculture

We work in the area of edible flowers, production technology of floricultural crops and value addition in floriculture.

Comparative evaluation of drying techniques on bioactive compounds, nutritional quality, and anti-nutrients of Kachnar (*Bauhinia variegata* L.) flowers

Recently, edible flowers have garnered the attention of researchers and industries owing to their nutritional, phytochemical, and therapeutic properties. They are rich sources of bioactive compounds, such as polyphenols and flavonoids, which contribute to their antioxidant, anti-inflammatory, and antimicrobial activities. Kachnar (*Bauhinia variegata*) is a deciduous tree widely found in South and Southeast Asia. Kachnar flowers and buds have been traditionally consumed and are even used in Ayurvedic formulations. This study evaluated the nutritional, phytochemical composition, and anti-nutritional factors of kachnar flowers collected from two locations (Mandi and Palampur) and dried using three methods: dehumidifier drying, oven drying, and shade drying. The nutritional analysis revealed a non-significant effect of drying method on ash content, ranging from 6.02 to 6.47%. The flowers from Mandi recorded slightly higher fat and protein concentrations than those from Palampur. Shade-drying treatment was most effective in preserving phytochemicals, irrespective of location location (**Fig. 1** & **Fig. 2**). The shade-dried flowers from Mandi had the highest carotenoid content (202.15 mg/100 g), while the oven-dried flowers from Palampur had the lowest (140.68 mg/100 g). A similar trend was observed for total phenolics and flavonoid content. The α-amylase inhibition was also highest for shade dried samples from Mandi (36.34 %). Anti-nutritional factors like alkaloids, saponins, phytates and tannins were also analysed in the study with oven dried samples showing comparatively lower concentrations. Shade dried and dehumidifier dried samples also exhibited good antimicrobial activity against some common pathogenic bacteria. The results highlight the potential of kachnar flowers as a source of biocative compounds and their potential application in functional foods and value added products.

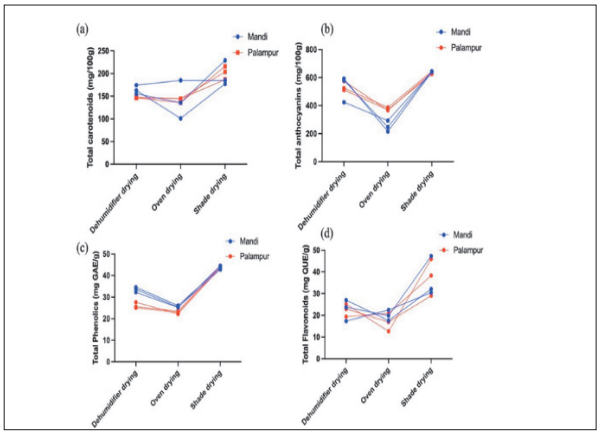


Fig. 1 Phytochemical content of kachnar flower dried using three different methods.

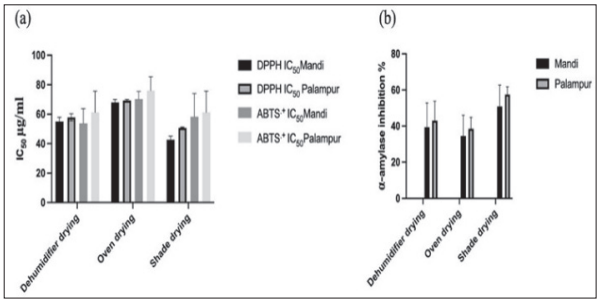


Fig. 2 Antioxidant activity (DPPH IC50 & ABTS.+ IC50 radical scavenging activity) and α-amylase inhibition of dried kachnar flower powders (Error bars indicate ± SE).

Salicylic acid-mediated salicylic acid-mediated enhancement of growth and bioactivity in edible flowers of pot marigold (*Calendula officinalis* L.)

Calendula (*Calendula officinalis*), commonly known as pot marigold, is a globally valued flower recognized for its ornamental appeal, edibility, and diverse bioactive properties. In the present study, the effects of foliar application of salicylic acid (SA) at different concentrations (50–200 mg/L) were evaluated under greenhouse conditions. The effect on various vegetative and floral growth parameters, along with their effect on phytochemical content, antioxidant activity, antimicrobial activity, and α-amylase inhibition activity of the flowers, was evaluated. The results showed that foliar spray of SA at a concentration of 100 mg/L was most effective for vegetative and floral growth, leading to improved plant height, leaf area, plant spread, flower weight, and flower size

in comparison to the control. The 200 mg/L SA treatment resulted in the highest levels of total phenolics, flavonoids, and carotenoids, as well as the highest antioxidant capacities (DPPH and ABTS+ assays). The α-amylase inhibition and antimicrobial activities were observed to increase at higher concentrations of foliar spray of SA (**Fig. 3**). The HPLC analysis of phenolic compounds revealed that rutin was the predominant phenolic compound in calendula flowers, with the highest concentration of 1064.65µg/ 100 mg recorded for treatment T3 (**Table 1**). This investigation underscores the efficacy of salicylic acid foliar application as a viable approach to improve agronomic performance and nutraceutical quality in calendula, presenting significant implications for its application in functional food, pharmaceutical, and ornamental sectors.

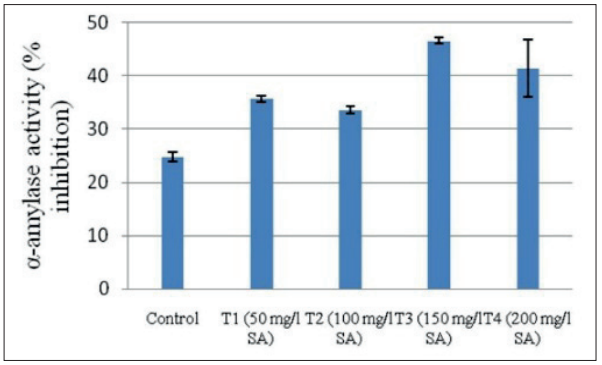


Fig. 3 α-amylase inhibition activity of calendula flower extracts. (Error bars indicate ± SE).

Table. 1 Quantification of phenolic compounds present in flowers of different treatments of foliar spray of SA using HPLC-DAD.

Treatment	Gallic acid, µg/100 mg	Rutin, µg/100 mg	Cinnamic acid, µg/100 mg	Quercetin, µg/100 mg	Catechin, µg/100 mg
Control	17.87	988.92	–	–	–
T_1 (50 mg/L)	16.63	877.60	12.90	–	–
T_2 (100 mg/L)	14.28	790.46	–	–	–
T_3 (150 mg/L)	18.45	1064.65	18.22	–	–
T_4 (200 mg/L)	22.05	696.46	–	–	–

Relevant Publications:

- New Zealand Journal of Crop and Horticultural Science. (2026), 54: e70021
- Journal of Environmental Biology. (2025), 46(5): 739-747

Research group: Sonia Sharma, Garima Kumari, Shubham Samkaria, Ananya Sood, Harman, Mrinali Sood, Payal Chauhan

Satbeer Singh, Senior Scientist
satbeer.singh@csir.res.in
Plant Breeding

In our 'Plant Breeding' lab we are working on genetic improvement and varietal development of German chamomile (*Matricaria recutita*), lavender (*Lavandula angustifolia*), pushkarmool (*Inula racemosa*), clary sage (*Salvia sclarea*) and quinoa (*Chenopodium quinoa*). We are evaluating cinnamon (*Cinnamomum verum*) for its introduction in non-traditional areas. Also, focusing on the revival of traditional plants such as grain amaranth species and different millets in Himachal Pradesh through the identification of potential variability.

Diversity patterns in lavender (*Lavandula angustifolia* Mill.)

A total of 61 genotypes developed through hybridization among four parental lines ('IHBT-3', 'AK-1', 'SeK-1', and 'No9') were evaluated in an augmented block design comprising four blocks and five checks. Rooted cuttings from each genotype were planted in paired rows of 2 meters by keeping 60 cm row to row and 45 cm plant to plant spacing. Also thirty-one SSR primer pairs were tested for molecular characterization.

The Euclidean distance-based cluster analysis based on phenotypic traits grouped 61 lavender genotypes into three phenotypic clusters labelled P-I, P-II, P-III comprising 22, 22, and, 17 genotypes, respectively, from which predominant presence of low spike yielding genotypes (8 nos.) were present in cluster P-III. While most genotypes were distributed across all three clusters irrespective of their pedigree and spike yield (**Fig. 1**), genotypes from the same parental cross were frequently dispersed across different plot regions, whereas some from different crosses clustered together. Similarly, the genetic relationship among lavender genotypes was also assessed based on SSR markers and the clustering based on roger's distance grouped all the genotypes in three molecular clusters M-I, M-II and M-III comprising 18, 14 and 32 genotypes, respectively (**Fig. 1**). Prominent grouping of low-yielding genotypes was present in cluster M-III, while high-yielding genotypes were grouped mainly in cluster M-I and M-II. Intermediate yielding was distributed across all the groups and revealed low congruency with morphological clustering. The tanglegram comparison between morphological and molecular dendrograms revealed partial consistency with an entanglement score of 0.347 indicated that the two clustering patterns were largely independent, as revealed by the numerous crossing lines linking corresponding genotypes resulting in heterogeneous and distinct cluster formations.

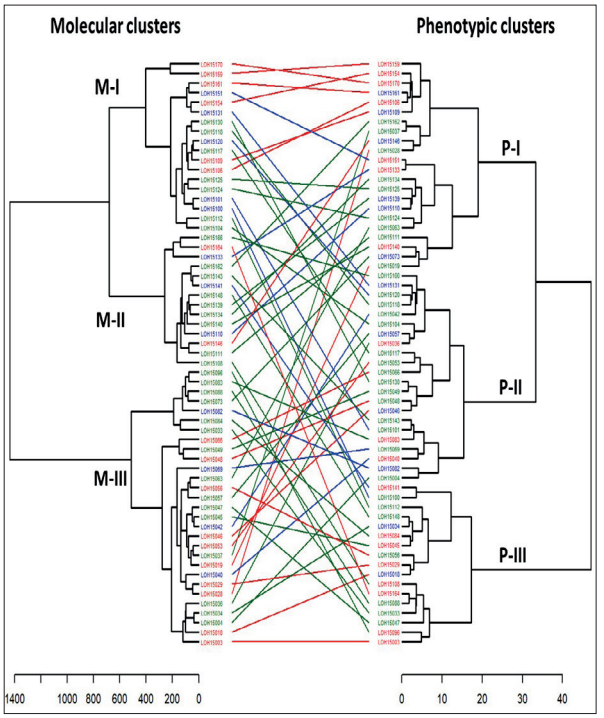


Fig. 1 Comparative clustering based on phenotypic and molecular dissimilarities.

Synchronous flowering in German Chamomile

Two diploid German chamomile populations having different types of growth habits i.e. "spread type" and "erect type" along with eleven different PGR treatments of 100 ppm concentration were tested in factorial randomized block design (RBD) with plant type and PGRs as the two different factors and three replications. Twenty days old seedlings were transplanted into a 3m × 2m plot, with spacing of 40 cm row to row and 20 cm plant to plant.

The two plant types were clearly separated into two distinct clusters (**Fig. 2**). All the observed traits categorized into three distinct groups for their interrelationship towards observed variability. Among all treatment combinations, treatment T_3 in the erect type recorded the

lowest flowering index, indicating T_3 as the best combination and the superiority of erect type over spread type for achieving flower synchronization. However, in terms of mean yield performance, spread type was superior to erect type. Hence, the erect type is better suited for synchronization with potential for further improvement in both yield and essential oil.

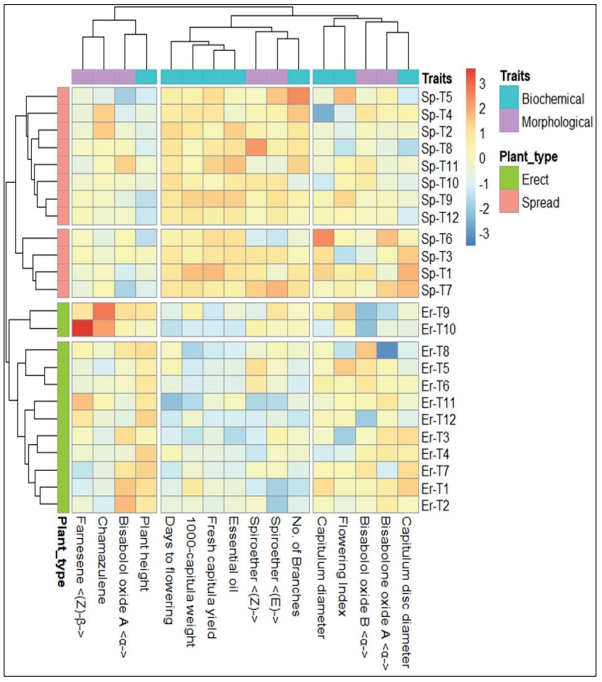


Fig. 2 Variation of all the studied traits across different treatments and genotypes.

The first two principal components explained the majority of the total variation, with PC1 accounting for 33.8% and PC2 accounting for 17.1%to the total variation (**Fig. 3**). Based on the biplots, the two plant types were clearly separated into two distinct clusters, with erect plant types located in the upper right and bottom right quadrants, and spread plant types positioned in the upper left and bottom left quadrants confirms the results of hierarchical clustering. Among the morphological and biochemical traits analyzed, farnesene<(Z)-β->, plant height, and bisabolol oxide A <α-> accounted for the greatest variability in the erect plant type.

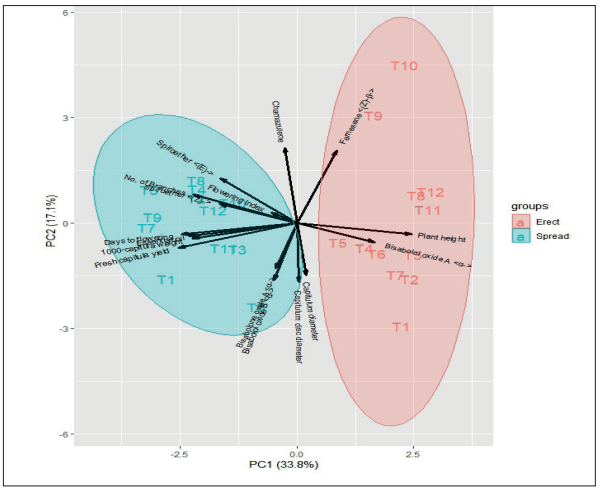


Fig. 3 Principal component analysis (PCA) for various traits.

Relevant Publications:

- Journal of Applied Research on Medicinal and Aromatic Plants, (2025), 50: 100690.
- Journal of Food Composition and Analysis, (2025), 144: 107679.

Research group: Navjot Kaur, Asmita Saini, Pratibha Pandey, Hari Sharan, Shaina Thakur.

Ramesh, Senior Scientist
ramesh.chauhan@csir.res.in
Agronomy

Our research group is focused on the development of agrotechnologies for *Salvia sclarea, Inula racemosa, Curcuma caesia, Rosa damascena, Bunium persicum, Ferula assa-foetida, Cinnamomum verum,* and *Dracocephalum heterophyllum*. We are also involved in introducing and expanding Heeng into non-traditional areas of India.

Irrigation–nitrogen interaction for maximizing biomass and essential oil production in *Salvia sclarea* L.

Irrigation and nitrogen levels are critical for maximizing biomass production and essential oil yield in aromatic crops. Adequate soil moisture sustains key physiological processes, whereas nitrogen availability regulates vegetative growth and the biosynthesis of secondary metabolites. Both deficit and excessive inputs can negatively impact yield and alter essential oil composition. In this context, an experiment was conducted with fifteen treatment combinations, comprising three irrigation regimes based on soil water potential (SWP: I_1 = 20 kPa, I_2 = 50 kPa, and I_3 = 75 kPa) and five nitrogen levels (N_0 = Control, N_1 = 40 kg ha^{-1}, N_2 = 80 kg ha^{-1}, N_3 = 120 kg ha^{-1}, N_4 = 160 kg ha^{-1}). Results indicated that irrigation at 50 kPa SWP significantly enhanced flower spike yield, whereas 75 kPa SWP resulted in higher essential oil yield than 20 kPa. Among nitrogen levels, application at 120–140 kg ha^{-1} resulted in superior flower spike and essential oil yields, indicating an optimal nitrogen range for maximizing productivity and oil accumulation in *S. sclarea* (**Fig. 1**).

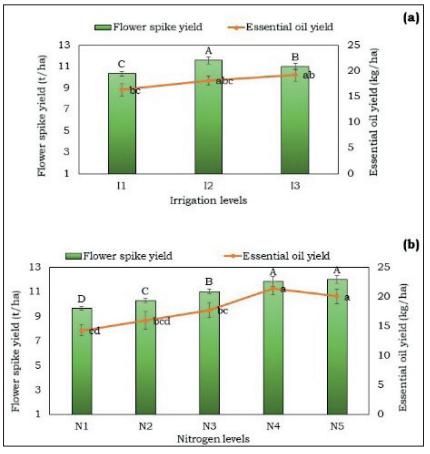


Fig. 1 Effect of irrigation (a) and nitrogen levels (b) on flower spike yield and essential oil yield of *S. sclarea*.

Impact of mulching practices and nutrient regimes on productivity and essential oil of *Rosa damascena* Mill.

Rosa damascena (damask rose), an important aromatic species of the family Rosaceae, is widely cultivated for its high-quality essential oil. It is extensively used in the formulation of premium perfumes, colognes, and cosmetic products. A field study was undertaken to assess the influence of moisture conservation through mulching (M_1: organic mulch; M_2: no mulch) in conjunction with different nutrient management levels (N_1: 0, N_2: 90:60:40 kg ha^{-1}, N_3: 120:60:40 kg ha^{-1}, and N_4: 150:90:50 kg ha^{-1} of NPK) on flower yield and essential oil content. Results indicated that organic mulching significantly increased flower yield compared with no mulch (**Fig. 2**). However, no significant differences in essential oil content were observed due to mulching; although organic mulch recorded slightly higher values than no mulch. Among nutrient doses, application of NPK at 150:90:50 kg ha^{-1} was comparable to 120:60:40 kg ha^{-1} and resulted in higher flower yield, increasing approximately 53.5% over the control. Regarding essential oil content, treatment with NPK at 120:60:40 kg ha^{-1} recorded the highest, which was at par with NPK at 150:90:50 and 90:60:40 kg ha^{-1}.

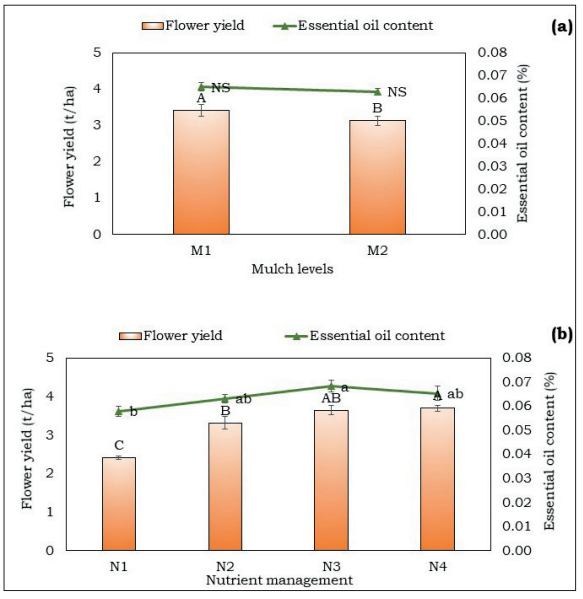


Fig. 2 Effect of mulch (a) and nutrient management (b) on flower yield and essential oil content of *R. damascene*.

Area expansion under Heeng cultivation

More than 9100 Heeng plants have been distributed during 2025-26 to the farmers of Himachal Pradesh (Kullu, Mandi, Chamba, Kinnaur, and Lahaul & Spiti), Ladakh (Khimi, Ayee, Kargil) and Jammu & Kashmir (Doda, Atholi, Kishtwar, Gulabgarh) and Uttarakhand (Joshimath, Surithota, Chamoli) to cover an area of about 3.36 acre. Additionally, more than 15,000 Heeng plants have been produced for distribution. Organized twenty (20) on-farm training programs in which more than 342 farmers and unemployed youth were trained in proper agronomic practices.

Relevant Publications:

- BMC Plant Biology. (2025), 25: 602.
- Discover Plant. (2025), 2: 111.

Research group: Diksha Dhiman, Tamanna Bhalla, Mohit, Ashumali, Aanchal Sharma

Amit Kumar, Scientist
kumar.a@csir.res.in
Field/plantation crops, Rhizosphere management

My research group is focused on the cultivation of fruit crops like dragon fruit and avocado in non-traditional areas of Himachal Pradesh. Our approach focuses on rhizospheric interventions and following plant functional trait-based strategies to establish fruit plants and other commercially important crops for their conservation, characterization, and the development of agrotechnology and postharvest technology. Initial trials are underway to develop agro-technologies for these fruits and other commercially important plants in the western Himalayan region.

Evaluation of avocado and dragon fruit for the cultivation in western Himalaya

In this experiment we are evaluating the suitability and performance of high-value fruit crops, namely avocado and dragon fruit, under agro-climatic conditions of the western Himalaya. The experiment aimed to assess varietal adaptability, growth performance, and physiological responses to facilitate the development of agro-technological practices. Planting material of avocado varieties (V_1-Hass, V_2-Arka Supreme, and V_3-Florida Gold) and dragon fruit varieties (V_1-VT White, V_2-Thai Red and V_3-Yellow Plora) was procured from certified sources and established under field conditions. A total of 30 plants per avocado variety and approximately 120 plants per dragon fruit variety were planted in the field for the evaluation (Fig. 1).

Morphological parameters such as plant height, leaf characteristics, and segment growth (in dragon fruit), along with biochemical traits including chlorophyll content and proline accumulation, were recorded to assess plant performance and stress adaptation. The results revealed that the avocado variety Hass (Fig. 1&2) exhibited superior morphological growth in terms of plant height (45.21±4.22 cm) and leaf area (41.14±4.93 cm^2) and higher chlorophyll content with lower proline accumulation, indicating better adaptation to the prevailing environmental conditions. Among dragon fruit varieties (Fig. 3&4), VT White and Thai Red showed enhanced growth attributes and favorable biochemical responses compared to Yellow Plora, suggesting their suitability for cultivation in the region.

Additionally, the introduction of a trellis-based support system significantly improved plant growth and structural stability in dragon fruit, highlighting its importance in crop management. Overall, the findings indicate that Hass in avocado and VT White and Thai Red in dragon fruit are promising candidates for cultivation in the western Himalayan region. The study provides a scientific basis for promoting these crops and developing region-specific management practices, with further scope for long-term evaluation of yield, fruit quality, and economic viability.

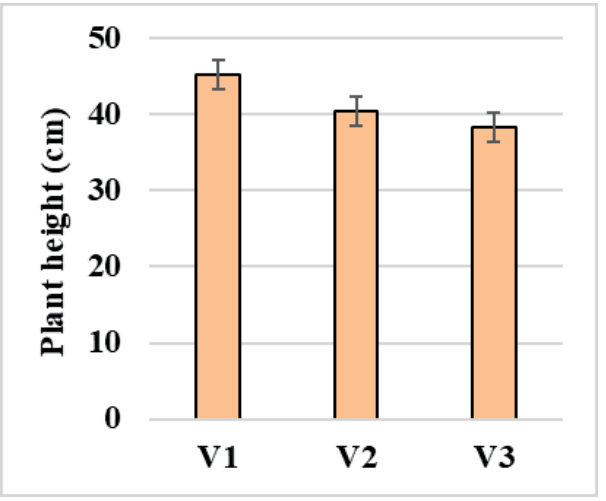


Fig. 1 Plant height of avocado varieties in western Himalaya.

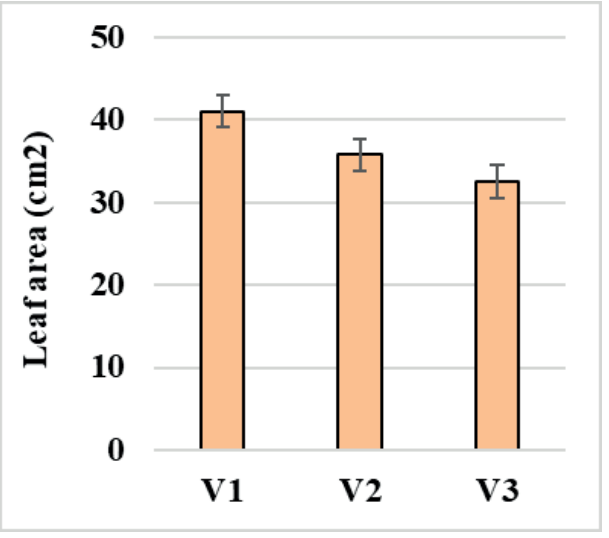


Fig. 2 Leaf area of avocado varieties in western Himalaya.

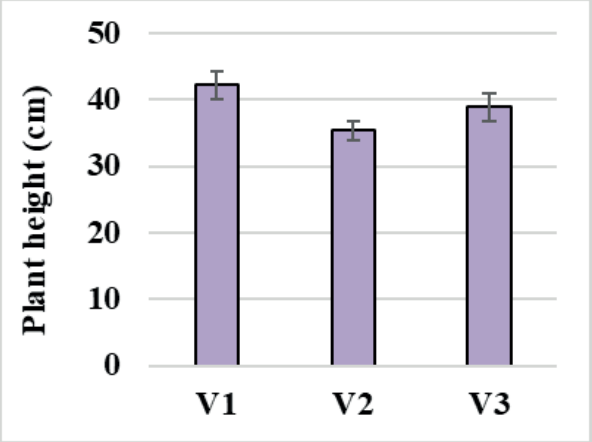


Fig. 3 Plant height of dragon fruit varieties in western Himalaya.

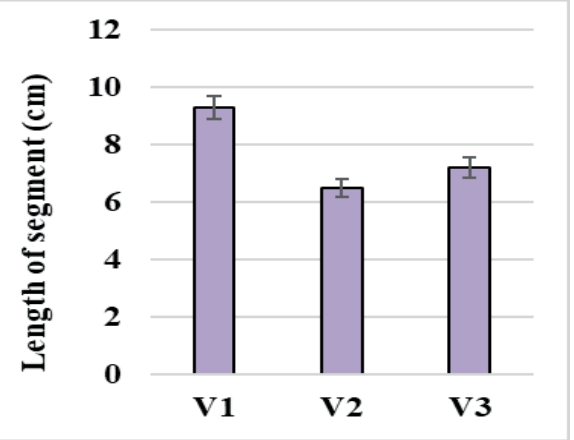


Fig. 4 Length of segment of dragon fruit varieties in western Himalaya.

Research group: Kamlesh Thakur, Manisha Chaudhary, Abhishek Thakur, Abhishek Nautiyal.

BIOTECHNOLOGY DIVISION

Aparna Maitra Pati, Chief Scientist
aparna.maitra@csir.res.in
PGPR and Waste Managementt

1. Plant Growth-Promoting Microbial Bioformulations for Sustainable Soil Health and Productivity

1.1. Heavy metals bioremediation

Continuing the previous bioremediation work, the mechanism of heavy metal [lead (Pb), chromium (Cr), and cadmium (Cd)] bioaccumulation by PGPRs was evaluated through expression analysis of key heavy metal transporter genes. Results showed that in the IHBT-705 PGPR strain, under 15 mM Pb stress, copper transporter (*YcnJ*, *CopZ* and *ZntA*), metal ion transporter (*YfjQ*), manganese transporter (*MntH*, *MntC*, *MntB,* and *MntA*), *MerR* and metal ABC transporter permease (*ZnuB*) genes were significantly upregulated as compared to the control. Notably, cobalt (*EcfT*) and nickel (*NikB*, *NikA* and *NikC*) transporters were significantly upregulated under Cr stress, whereas cadmium (*cadA*) and zinc (*zosA* and *ZnuC*) transporters were selectively induced under Cd stress, indicating their role in Pb, Cr and Cd uptake by bacterial cells (Fig. 1a-c). This is the first novel evidence for the functional validation of nickel, cobalt, manganese, and siderophore operon genes involved in the active uptake of Pb, Cr, and Cd metal ions by IHBT-705 PGPR.

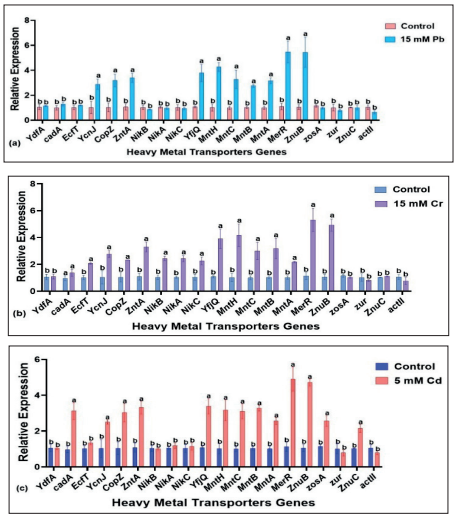


Fig. 1 Relative expression analysis of heavy metal transporter genes of IHBT-705 PGPR. (a) Pb stress; (b) Cr stress; (c) Cd stress. Bars represent the mean ± SE of independent replicates (n=3). Different letters a and b represent the significant difference between the control and treatment groups at p<0.05 (Student's t-test).

1.2. Multi-season evaluation of microbial consortia in baby corn and saffron

Preliminary field evaluations conducted during Kharif 2024 established the potential of microbial consortia, particularly combinations of Arbuscular Mycorrhizal Fungi (AMF) and Plant Growth-Promoting Rhizobacteria (PGPR), in enhancing baby corn productivity under reduced fertilizer inputs. Building on these observations, the present study conducted during Rabi 2025 at the GNDU experimental field, Amritsar, was designed to validate and extend these findings under contrasting seasonal conditions, thereby enabling a more robust and field-relevant assessment.

The Rabi trial incorporated a comprehensive evaluation framework integrating yield and economic analysis. Consistent with earlier findings, consortium-based treatments demonstrated superior performance over control and conventional fertilizer (RDF) treatments. Notably, integrated systems combining microbial consortia with reduced fertilizer application (50% RDF) achieved the highest yields, indicating that specifically selected biological inputs can effectively compensate for reduced chemical fertilization. Similarly, a saffron field trial was again conducted at Palampur for the year 2025-26 in continuation of the previous year's trial, which demonstrated significantly higher stigma yield and corm production, suggesting that the usage of bio-formulations can help in establishing saffron in non-traditional areas (Fig. 2).

Fig. 2 Field trial of baby corn and saffron.

1.3. Evaluation of soil health parameters of fields under plastic mulch sheet

We attempted to evaluate the influence of different plastic mulch types on soil properties

across 40 fields from Kangra, Mandi, Shimla, and Solan districts. The assessment indicated that mulch type-specific effects suppressed key soil enzyme activities and altered microbial community structure, highlighting the material-dependent impact of plastic mulch on soil biological health.

2. Integrated Organic Waste Management and Resource Recovery in Himalayan Ecosystems

The Compost Booster distribution initiative undertaken by CSIR-IHBT focused on promoting decentralized, eco-friendly organic waste management practices (Fig. 3). The technology enables efficient conversion of kitchen and faecal waste into high-quality compost. During the reporting year, approximately 5.2 tons of compost booster were supplied to Army units and cold desert regions of Lahaul & Spiti. In addition, awareness and training programs were conducted across schools, self-help groups, and NGOs, reaching nearly 450 participants. The deployment of compost boosters has contributed to improved sanitation, reduced waste accumulation, and enhanced adoption of sustainable agricultural practices through compost utilization.

Fig. 3 Distribution of Compost Booster.

Building on this initiative, a cold-adapted microbial bioformulation was developed by screening 200 psychrotrophic bacterial strains from CSIR-IHBT's high-altitude microbial repository (Lahaul-Spiti and Palampur regions). These strains can function efficiently at temperatures ≤10 °C and were screened for strong hydrolytic enzyme activities (cellulase, amylase, protease, lipase, pectinase, and xylanase), as well as plant growth-promoting (PGP) traits, including phosphate solubilization, nitrogen fixation, siderophore production, and IAA production. Selected strains were identified through 16S rRNA analysis and evaluated for compatibility to formulate a robust consortium. This bioformulation enables accelerated composting under Himalayan conditions while producing nutrient-enriched compost with added agronomic benefits.

The developed consortium was further applied for lignocellulosic biomass valorization, particularly targeting pine needles and apple pomace (Fig. 4). For pine needles, an in-vessel co-composting strategy with kitchen waste was optimized to overcome challenges associated with lignin-rich, resinous substrates. The process achieved a thermophilic phase (~50 °C), indicating active microbial degradation, and resulted in compost maturity within 28 days, with a stabilized C/N ratio (~17). The final compost demonstrated strong plant growth potential, comparable to that of chemical fertilizers.

Similarly, apple pomace, a high-moisture and acidic agro-waste, was efficiently processed using the cold-adapted consortium under ambient conditions. Rapid composting was achieved within 24 days without chemical additives, yielding nutrient-rich, stabilized compost with reduced odour and leachate issues.

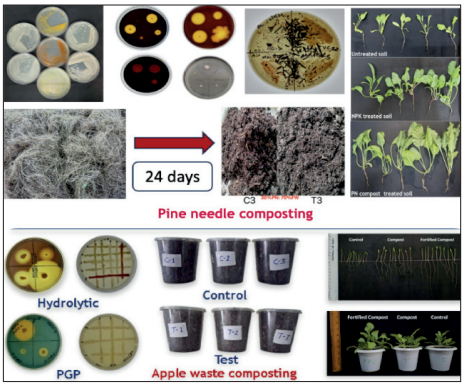


Fig. 4 Consortium-mediated conversion of lignocellulosic biomass into nutrient-rich compost.

Overall, the integrated approach combining compost booster deployment, cold-adapted microbial bioformulation, and targeted biomass conversion provides a sustainable, scalable solution for organic waste management and soil health improvement in Himalayan and cold-region ecosystems.

Relevant Publications:

- Archives of Microbiology. (2026), 208:188.
- Environmental Research. (2026), 295:123949
- Frontiers in Microbiology. (2025), 16:1662000.

Research group: Dr. Shubham Kaundal, Aman Kumar, Ayush Lepcha, Priya Kaushal, Sanjeev Kumar Sharma, Sourav Kanungo, Gowher Rashid Lone, Pallavi Sharma, Sakshi Dogra, Sakshi and Jagdeep Singh

Vipin Hallan, Chief Scientist
vipin.hallan@csir.res.in
Plant Microbe Interaction involving viral pathogens

The lab works in the area of Plant-microbe interaction involving viral and viroid pathogens, molecular characterization, epidemiology and farmer-friendly diagnostics for commercially important crop viruses. Current projects where the lab is associated deal with plant microbe vector interaction of tomato leaf curl virus, multiplex diagnostics of apple virus and virus-like pathogens and metabolite enhancement using virus-based elicitors

Viral suppressor AC4 encoded by Tomato leaf curl Palampur virus hijacks SA signaling to promote pathogenesis

Systemic acquired resistance (SAR) is a vital long-distance defense mechanism in plants, orchestrated by salicylic acid (SA) and its mobile signaling derivatives, methyl salicylate (MeSA) and azelaic acid (AzA). While SAR- disabling viral suppressors have been extensively studied in monopartite begomoviruses, their role in bipartite viruses remains largely unexplored. This study provides the first experimental evidence that the AC4 protein encoded by Tomato leaf curl Palampur virus (ToLCPalV), a bipartite begomovirus, contributes to suppression of SAR responses. Using quantitative gene expression profiling and targeted metabolite assays, we observed a reduction in the transcription of SAR marker genes ICS1 and PR1, as well as significant reductions in SA, MeSA, and AzA levels at progressive infection stages. These alterations were substantially alleviated in plants infected with an AC4-deficient mutant virus, confirming that AC4 plays a functional role in diminishing SAR activation. Complementary *in silico* analysis predicted that both AC4 and another ToLCPalV-encoded suppressor, AV2, may interact with key enzymes involved in SA biosynthesis and metabolism and may bind SAR-related mobile signals, including MeSA, AzA, pipecolic acid, and glycerol-3-phosphate. Together, the experimental results supported by computational modelling indicate that AC4 likely interferes with specific steps in SA production and the movement of SAR signals during systemic immunity. Our study suggests that the viral proteins AC4 and AV2 may suppress SAR in a bipartite begomovirus and provides a clear starting point for future experiments, including interaction studies, targeted mutations, or resistant plants, to test and confirm their roles in plant immunity (Fig. 1).

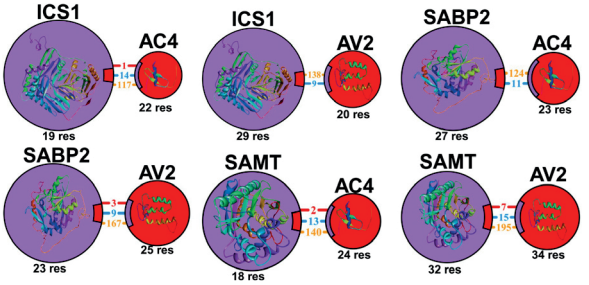


Fig. 1 Schematic representation of protein–protein interactions between viral proteins AC4 and AV2 with various plant defense-related proteins. Protein-protein interaction (PPI) data from PDBsum is shown, illustrating structural interactions among five proteins: ICS1, SABP2, SAMT, AC4, and AV2. Each protein is shown as a 3D structure within a circular boundary, with a black wedge indicating the extent of the interface surface area, whose size is proportional to the interface involved in the interaction. Interacting protein pairs are connected by colored lines representing distinct types of molecular interactions: red for salt bridges, blue for hydrogen bonds, orange for non-bonded contacts, and yellow for disulfide bonds. The number of interface residues for each protein is shown below its respective circle.

Seaweed-derived oligosaccharides confer broad-spectrum antiviral defenses in tomato and Arabidopsis plants

Seaweed extracts (SWEs), particularly those derived from red algae, are increasingly recognized as sustainable, eco-friendly alternatives to synthetic agrochemicals. AG Fort, a commercial formulation comprising derivatized low molecular weight oligosaccharides from *Kappaphycus alvarezii*, was previously reported to prime antibacterial immunity in *Arabidopsis thaliana*. In this study, we evaluated the antiviral efficacy of the seaweed-based formulation AG Fort against ToLCPalV, a bipartite begomovirus that causes severe disease in tomato crops across northern India and parts of the Middle East and has a wide natural host range. Symptoms of ToLCPalV infection include extensive leaf curling, chlorosis, and stunted growth, leading to significant yield loss. With current control strategies relying heavily on hazardous pesticides targeting insect vectors, there is an urgent need for safer alternatives. We demonstrate that prophylactic application of

AG Fort, either via foliar spray or transient root dipping, significantly reduces disease incidence and symptom severity in the virus challenged tomato plants. Treated plants exhibited upregulated expression of defense related genes, increased phytohormone levels, decreased accumulation of viral replicative intermediates, and reduced levels of viral transcripts. Notably, similar antiviral protection was also observed in AG Fort-treated Arabidopsis plants challenged with Cucumber mosaic virus (CMV), suggesting a broad-spectrum antiviral potential. Together, our findings highlight seaweed derived oligosaccharides as sustainable, seaweed based crop protection agents capable of mitigating viral infections in Arabidopsis thaliana and tomato, with broader crop applicability indicated in manufacturer data as part of integrated disease management against multiple plant viruses (Fig. 2).

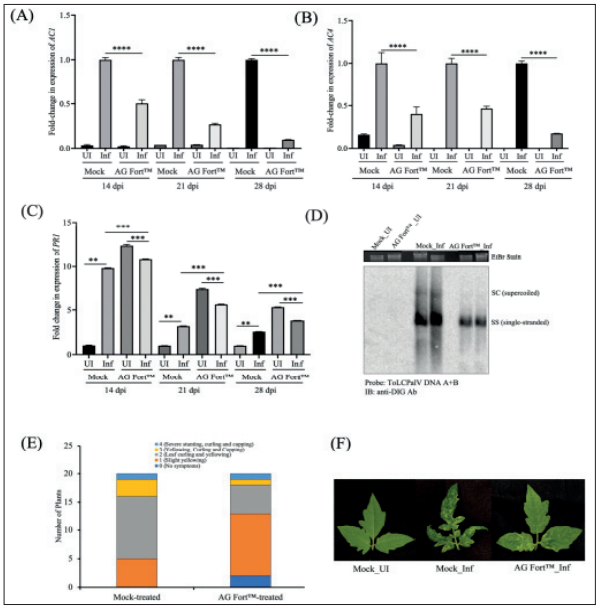


Fig. 2 Pretreatment with AG Fort alleviates ToLCPalV infection severity and virus accumulation. Relative transcript abundance of virus- encoded genes (A) AC1, (B) AC4, and defense- associated (C) PR1 expression in plants across various treatment regimens and time points. The qRT- PCR data were normalized to endogenous actin expression. Data shown are fold change relative to the levels in mock- treated samples and are representative of mean values from three biological replicates (n = 3) per treatment group. Error bars indicate SD. Student's t- test was performed to calculate pairwise statistical significance relative to mock- treated plants; **p < 0.01; ***p < 0.001; ****p < 0.0001; ns = not significant. (D) Southern blot analysis demonstrating viral titre and ToLCPalV replicative forms in the Mock or AG Fort- treated plants. (E) Symptom severity in the infected plants was scored on the basis of the AVRDC scale (n = 20). (F) Representative images of viral symptom severity in leaves from formulation treated and untreated plants relative to uninfected controls.

Prevalence, genetic diversity, and phylogenetic analysis of apple stem grooving virus in low-chilling apple cultivars

Apple is one of the most important fruit crops worldwide. Due to climate change-related issues, cultivating low-chilling commercial apple cultivars has become a widespread practice among growers in the mid-hill region of India. Additionally, several biotic and abiotic factors influence apple cultivation, with viral diseases being a major biotic threat to crop productivity and nutritional quality. Among all viruses affecting apples, the apple stem grooving virus is one of the major ones. It primarily causes a latent infection, which makes its detection and management challenging. Additionally, the adoption of low-chilling cultivars has also created new niches for ASGV infection. A survey of the low-chilling apple cultivars in the states of Himachal Pradesh and Manipur was conducted, and 105 samples from five locations were analyzed. This study documented the co-infections of major apple viruses and viroids, notably apple stem grooving virus, apple chlorotic leaf spot virus, apple stem pitting virus, apple mosaic virus, and apple scar skin viroid, detected through multiplex PCR standardized primarily in our lab. Among these viruses, apple stem grooving virus showed the highest incidence, and its infection was detected in Anna, Dorsett Golden, and Michael cultivars. The complete coat protein gene sequences of thirty-seven isolates of ASGV were analyzed. The sequence identities of the characterized ASGV isolates ranged from 87.34 to 100%. Phylogenetic analysis revealed no clear correlation between cultivar and the geographic origin of the isolates. Alignment of the CP gene sequences from ASGV isolates with global isolates obtained from various host species revealed the formation of eight distinct clusters, effectively grouping the isolates. Significantly, six isolates showed little spatial clustering and were closely related to isolates from China and Canada. natural and experimental hosts (Fig. 3).

Fig. 3 Symptoms induced on apple by Apple stem grooving virus.

Wild roses as natural hosts of apple stem grooving virus in India

Apple stem grooving virus (ASGV), a member of the genus Capillovirus, is a graft-transmissible RNA virus commonly associated with latent infections in apples and pears (Bhardwaj et al.

2014, 2023). In 2014, virus-like symptoms including chlorotic spots, interveinal yellowing and leaf curling were observed on wild rose plants growing at CSIR-IHBT campus and adjoining areas in Kangra district, Himachal Pradesh, India. A total of 32 symptomatic leaf samples belonging to six different species viz. Rosa brunonii (10), R. cathayensis (10), R. multiflora (8), R. moschata (2), R. alba (1), and R. indica (1) were collected and subjected to ASGV detection using double antibody sandwich enzyme-linked immunosorbent assay (DAS-ELISA), dot blot hybridization, and reverse transcription polymerase chain reaction (RT-PCR; Bhardwaj et al. 2023). Of these, ASGV tested positive in only two samples WR-1 (R. brunonii) and WR-32 (R. moschata) for ASGV by all three assays. Sanger sequencing of the 755 bp coat protein gene from both isolates (GenBank Accession Nos. LN559086 and LN559087) revealed 100% nucleotide identity with ASGV isolates from apple in China (JX885580), Brazil (AF438409), and India (FM204881). Further, coat protein gene sequences exhibited 87–100% nucleotide and 94–100% amino acid identity with other ASGV isolates from various origins worldwide. Mechanical inoculation of ASGV-positive sap from WR-1 and WR-32 onto six herbaceous hosts (Chenopodium amaranticolor, Cucumis sativus, C. quinoa, Phaseolus vulgaris, Nicotiana benthamiana and N. glutinosa) confirmed infectivity, displaying symptoms like leaf curling, chlorosis, and chlorotic spots. The detection of ASGV in wild rose species, found near horticultural orchards, raises concerns about their role as potential viral reservoirs. This study expands the natural host range of ASGV. This is the first natural occurrence of ASGV in wild roses.

Relevant Publications:

- Plant Physiology and Biochemistry. (2025), 110789.
- Physiologia Plantarum. (2025):177: e70562.
- Virus disease. (2025), 36(3): 496-505.

Guava as an alternate host of Apple chlorotic leafspot virus

Guava is an important fruit crop and its quality is effected by several pests and diseases. During a survey of guava, 12 leaf samples showing symptoms of virus infection (chlorosis, reddening and mosaic patterns) were collected in the kangra district, Himachal Pradesh, India. The samples were tested for the presence of major apple viruses and a viroid, viz. apple chlorotic leaf spot virus (ACLSV), apple mosaic virus, apple stem grooving virus, apple stem pitting virus and apple scar skin viroid. These viruses and the viroid were selected based on an ongoing surveillance programme on low-chilling apple culti- vars in the same region using the same multiplex assay. The guava plants sampled were located adjacent to apple orchards previously found infected with these pathogens. Among all the pathogens tested, only ACLSV was detected, being found in seven samples (three from Punner, two from Shahpur and one each from Palampur and Tanda), while in the rest 5 samples, it was not detected. This is first report of ACLSV on guava and has implications for future disease monitoring and surveillance (Fig. 4).

Fig. 4 Guava plants showing symptoms induced by apple chlorotic leaf spot virus on leaves.

Ram Kumar Sharma, Chief Scientist
ram.sharma@csir.res.in
Molecular Genetics and Genomics

Our research group employs molecular genetics and genomics approaches to harness natural diversity for the genetic improvement of Himalayan plant genetic resources and commercially important plant species. I serve as the Key Investigator of Mission projects, and several projects sponsored by DBT.

Building on our previous leads, the group has achieved the following significant milestones during the current reporting period:

Integrative QTL Mapping and Transcriptomics identified key genes for Blister Blight Tolerance in Tea

Blister blight (BB) disease, caused by the obligate pathogen *Exobasidium vexans*, severely affects tea quality and yield. Conventional reliance on fungicides has led to phytotoxic effects and stunted plant growth. Although the pathogenesis and epidemiology of BB have been widely studied, its genetic basis remains insufficiently understood. To address this gap, this study aimed to identify quantitative trait loci (QTLs) and protein-coding sequence variants in candidate genes, with the objective of shortening ~20 years of selection cycle and enhancing trait improvement through modern breeding strategies. Genotyping-by-sequencing was performed on a pseudo-testcross progeny derived from a tolerant cultivar (SA6) and a susceptible cultivar (Kangra-Asha) that identified 6,650 high-quality single-nucleotide polymorphisms (SNPs), which were used to construct a high-density linkage map spanning 4,637.4 cM (Fig. 1).

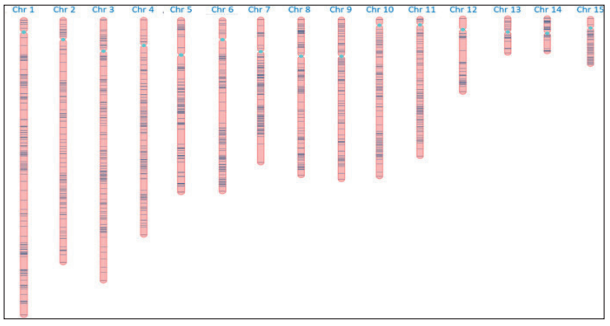


Fig. 1 Representative high-density linkage map constructed using high-quality 6556 SNPs markers.

Using ICIM and MET analyses, 15 QTLs were detected, including 11 major QTLs associated with BB tolerance, explaining 5–20% of the phenotypic variation across nine tea chromosomes (Fig. 2).

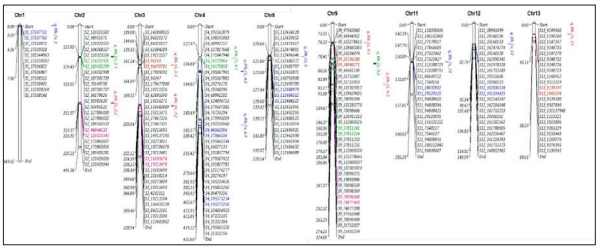


Fig. 2 Chromosomal coordinates of quantitative trait loci (QTLs) regulating Blister blight traits identified using polymorphism SNPs markers.

Further validation of 14 candidate genes within these QTL regions, supported by transcriptomic data, revealed significant differential expression between SA6 and Kangra-Asha. Notably, key genes identified included resistance-related genes (WAK2, WAK5, alpha/beta hydrolase fold proteins, NBS, and TIR domain-containing genes), transcription factors (Trihelix-TF-GT2, MYB52, bZIP40), transposable elements (Tx1, Ty3-1, Ty5-1, T2-6), and RING-type E3 ubiquitin transferases (PUB29 and PUB28). These genes were located within major QTLs, including q_Bb_Cs_3.2, q_Bb_Cs_4.3, q_Bb_Cs_9.2, q_Bb_Cs_9.3, q_Bb_Cs_11, and q_Bb_Cs_13.

Additionally, post-QTL analysis identified amino acid variations in four BB-associated genes, further strengthening the findings. Overall, the discovery of novel QTLs harboring significantly expressed candidate genes provides valuable resources for genome editing and the development of blister blight-tolerant tea cultivars through advanced breeding programs.

Multi-Omics reprogramming under combined drought and s alinity stress in ***Stevia rebaudiana***

Stevia rebaudiana, a primary source of plant-derived low- and non-calorie sweeteners (LNCSs) in the form of steviol glycosides (SGs), faces significant economic losses under environmental stresses, particularly drought (D) and its combination with salinity (S). Integration of 936 million high-quality transcriptional reads with morpho-physiological (eight parameters) and both targeted and untargeted metabolomic analyses provided comprehensive insights into the plant's response to combined drought and salinity (CDS) stress. Notably, a significant increase in non-glandular trichome density was observed under CDS at 15 days after treatment (15 DAT), indicating a potential adaptive mechanism in stevia (Fig. 3).

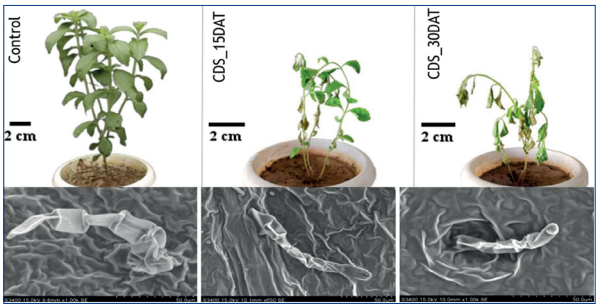


Fig. 3 Morphological and leaf abaxial surface features under scanning electron microscope (SEM) of control and treatment plants under CDS stress at 15 DAT and 30 DAT in *S. rebaudiana*.

Transcriptomic analysis revealed 9,643 differentially expressed genes (DEGs) uniquely associated with CDS, highlighting a distinct molecular response compared to individual drought or salinity stress. Enrichment of stress-responsive metabolic pathways, including sphingolipid metabolism, arginine and proline metabolism, and the biosynthesis of diverse secondary metabolites, further underscored the specificity of the CDS response. Moreover, root-specific upregulation of key genes involved in stress response (AKT1, HAK12, P5CS), stress perception (WAK5, LRR-RLK, CERK1), and signal transduction (PP2C13, MAPKK, CML38) indicated the heightened severity of combined stress conditions (Fig. 4). CDS-specific nucleotide variations were subsequently validated through resequencing of contrasting susceptible and tolerant stevia cultivars. This analysis confirmed amino acid substitutions in critical genes (AKT1: Pro695Ala; MAPKK5: His317Ile; HAK12: Tyr370Asn; P5CS: Lys495Arg), suggesting important functional and translational implications.

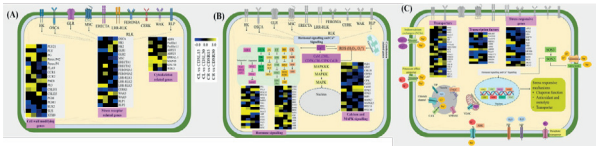


Fig. 4 Dynamics of CDS-Responsive DEGs Involved in Stress Perception in *S. rebaudiana*.

Overall, this study presents the first comprehensive CDS-specific genomic resource in *S. rebaudiana*, identifying key genes and regulatory mechanisms that can facilitate the development of climate-resilient stevia cultivars with optimized SG accumulation for commercial applications.

Transcriptional intricacies of picrosides biosynthesis in endangered ***Picrorhiza kurroa***

Picrorhiza kurroa, an endangered medicinal plant, is renowned for its diverse pharmacological properties attributed to the accumulation of iridoid glycosides, primarily picroside-I and picroside-II. The differential distribution of these bioactive metabolites across plant tissues reflects inherent tissue-specific metabolic activities and underlying gene expression patterns. Spatial transcriptome profiling was conducted to elucidate the tissue-specific molecular mechanisms governing the biosynthesis of specialized metabolites in *P. kurroa.* De novo assembly of over 182 million high-quality paired-end reads generated 82,872 transcripts, of which 70.92% were functionally annotated using multiple public protein databases. Organ-specific differential expression analysis identified 24,604 differentially expressed genes (DEGs), highlighting significant enrichment in pathways associated with picroside biosynthesis. Spatial transcriptional profiling revealed that key genes involved in the methylerythritol phosphate (MEP) and mevalonate (MVA) pathways, central to picroside-I and picroside-II biosynthesis, exhibit strong organ-specific expression patterns. Notably, shikimate pathway-associated genes suggest preferential biosynthesis of picroside-I in aerial tissues, whereas genes implicated in picroside-II biosynthesis are predominantly upregulated in the inflorescence and rhizome Additionally, DEGs encoding regulatory and functional components such as transcription factors (TFs), cytochrome P450 enzymes (CYPs), and UDP-glucuronosyltransferases (UGTs) were identified, underscoring their roles in modulating and diversifying secondary metabolite biosynthesis (Fig. 5).

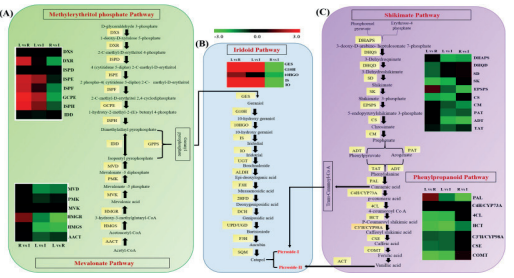


Fig. 5 Picrosides biosynthesis mediated by; (A) MEP/ MVA pathway, (B) Iridoid pathway, (C) Shikimate and Phenylpropanoid pathway in *P. kurroa*.

This comprehensive organ-specific transcriptional landscape not only advances our understanding of specialized metabolic pathways in *P. kurroa* but also identifies promising candidate genes for metabolic engineering. The generated genomic resource provides a valuable foundation for developing functional molecular markers, thereby enabling precise breeding strategies aimed at the revival, sustainable cultivation, and long-term conservation of this pharmaceutically important endangered species.

Relevant Publications:

- Food Bioscience. (2025), p.107967.
- Physiologia Plantarum. (2025), 177(3), p.e70305.
- Trends in Plant Science. (2025), 31: 123-125.

Ravi Shankar, Senior Principal Scientist
ravish@ihbt.res.in
Bioinformatics

We work in the area of high-throughput computational biology, where prime areas of research include next-generation sequencing, computational genomics and regulomics, high-performance computing, and machine and deep learning. This report covers the research output for the period April 2025 to March 2026. Seven peer-reviewed studies have been published during this period, spanning across multiple domains of science and deep learning. A defining theme runs through a substantial part of this body of work: the development of first-of-their-kind software tools that can serve as a cheaper, more reliable alternative, dramatically reducing the need for expensive, time-consuming wet-lab experiments. These software tools developed here offer computational alternatives that work across multiple plant species and conditions, outperforming the existing methods by wide margins.

PTF-Vac: An explainable and generative deep co-learning encoders-decoders system for ab-initio discovery of plant transcription factor binding sites

Identifying transcription factor binding sites (TFBSs) in plants is challenging due to high cross-species variability, context-specific TF-DNA interactions, and limitations of existing tools that rely on predefined TF-specific models and large species-specific datasets. PTF-Vāc addresses these bottlenecks through an explainable deep-learning encoder-decoder generative system built on PTFSpot, a universal co-learning model of TF structure and binding site variability. It decouples TFBS discovery from prior motif-finding steps, works independently of data volume and species, and requires no TF-specific motif models. In comprehensive benchmarking against large-scale experimental data, PTF-Vāc outperformed leading deep-learning motif-finding algorithms, opening a new chapter in abinitio TFBS discovery through generative AI.

What makes PTF-Vac different

The core innovation is a shift in the question being asked. Rather than scanning for DNA patterns that happened to appear in one species's experimental data, PTF-Vāc asks: given the physical shape of this protein, what DNA sequence would fit it best? It answers this by learning simultaneously from two sources: the protein's 3D atomic structure (generated by AlphaFold2) and the surrounding DNA sequence context.

Two deep learning architectures run in parallel (Fig. 1). The left branch is a DenseNet, a deep convolutional network, that processes the TF 3D structure by reading the X, Y, Z atomic coordinates of every residue as a 300 X 24 X 3 numerical grid. The right branch is a Transformer encoder that reads the TF binding region as overlapping five-, six-, and seven-mer words. While the decoder processes TFBS information as k-mers. Both DenseNet and the encoder output feed into a shared multi-head attention layer, and a six-layer Transformer decoder then generates the binding site for the given TFBR. This generative design makes PTF-Vāc fundamentally different from all previous TFBS tools.

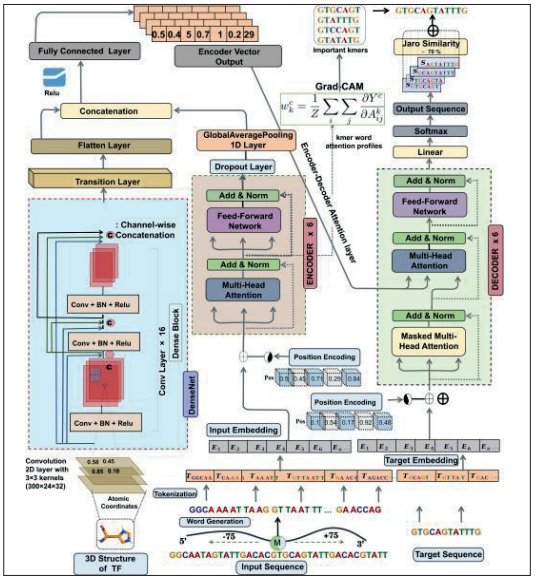


Fig. 1 The PTF-Vāc deep co-learning architecture.

Key findings

Accuracy reached 93.2% on test data drawn from 40 TF families, covering a wide span of TF 3D structures and its binding preferences.

For all 36 TFs benchmarked in this study, their motifs identified by PTF-Vāc shared higher similarity with the ones present in the JASPAR database (TOMTOM p << 0.01). Thirteen TFs showed perfect 100% similarity.

PTF-Vāc works equally well with a single input sequence as with multiple input sequences while

sharing higher similarity with experimental motif. No other existing method can claim this.

Distinct binding site sequences were successfully estimated for splice variants of the same TF (*ARF8*), a capability no existing method possesses.

Applied genome-wide to tea (*Camellia sinensis*), PTF-Vāc identified 1,878 BES1 target genes. Of these, 98% matchzed independently collected ChIP-seq data for the same.

Significance

Before PTF-Vāc, annotating TF binding sites in a newly sequenced plant required running species-specific experiments first. That is expensive, slow, and impossible for crops without an established research infrastructure. PTF-Vāc removes this bottleneck. Now, anyone can upload a DNA sequence and an AlphaFold2-derived 3D structure to receive reliable binding-site identifications, regardless of species or available experimental data.

Decoding stress-specific transcriptional regulation by causality aware Graph-Transformer deep learning

Transcription factors (TFs) interpret cis-regulatory DNA sequences to orchestrate gene regulatory networks (GRNs) that underpin plant stress adaptation, yet deciphering condition-specific TF binding patterns for spatiotemporal gene expression remains a major challenge. CTF-BIND addresses this through a novel computational framework that leverages approximately 23 TB of multi-omics data (ChIP-seq, RNA-seq, and protein-protein interaction data) to construct Bayesian causal networks capturing condition-specific TF binding dynamics in *Arabidopsis*. These validated networks serve as input to a Graph-Transformer deep learning system, enabling accurate condition-specific TF binding detection directly from RNA-seq data for 110 abiotic stress-related TFs, bypassing the need for separate ChIP-seq experiments. Tested against large-scale experimental data across diverse conditions, CTF-BIND achieved an average accuracy of approximately 93% and is available as an open-access web server and database, offering a cost-effective tool expected to accelerate crop improvement research.

Approach

The key biological insight driving CTF-BIND is that TF binding is not determined solely by DNA sequence. It depends on the entire regulatory network the TF lives in, which proteins interact with it, how central it is under the current condition, and what signals the broader cellular environment is sending. CTF-BIND was developed through a structured three-stage pipeline (Fig. 2). In the first stage, 780 RNA-seq samples representing 46 stress conditions alongside 490 ChIP-seq samples for 124 TFs for species *A. thaliana* were collected. After filtering, only high-confidence data (TF-target) were retained, yielding a working set of 110 TFs. The second stage builds Bayesian causal networks from the filtered data for 110 TFs, constructing 11,556 condition-specific directed networks. The third stage feeds these causal networks, along with corresponding DNA sequence and transcriptome information, into a Graph-Transformer architecture. The model output was passed to an XGBoost classifier, which produced a final binding probability score for each candidate site under the specified condition, derived from transcriptomic information, achieving an average accuracy of 93%.

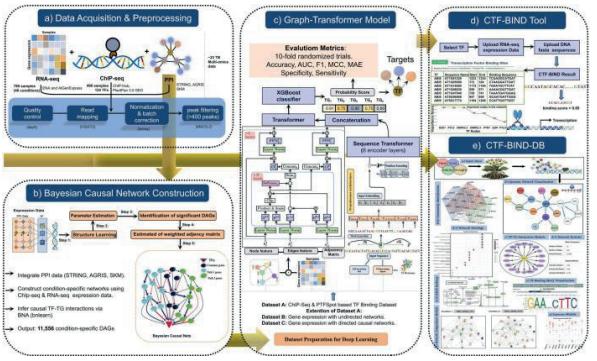


Fig. 2 The CTF-BIND framework. Panel (a) shows data acquisition and quality control. Panel (b) illustrates Bayesian causal network construction yielding 11,556 condition-specific networks. Panel (c) presents the Graph-Transformer deep learning architecture. Panels (d) and (e) show the web interface and integrated database.

Key findings:

Examining the regulatory networks built for each stress type reveals both condition-specific and shared regulatory architecture. The cold stress network is anchored by the CBF family (CBF1, CBF2, CBF3) and upstream activator ICE1. The salinity stress network centres on WRKY and NAC family TFs, with WRKY33 and SOS2 among the most highly connected nodes. The drought stress network converges on DREB2A and MYB60, while the heat stress network is driven by HSFA2 and HSFA1, activating an extensive set of chaperone-encoding target genes.

Significance

Stress-responsive regulatory networks are at the core of crop improvement research. Being able to computationally map them at scale using RNA-seq data rather than costly ChIP-seq experiments opens new possibilities for species with limited experimental resources. The CTF-BIND database makes these networks searchable and comparable across conditions, giving researchers a new resource for hypothesis generation.

DMRU: generative deep learning to methylation in plants

Cytosine methylation in plants regulates gene expression by controlling chromatin structure and accessibility, yet existing computational tools cannot predict condition-specific methylation patterns, limiting their practical utility. DMRU (DNA Methylation Recognition Unit) is the first explainable deep encoder-decoder generative system to learn the relationship between transcriptomic status and DNA methylation states under any given condition. A key finding is that GC content similarity, rather than sequence homology, better determines methylation pattern specificity, enabling DMRU to operate accurately across species in a universal manner. Tested across 85 conditions and multiple plant species, DMRU consistently achieved above 90% accuracy, making it a powerful and cost-effective alternative to bisulfite sequencing.

The Innovation

DMRU (DNA Methylation Recognition Unit) is the first tool to identify condition-specific dynamic DNA methylation. It combines two deep learning systems in parallel (Fig. 3). The left branch is a 121-layer DenseNet that receives the full transcriptome expression profile for the target condition, where each position in a 38,912-element numerical array corresponds to the expression level of one specific gene. The right branch is an eight-layer Transformer encoder-decoder; the encoder receives the 2,000-base promoter sequence as overlapping k-mer word tokens, without any methylation information at the input stage. The decoder receives similar sequence information but with methylation marked in the sequence. The outputs from the dense net and the encoder merge at the encoder-decoder multi-head attention layer, and the decoder then generates the complete promoter sequence, with methylated cytosine positions explicitly marked. This generative design, producing a sequence with condition-specific methylation marks from RNA-seq data alone, sets DMRU apart from all existing approaches. DMRU has implemented the explainable AI (Grad-CAM) scoring scheme to identify genes in the transcriptome profile that appear to be critical for condition-specific methylation within a given sequence stretch.

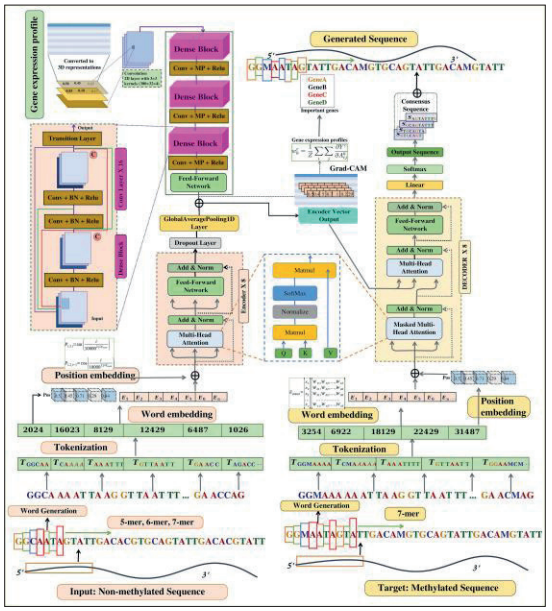


Fig. 3 The DMRU deep co-learning architecture. The Transformer encoder (right branch) reads the input promoter sequence without methylation information as overlapping k-mer words. The DenseNet (left branch) processes the full transcriptome expression profile for the target condition. Both streams merge at the attention layer, and the decoder generates the methylated output sequence with cytosine methylation marks placed.

Key Findings

The most striking benchmarking result is not an accuracy number but a visual one. When three competing tools (iDNA-ABF, iDNA-ABT, and MaskDNA-PGD) are tested across 12 experimental conditions for the same rice gene Os01g0110100, each produces an identical methylation pattern in every condition. The maps do not change whether the plant is under salt stress, growing normally, or responding to abscisic acid treatment. This reveals that these tools predict whether a cytosine is capable of being methylated based solely on sequence, not whether it is actually methylated under a specific biological state. DMRU accurately captures dynamic, condition-specific changes, as validated against WGBS experimental data.

Significance

DNA methylation plays a fundamental role in regulating plant responses to stress, coordinating development, and mediating epigenetic inheritance. The ability to predict condition-specific methylation from RNA-seq data, which is widely and cheaply available, opens the door to epigenomic research in any plant species. Researchers can now identify the most biologically relevant methylation sites before committing to expensive bisulfite sequencing experiments, enabling targeted and cost-effective experimental follow-up.

Software developed

1. PTF-Vāc
2. CTF-BIND
3. DMRU

Relevant Publications:

- Briefings in Bioinformatics. (2025), 26, 6; bbaf579.
- Current Plant Biology. (2025), 43:100521.
- Plant Communications. (2025), 6:101543.

Rituraj Purohit, Senior Principal Scientist
rituraj.purohit@csir.res.in, riturajpurohit@gmail.com
Biotechnology (Bioinformatics)

Our research evaluates Himalayan bioactive compounds against diverse molecular targets, including phosphodiesterases, using advanced biophysical and computational methods. Despite their therapeutic potential, these polyphenolic compounds suffer from poor aqueous solubility. To address this, we investigate cyclodextrin-based host–guest inclusion complexes to enhance solubility, stability, and bioavailability. Our integrated approach, combining molecular modeling and experimental validation, provides key insights into drug–carrier interactions, demonstrating a promising strategy to overcome formulation challenges and improve the pharmaceutical potential of bioactive compounds.

PDE10A Inhibitors: Insights from absolute binding free energy and In-vitro studies

In preclinical models, Phosphodiesterase-10A (PDE10A) inhibition shows therapeutic potential for Parkinson's, Huntington's, and schizophrenia. Here, olefinated benzosuberene analogues were screened computationally to identify selective PDE10A inhibitors. Docking and molecular dynamics simulations revealed stable binding, with AMKPD-52 uniquely engaging the selectivity residue Tyr-683. Enhanced sampling (steered MD and umbrella sampling; ~72 µs total) and absolute binding free energy calculations using the multistate Bennett acceptance ratio consistently ranked AMKPD-52 as the top candidate. In vitro assays confirmed inhibitory activity (IC_{50} = 11.52 µM). Despite modest potency relative to TAK-063, AMKPD-52 offers a promising scaffold for optimization and further in vivo validation **(Fig. 1)**.

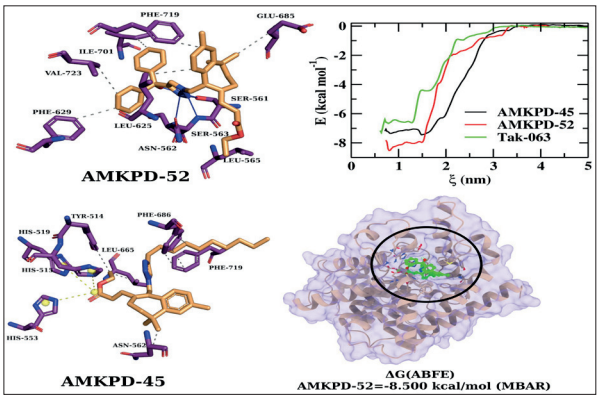


Fig. 1 Illustration of the comprehensive workflow employed in the study aimed to identify PDE10A inhibitor.

Mechanistic Identification of PDE2 inhibitors from acridine analogues

Phosphodiesterase 2A (PDE2A) is underexplored in CNS drug discovery despite its role in neuronal signaling and cognition. Here, acridine analogues were evaluated as PDE2A inhibitors using docking, molecular dynamics, and free energy calculations. Docking revealed favorable binding comparable to co-crystal ligands, with key interactions involving Leu-809, Leu-770, and Ile-866. MD simulations confirmed complex stability, with amsacrine showing the most stable binding. Umbrella sampling indicated strong affinities (≈ −45 kcal/mol), supported by MBAR-based absolute binding free energies (−11.23 kcal/mol). quinacrine also showed favorable binding, highlighting acridine scaffolds as promising leads for CNS therapeutics **(Fig. 2)**.

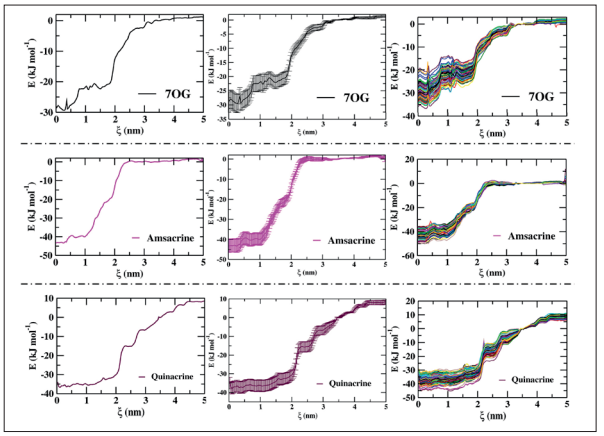


Fig. 2 The potential mean force (PMF) obtained from umbrella sampling windows.

Refined Encapsulation of Silybin A in β- and γ-Cyclodextrin Cavitands.

Silybin A (Slym) shows therapeutic promise but suffers from poor bioavailability due to low solubility. Here, cyclodextrins were evaluated as solubilizing carriers. While β- and γ-cyclodextrins provide suitable cavities, derivatives G-β-CD, SBE-β-CD, and HP-γ-CD exhibited superior binding. MM/PBSA analyses from 1 µs MD simulations demonstrated enhanced encapsulation efficiency, further supported by 5 µs triplicate simulations confirming stable complex formation via nonbonded interactions. DFT calculations (M06-2X/6-31G(d)) identified SBE-β-CD/Slym as the most favorable complex

(−303.82 kJ/mol). QM-derived IR spectra and IGMH analyses validated interactions, highlighting SBE-β-CD as a promising carrier for improving Slym solubility and efficacy **(Fig. 3).**

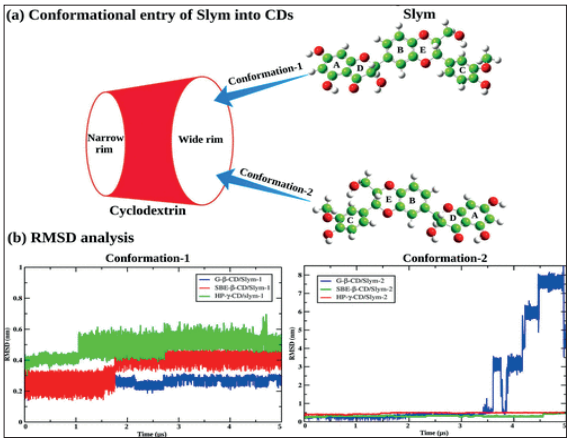


Fig. 3 Schematic representation of the conformational entry of Slym into CD.

Relevant Publications:

- Protein Science. (2026), 35 (2): e70472.
- Materials Chemistry and Physics. (2026), 347, 131477.
- Journal of Chemical Information and Modeling. (2025), 65,10.

Research group (From left to right): Pramod Kumar, Rahul Singh, Dr. Rituraj Purohit, Dr. Ankita Dhiman, Vidhi Bidaliya, Mukesh Chand Bairwa, Amit Daroch, Dr. Ashish Gupta, Bhanu Sharma, Vishal Kumar.

Vishal Acharya, Principal Scientist
vishal.acharya@csir.res.in
Artificial Intelligence for Computational Biology

Our research focuses on key areas of bioinformatics, including evolutionary biology, comparative genomics, systems biology, and functional genomics. We integrate artificial intelligence to address complex biological challenges. Major thrust areas include AI-driven drug discovery from Himalayan bioresources, understanding host–pathogen interactions, developing genomics-based solutions, and applying AI in plant and human imaging for advanced phenotyping and diagnostics.

Lightweight Vision Transformer with transfer learning for interpretable Alzheimer's disease severity assessment

We propose ViTTL (Vision Transformer Transfer Learning), a hybrid deep learning framework for early identification and severity classification of Alzheimer's disease (AD) using structural MRI scans. The approach utilizes 2D MRI slices, where convolutional neural networks (CNNs) extract localized spatial features, while a Vision Transformer (ViT) captures global dependencies across brain regions, enabling improved disease characterization (Fig. 1).

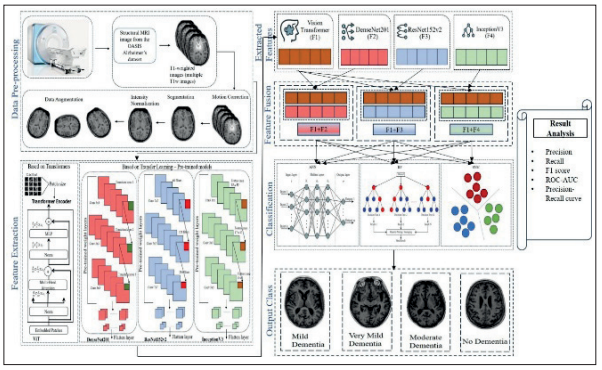


Fig. 1 Overview of the suggested transformer–transfer learning framework for Alzheimer's classification using MRI. MRI images are from the OASIS-1 dataset (https://www.oasis-brains.org/). Dataset released under the OASIS Data Use Agreement.

The framework integrates pre-trained CNN architectures- DenseNet201, ResNet152v2, and InceptionV3—with a Vision Transformer in a two-stage pipeline. In the first stage, MRI slices are processed in parallel to extract complementary local and global features. In the second stage, these features are normalized, fused into a unified representation, and passed to lightweight classifiers such as Random Forest (RF), Support Vector Machine (SVM), and Artificial Neural Network (ANN) to classify AD severity into mild, moderate, and severe stages. This design ensures efficient computation while maintaining high diagnostic accuracy (Fig. 2).

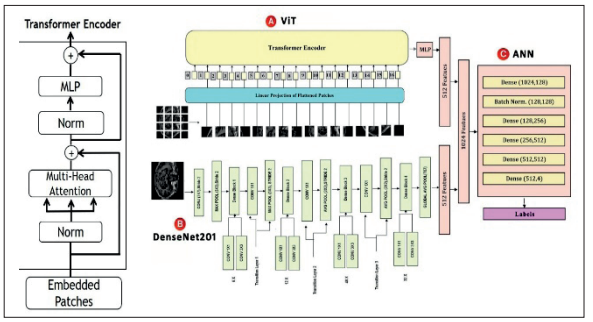


Fig. 2 Architectural diagram of the proposed ViTTL. MRI images are from the OASIS-1 dataset (https://www.oasis-brains.org/). Dataset released under the OASIS Data Use Agreement.

A key contribution of this work is the development of a lightweight and cost-effective framework suitable for deployment in resource-limited settings. The proposed feature fusion module effectively combines global contextual information from the Vision Transformer with localized structural patterns extracted by CNNs, enhancing the robustness of the model. Additionally, a systematic evaluation of multiple ViT-CNN and classifier combinations was conducted to identify the most effective configuration for Alzheimer's risk assessment.

To improve interpretability, Local Interpretable Model-Agnostic Explanations (LIME) and Gradient-weighted Class Activation Mapping (Grad-CAM) were employed (Fig. 3 and 4). Both methods consistently highlighted cortical and hippocampal regions associated with Alzheimer's pathology, indicating that the model captures biologically meaningful patterns.

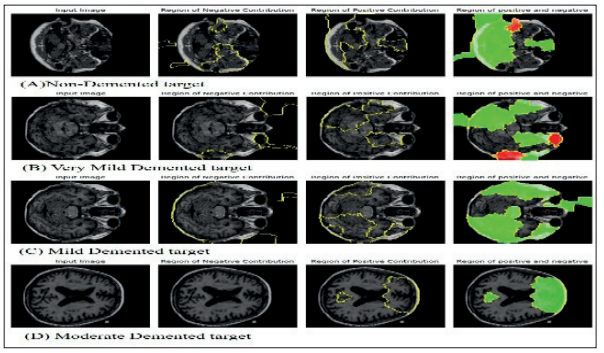


Fig. 3 Demonstration of the use of LIME alongside the DenseNet201 transfer-learning algorithm, depicted in subplots. MRI images are from the OASIS-1 dataset(https://www.oasis-b rains.org/).

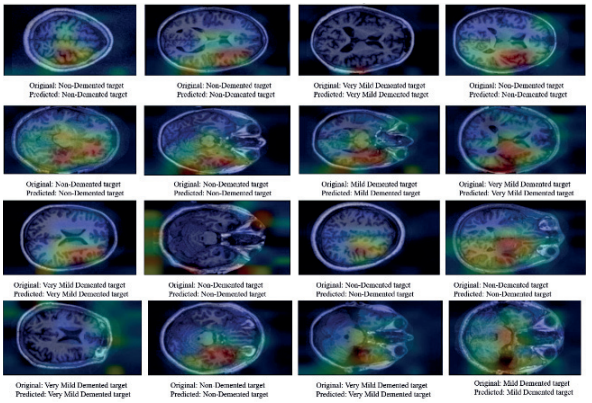


Fig. 4 Grad-CAM visualization of MRI scans for different stages of AD, including non-demented, very mild demented, mild demented. MRI images are from the OASIS-1 dataset (https://www.oasis-brains.org/). Dataset released under the OASIS Data Use Agreement.

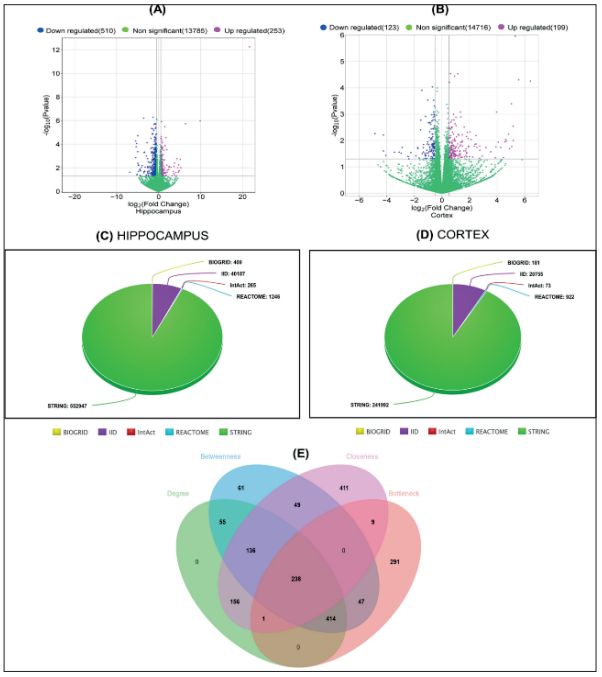


Fig. 5 Region-specific transcriptomic changes in chronic global ischaemia rat model relative to *sham* represented by (A) Volcano plot of entire set of the differentially expressed genes in hippocampus; and (B) Volcano plot of entire set of the differentially expressed genes in cortex, where each point represents the difference in expression (log2 Fold change) between *ischaemia* and *sham* subjects against the levels of statistical significance **p*-value < 0.05. Upregulated genes are represented in pink, downregulated genes are represented in blue, and non-significant genes are represented in green. *ischaemia* group (*n* = 6) subjected to BCCAo surgery and *sham* group (*n* = 6) not subjected to BCCAo surgery. Total protein-protein interactions extracted from different databases (BIOGRID, IID, IntAct, REACTOME, STRING) in (C) Hippocampus, and (D) Cortex. Venn diagram in (E) showing different network properties (Betweenness, Closeness, Degree, Bottleneck) and their intersecting 238 nodes showing statistical significance out of top 1000 genes from all interaction pairs.

Overall, ViTTL demonstrates strong potential as an accurate, interpretable, and resource-efficient tool for Alzheimer's diagnosis and clinical decision-making. The related codes are available at https://github.com/RuhikaSharma/enhanced-alzheimer-risk-assessment.

Differential Roles of Neuro-Inflammatory Regulator, MAPK11 in Cortex and Hippocampus Following Post-Stroke Cognitive Impairments in Rats

Ischaemic stroke is a leading cause of long-term cognitive impairment, affecting brain regions critical for memory and learning, particularly the cortex and hippocampus. However, region-specific molecular and inflammatory mechanisms underlying post-stroke cognitive impairment (PSCI) remain poorly understood. In this study, we developed a bilateral common carotid artery occlusion (BCCAo) rat model and performed comprehensive neurobehavioral assessments, revealing significant deficits in spatial and non-spatial memory, learning, and locomotor functions (Fig. 5).

To investigate region-specific responses, we conducted transcriptomic (NGS) and network-based analyses of cortical and hippocampal tissues. Differential gene expression analysis identified 199 upregulated and 123 downregulated genes in the cortex, and 253 upregulated and 510 downregulated genes in the hippocampus. Interactome analysis further revealed 13 key hub genes associated with neurodegenerative pathways, prominently involving the PI3K/Akt/MAPK signaling axis. Among these, Map2k6 and Mapk11 emerged as critical regulators (Fig. 6).

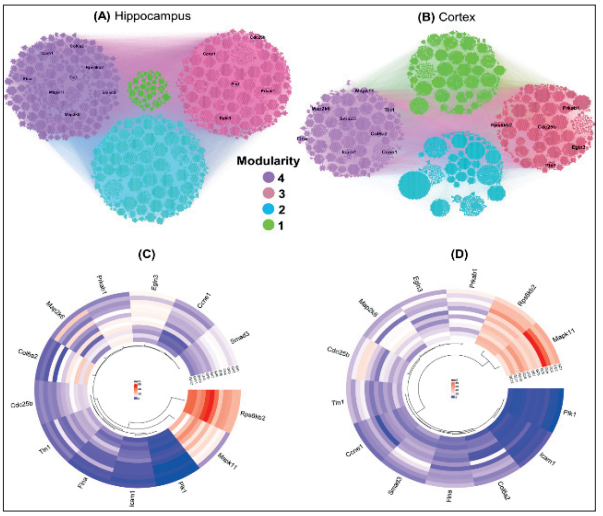


Fig. 6 Network visualization of all the protein-protein interaction pairs in (A) Hippocampus and, (B) Cortex showing different clusters with their modularity score from 4 (purple in colour) being densely connected and 1 (green in colour) being comparatively sparsely connected. The 13 significant hubs deduced on the basis of GO and pathway analysis are being highlighted in the network. Circular heatmaps showing TPM expression values of the same 13 significant

hubs extracted from the transcriptomic data of (C) Hippocampus, and (D) Cortex; showing similar behavior of a few genes (*Map2k6*, *Plk1*, *Smad3*) in the two regions. *ischaemia* group (*n*=6) subjected to BCCAo surgery, and *sham* group (*n*=6) not subjected to BCCAo surgery.

Notably, Map2k6/Mapk11 expression was significantly elevated in the cortex but comparatively reduced in the hippocampus, suggesting distinct region-specific inflammatory responses. Integrated in vivo and in silico analyses identified MAPK11 as a central mediator of inflammation-driven neurodegeneration, particularly in the cortex. In contrast, the hippocampus exhibited relative resilience, potentially due to inherent neuroprotective mechanisms.

Overall, this study highlights MAPK11 as a promising therapeutic target for mitigating PSCI through region-specific modulation of neuroinflammatory pathways in chronic ischaemic conditions.

Relevant Publications:

- Journal of Neuroimmune Pharmacology. (2025), 20, 93.
- Scientific Reports. (2025), 15, 44028.
- Archives of Microbiology. (2025), 207, 115.

Research group: Kritika, Nymphaea, Kanika, Ruhika, Krishna, Aakarshan, Jatin

Kunal Singh, Principal Scientist
Kunal.singh@csir.res.in
Plant Biotechnology

Our group is working to explore the beneficial stimulants, including microbial and chemical for *Crocus sativus* plant (Saffron). Comprehensive analysis to decipher the developmental dynamics of saffron life cycle become imperative for that. Simultaneously, understanding the gene pool with ability to provide resistance against biotic stress is also a topic of interest.

Fungal isolates carry potential to increase key metabolites Safranal and Crocin

Stigma produced in flowers of *Crocus sativus* plants are most valued part due to accumulation of metabolite compound Crocin and Safranal. Recent result suggests that treatment with strains S9, S12, S13, and S14 showed higher Safranal content (>25%) while enhanced Crocin content was observed with strains S3, S6, S9 and S10 (>30%). Enhanced content for both metabolite was observed under S9 (**Fig. 1**).

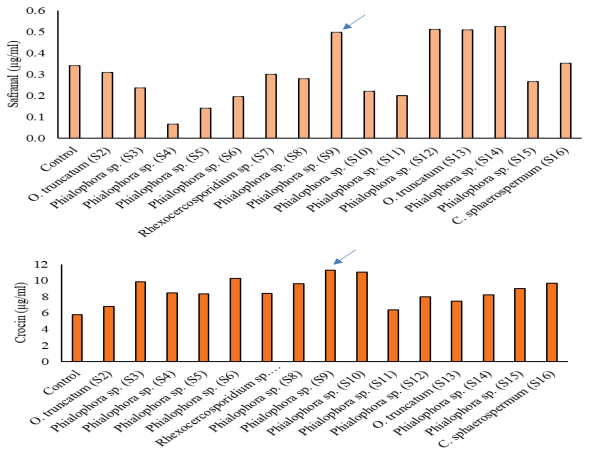


Fig. 1 Treatments with selected fungal strains can enhance metabolites in saffron.

The *StTNLC7G2T1* enhances resistance to biotic stress in *Arabidopsis* via pathogen triggered immunity

Work on plant defence against fungal phytopathogen identified a major defence gene *StTNLC7G2T1*. The gene is a member of NBS-LRR protein family and encodes a TIR-NBS-LRR cDNA and protein. Transgenic lines under constitutive 35S promoter raised and checked for effect under biotic stress. Transgenic lines expressing *StTNLC7G2T1* displayed significant resilience against bacterial pathogen *Pseudomonas syringae* and fungal pathogen *Alternaria brassicicola*, by remaining healthy at 5-day post inoculation (5dpi), while wild-type plants showed severe symptoms (**Fig. 2**). The *StTNLC7G2T1* provided resilience against pathogens via enhanced pathogen triggered immunity (PTI) as observed by very high callose deposition and ROS generation at the site of pathogen attack.

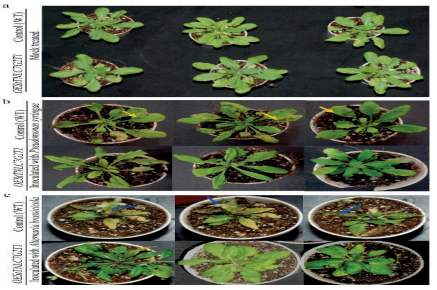


Fig. 2 Transgenic plants under constitutive expression of *StTNLC7G2T1* were tolerant to biotic stress. © Springer, 2025.

The hormone signaling genes regulate the resistance response under a complex mechanism with resistance against bacterial pathogen govern more by Salicylic acid (SA) signalling while against fungal pathogen via Jasmonic acid signalling genes (**Fig. 3**).

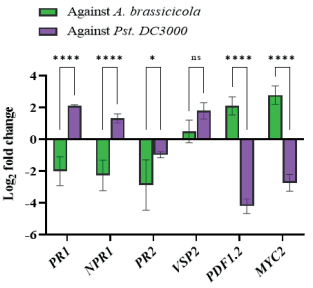


Fig. 3 Response to fungal pathogen *A. brassicicola* was led by JA signaling. © Springer, 2025.

Relevant Publications:

- Physiology and molecular biology of Plants. (2025), 31: 2217.
- Journal of Plant Biochemistry and Biotechnology. (2025), 51, 605.

Research group: Kanchan Yadav, Ruben Ahlawat, Noni Narula, Smriti Aswal.

Rajiv Kumar, Principal Scientist
rajiv.kumar@csir.res.in
Stress biology and Proteomics

Picrorhiza kurroa is an economically important high-altitude medicinal plant with huge therapeutic potential due to iridoid glycoside, i.e, picrosides. However, fragmented genomic information, the lack of genetic transformation protocols, and the unavailability of silencing methods limit the functional validation of key pathway genes *in planta* involved in picroside biosynthesis in *P. kurroa*.

In this study, we established a method of virus-induced gene silencing (VIGS) in *P. kurroa* using a Tobacco rattle virus (TRV) derived vector and successfully silenced the phytoene desaturase (*Pk*PDS) gene. VIGS is a PTGS technique that uses the natural defense mechanism utilized by plants to protect themselves from invading viruses. It is an RNA-mediated reverse genetics knockdown method to identify the gene function by sequence-specific degradation of the gene of interest in dicotyledon and monocotyledon plant species. The vectors used for VIGS are mostly derived either from single-stranded RNA (ssRNA) or DNA viruses. Tobacco rattle virus (TRV) derived vector is one of the most widely used systems in dicots because of its broad host range and ability to infect meristematic tissue.

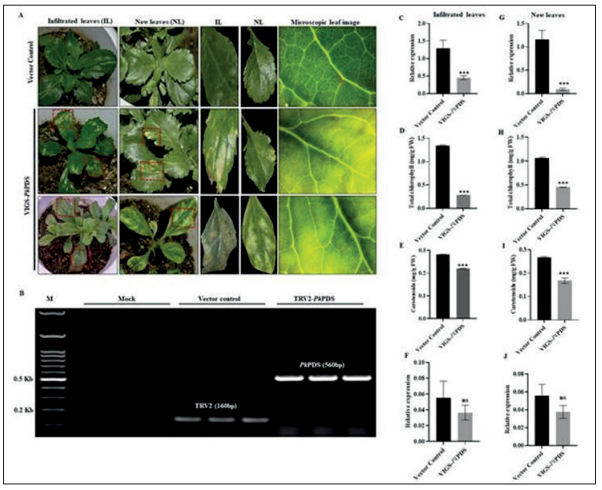


Fig. 1 VIGS phenotype in P. kurroa. The appearance of photobleached phenotype in infiltrated and newly emerged leaves of *P. kurroa* (A), confirmation of TRV2 and TRV2-PkPDS construct after infiltration in leaves (B), relative expression of the PDS gene in vector control and TRV2-PkPDS infiltrated leaves (C), quantification of chlorophyll content (D), carotenoid content (E), relative expression of the ZDS gene (F), relative expression of the PDS gene (G), quantification of chlorophyll content in new leaves (H), quantification of carotenoid content in new leaves (I), and relative expression of the ZDS gene (J) in vector control and TRV2-PkPDS new leaves. The values are means ± SD of triplicate analyses. * mark depicts a significant difference at p < 0.001 using the student t-test.

Monitoring the photobleaching phenotype in *Pk*PDS silenced leaves

The primary goal of this study is to assess the effectiveness of Tobacco Rattle Virus (TRV) in inducing gene silencing in *P. kurroa*. If yes, then could it serve as an effective method for gene silencing in *P. kurroa*. For this, we have taken TRV-based vectors (pTRV1 and pTRV2) that can infect various plants, produce mild symptoms, and spread from one meristematic tissue to another. To test the effectiveness of the TRV-based vector in *P. Kurroa,* we

silenced an endogenous gene phytoene desaturase (*Pk*PDS), a key enzyme in the biosynthesis of carotenoids using TRV2-*Pk*PDS construct which results in photobleaching phenotype in infiltrated leaves as well as newly emerged leaves (Figure 1A). PDS plays a crucial role in the carotenoid biosynthesis pathway, and silencing of this gene leads to a marked reduction in carotenoid accumulation. It is a well known fact that carotenoids are essential for protecting chlorophyll from photooxidative damage by quenching excess light and reactive oxygen species. The disruption in the carotenoid synthesis unables its protective function, resulting in chlorophyll degradation and the development of visible photo-bleaching. The observed phenotype in leaves might be due to silencing of *Pk*PDS, which interferes with the synthesis of carotenoids involved in protecting chlorophyll from photooxidation. Sequence alignment showed that *Pk*PDS protein sequences have a highly conserved Flavin-containing oxidoreductase domain belonging to the superfamily FAD NAD (P)-binding domain common in the other plant species. This domain belongs to the NAD_binding_8 superfamily, having Rossmann-fold NAD(P)H/NAD(P)(+) binding (NADB) domain and found in numerous dehydrogenases of as glycolysis and many other redox enzymes.

VIGS's effectiveness largely depends on plant growth and interaction between the host plant and the virus. Maintaining the ideal environmental conditions for viral propagation, choosing the appropriate developmental stage, and *Agrobacterium* infiltration methods are critical to VIGS efficiency and which have been discussed in the various previously reported studies. Previously, it has been established that the needle-less syringe infiltration method having *Agrobacterium* suspension OD_{600} of 0.7 to 1.0 at cotyledonary leaf was effective in producing the detectable photobleaching phenotype in various plant species. Therefore, we considered the needle-less syringe infiltration method for VIGS in *P. kurroa* plants at the 6-8 leaf stage. Firstly, we optimized the OD of the *Agrobacterium* suspension harboring TRV1 and TRV2-*Pk*PDS in 1:1 and found that *P. kurroa* plant infiltrated with OD_{600} 1.0 produced the detectable intermediate photobleaching phenotype, including green-whitish variegated phenotype in the infiltrated leaves at 15-17 dpi (Figure 1A). However, leaves infiltrated with an equal ratio of TRV1 and TRV2 construct (vector control) didn't show photobleaching phenotype. Moreover, lower density (OD_{600} 0.8 or less than 0.8) fails to produce the detectable photobleaching phenotype, and higher density (OD_{600} 1.2 or 1.5) results in the death of the leaves Therefore, for VIGS experiment in *P. kurroa*, an OD_{600} range of 0.8-1.0 was optimized and used for all subsequent infiltration experiments. Next, we observed that the *P. kurroa* older leaves (3rd and 4th pairs of leaves) infiltrated with *Agrobacterium* suspension harboring TRV1 and TRV2-*Pk*PDS in a 1:1 ratio were alive and produced a detectable photobleaching phenotype. In contrast, younger leaves (2nd pair of leaves) died within a week after the infiltration. These results suggest that the plant's developmental stage and density of *Agrobacterium* suspension are essential parameters for successfully implementing VIGS in *P. kurroa*. Further, to know the stability of the photobleaching phenotype, *P. kurroa* plants were grown for 8-9 weeks' post-infiltration. Interestingly, it was observed that the photobleaching phenotype was more prominent in newly emerged leaves, suggesting silencing of pTRV2-*Pk*PDS spread from one meristematic tissue to another, resulting in silencing of *Pk*PDS in newly emerged leaves.

Significant reduction of transcript, chlorophyll and carotenoids content confirms targeted silencing of *Pk*PDS

To endorse the successful infiltration PCR was performed in the photobleached leaves collected at 20 dpi following DNA isolation. For this, PCR was performed with TRV2 universal forward primer and *Pk*PDS reverse primer for VIGS-silenced tissue, whereas TRV2 universal vector-specific primers were used for control tissue. The figure depicts a band of 160bp and 560 bp fragments in vector control and VIGS plant, respectively, whereas mock infiltrated leaves did not show expression of TRV2-*PK*PDS (Figure 1B). These results suggest the confirmation of the construct infiltration into *P. kurroa* leaves. Further, we checked the expression of *Pk*PDS in TRV2-*Pk*PDS infiltrated leaves after 20 dpi and newly emerged leaves using qRT-PCR. There was significant down-regulation (up to 65%) of the PDS gene in TRV2-*Pk*PDS leaves compared with the vector controls (Figure. 1C, G). Similarly, the total chlorophyll and carotenoid content in VIGS silenced *P. kurroa* leaves was reduced to 60-75% compared to vector control (Figure 1D, E, H, I). Our studies are consistent with the previous reports in which they estimated the total chlorophyll and carotenoid content. Further to check the specificity of *Pk*PDS, we analyzed the expression of *ζ-carotene desaturase* (*ZDS*), which is an another key gene in the carotenoid biosynthetic pathway. The expression of *PkZDS* did not show any significant change in *PkPDS*-silenced plants compared to vector controls, which suggested that the observed silencing effect was specific to *PkPDS* and did not broadly affect other carotenoid biosynthesis genes (Figure 1F, J). Therefore, the molecular analysis of VIGS-silenced plants suggests successful silencing of the *Pk*PDS gene in *P. kurroa*. The result of *Pk*PDS silencing in *P. kurroa* is consistent with VIGS-mediated gene silencing observed in other plants like *Andrographis paniculata, Withania somnifera,* and *Camellia sinensis,* in which they have shown the photobleaching phenotype by downregulating the PDS gene As in *P. kurroa* the newly emerged photobleached leaves also showed the reduction in the transcript level, chlorophyll content and carotenoids which indicated that VIGS could work in *P. kurroa* efficiently and can be utilized to study the stress related studies *P.kurroa*.

Virus-induced silencing of the *Pk*PDS gene results in a photobleaching phenotype in *P. kurroa.* The silencing of the *Pk*PDS gene was confirmed by the *Pk*PDS transcript, followed by an estimation of chlorophyll content in VIGS-treated leaves. RT-PCR analysis suggests a 65% reduction in transcript and a 60% reduction in total chlorophyll in VIGS leaves. Furthermore, we observed photobleaching in newly emerged leaves after infiltration, indicating that *Pk*PDS silencing spreads from one meristematic tissue to another. Thus, the current VIGS method

might be employed to study the gene function involved in the biosynthesis of picrosides and other metabolites in *P. kurroa*.

Relevant Publications:

- Planta. (2025), 261,111.
- Nucleus. (2026), 10.1007/s13237-026-00648-4.
- Critical Review in biotechnology. (2026), 1-21.

Research group: Dr. Paramdeep Kumar, Vishal Saini, Monika Chauhan, Amit Chauhan, and Ashima Dhiman.

Vivek Dogra, Principal Scientist
vivekdogra@ihbt.res.in
Plant Adaptation and Stress Signaling

Research interests and long-term goals of our lab are (i) decoding stress-induced damage and signalling cascades; (ii) understanding the adaptive mechanisms in high-altitude plants; (iii) engineering stress resilience in plants. In line with these goals, we are currently working on the following projects:

Decoding stress-induced damage and signalling cascades

Various stress factors directly affect the photosynthetic electron transport chain, generating ROS. The ROS, thus generated, primarily targets photosynthetic machinery, leading to reduced efficiency. Chloroplasts activate distinct retrograde signalling pathways. ROS per se, ROS-oxidised derivatives, and ROS-generated metabolites activate signalling to deal with elevated ROS and its effects. Despite several studies, the precise extent of oxidative damage to the photosynthetic machinery remains unknown. Our investigations mapped specific proteome changes and oxidative posttranslational modifications in cognate proteins (Fig. 1).

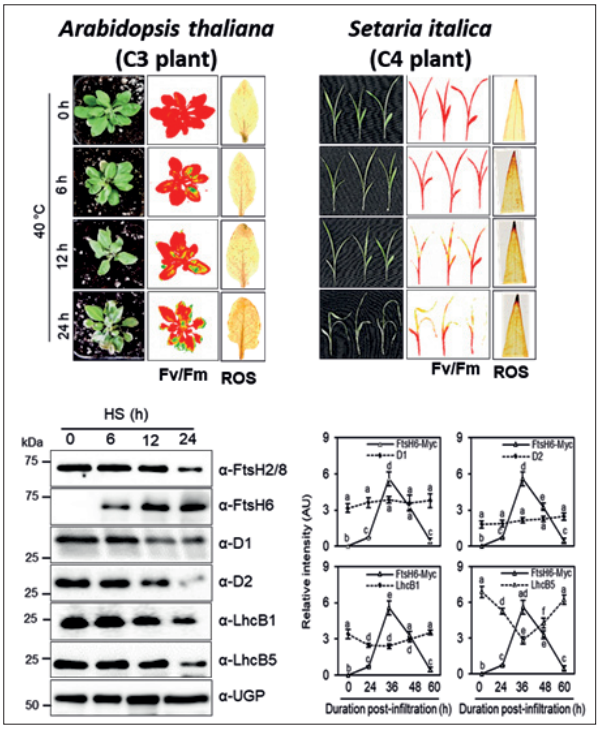


Fig. 1 Heat-induced metalloprotease maintains proteostasis in the photosynthetic apparatus, reinstating photosynthetic efficiency under elevated temperatures in plants. © Plant Cell Reports, 2025.

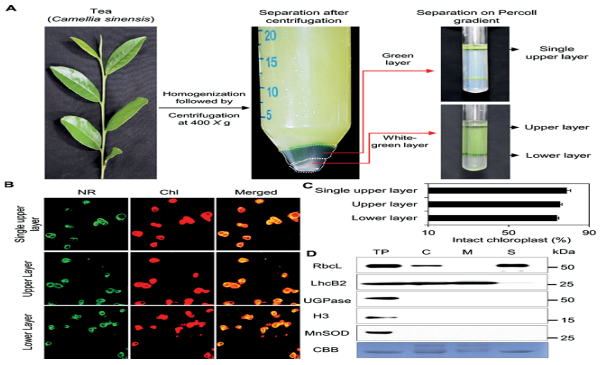
We analysed the impact of elevated temperatures on the photosynthetic proteins in C3 and C4 model plants, *Arabidopsis thaliana* and *Setaria italica* (foxtail millet). The results revealed the vulnerability of photosystem II and light-harvesting proteins (LHCP), which readily undergo stress-induced oxidative damage, indicating their turnover. An evolutionarily conserved heat-induced, chloroplast-localised metalloprotease selectively degrades damaged proteins to maintain turnover and thus photosynthetic efficiency (Ghosh et al. 2026).

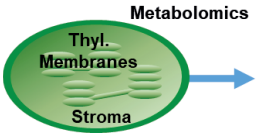
In response to oxidative damage, chloroplast activates retrograde signaling pathways through oxylipins and metabolites to reprogramme nuclear gene expression and trigger cognate responses to deal with adversity. The sub-lethal stresses induce plant growth inhibition by arresting chloroplast division and cell cycle and activating programmed cell death (PCD). However, the precise mechanism is not clear. To decipher this retrograde signaling, we performed a chemical-based mutagenesis screening of an Arabidopsis mutant with dysfunctional chloroplasts, cell cycle defects, and light-dependent cell death. Several second-site mutants showing attenuation of cell death, chloroplast, and growth defects have been identified and are under characterization.

Secondary metabolites in Tea constitute a stress regulatory module

Polyphenols constitute an important class of secondary metabolites in Tea that not only determine the quality traits, but also regulate stress responses. Polyphenol oxidase (PPO), a copper-containing chloroplast thylakoid-localised enzyme, catalyses the oxidation of phenols, such as catechins, into theaflavins. We recently revealed that PPO senses a stress-induced decrease in pH and undergoes proteolysis for activation. PPO activation accumulates theaflavins, which act as signalling molecules, triggering an ER-stress-like response leading to programmed cell death, an essential process for sustaining stress conditions. This work unveiled the role of PPO in triggering a novel inter-organelle communication that activates stress responses in tea and other plants (*bioRxiv*, 2025). During this study, a protocol was developed to isolate intact chloroplasts for detailed analysis in various secondary metabolite-rich plants (*Plant Growth Regulations*, 2025).

The tea metabolites showed potential for growth promotion and eliciting defence/secondary metabolite accumulation. This potential has been documented as a patent and technology (Fig. 2).





Stress	Catechins (mg mg^{-1} Chl)	Theaflavins (mg mg^{-1} Chl)
0 h	0.99 ± 0.006	0.027 ± 0.008
6 h	0.27 ± 0.006	0.123 ± 0.013
12 h	0.13 ± 0.001	0.142 ± 0.005

Fig. 2 Isolating intact and contaminants-free chloroplasts from secondary metabolite-rich plants. © Plant Growth Regulation, 2025.

Understanding adaptive mechanisms of plants in high-altitude environments for sustaining adverse conditions

Despite exposure to environmental extremes such as fluctuating temperatures (warmer days and cooler nights), intense UV-B radiation, low partial pressures of gases, and inadequate availability of water and nutrients, high-altitude plants sustain and complete their life cycles. Deciphering the mechanisms by which these plants deal with these cues is essential for understanding the adaptability of these extremophiles. Our screening of Foxtail germplasm revealed resilience and adaptation to photoinhibitory stress (high light/cold) in landraces from high-altitude habitats. The resilient genotypes possess lesser chlorophyll contents, better non-photochemical quenching, and a comparatively shorter life cycle (*In communication*). The nutritional aspects of resilient genotypes under study.

Glandular prickles in Rosa hybrida accumulate specific sesquiterpenes implicated in defence against aphid pests

Many plants, including roses, possess prickles, the epidermal outgrowths that accumulate secondary metabolites. These epidermal appendages are of two types: hard and edgy (also called non-glandular prickles) or soft with a stalk and glandular head (called glandular prickles). The relevance and mechanism of this epidermal differentiation process are unclear. Earlier, we identified a transcriptional module that regulates prickle morphogenesis and secondary metabolite accumulation. Recently, we characterised the glandular prickles and discovered that these glandular structures accumulate specific sesquiterpene hydrocarbons with insect-attractant and insecticidal properties. Experimental results showed that glandular prickles exhibit acetylcholine esterase inhibitory activity, and release volatile sesquiterpenes β-cis-Caryophyllene, γ-Muurolene and β-Copaene to trap aphids and attract their predators to protect floral buds (Fig. 3).

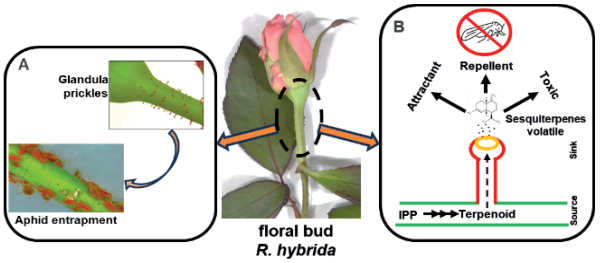


Fig. 3 Glandular prickles-mediated defense mechanism against aphid herbivores in the rose plant. © Biocatalysis & Agricultural Biotechnology, 2025.

Relevant publications:

- Plant Cell Report. (2026), 45, 83.
- Journal of Plant Growth Regulation. (2025). 10.1007/s00344-025-11911-4
- Biocatalysis and Agricultural Biotechnology. (2025), 69, 103785

Reseach group (From left to right): Ritu Godara, Kajal Thakur, Dipanshu Ghosh, Vivek Dogra, Rajvir Singh, Twinkle, S. Vaishnavi, Sapna Thakur, Sumanta Mohapatra, Shagun Bali.

Gaurav Zinta, Principal Scientist
gaurav.zinta@csir.res.in
Adaptation, Climate change, Genomics/Epigenomics

The Integrative Plant AdaptOmics Laboratory (iPAL) investigates plant molecular, physiological, and nutritional responses to climatic factors, such as elevated CO_2, heat, and drought, to uncover the genetic, epigenetic, and biochemical bases of resilience for sustainable agriculture.

Nutritional dynamics under climate change

Climate change is placing increasing pressure on agriculture by reducing the efficiency with which crops use nutrients, degrading soil health, and ultimately affecting food quality and security. Shifts in temperature and rainfall disrupt the soil's nutrient balance, potentially reducing crop nutritional value. To cope, plants rely on specialised proteins that transport nutrients from the soil to different parts of the plant, especially the seeds **(Fig. 1)**. This process is carefully controlled by genetic, epigenetic, and environmental signals. Importantly, plants do not absorb nutrients in isolation; however, multiple nutrients are transported together, creating complex interactions in their uptake, distribution, and utilisation.

Understanding how nutrients move within plants from roots to leaves and seeds, and how they are stored and regulated under changing environmental conditions, is essential. Plants also adjust these processes in response to stresses such as drought, heat, and elevated CO_2 levels. Insights into how nutrients are distributed within cells and how epigenetic mechanisms fine-tune them can help us better understand plant adaptation.

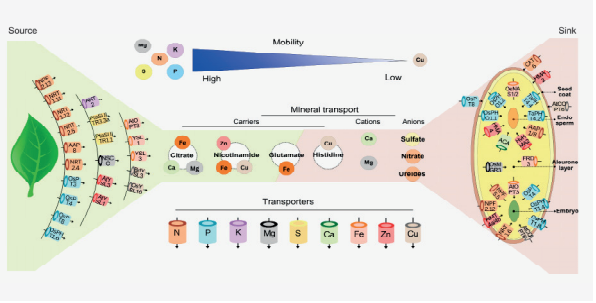


Fig. 1 Overview of how mineral nutrients move from source leaves to seed sinks. These nutrients are transported through the phloem from photosynthetically active source leaves to developing seeds. Unloading and redistribution occur through tissue-specific transporters in the seed coat, endosperm, aleurone layer, and embryo.

Such knowledge can guide improved farming practices, breeding strategies, and biotechnological approaches to develop crops with enhanced nutritional quality in a changing climate.

Mapping nutritional traits in C3 and C4 pseudocereals

The escalating challenges of climate change and malnutrition demand the integration of climate-resilient, nutrient-rich crops. However, how photosynthetic pathways shape trait expression across environments remains poorly understood. We evaluated two superfood pseudocereals, viz. C3 quinoa and C4 amaranth germplasm under four contrasting conditions: growth room, heat stress, rain shelter, and open field, by using agronomic, nutritional, ionomic, and metabolomic analyses **(Fig. 2)**.

Quinoa exhibited a higher harvest index, while amaranth showed greater protein and

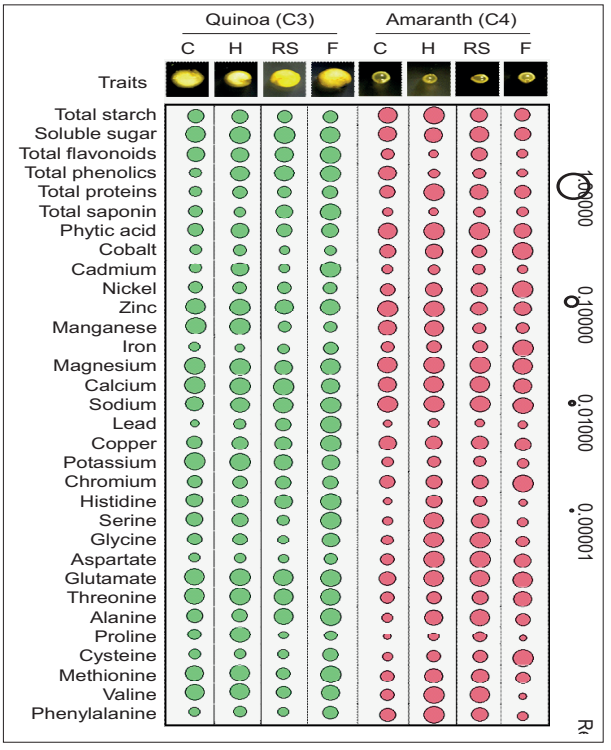


Fig. 2 Bubble plot showing the relative abundance (%) of plant nutrients (soluble sugar, total starch, protein, flavonoids, and phenolics), anti-nutrients (saponin and phytic acid), amino acids, and minerals in quinoa and amaranth grown in four different environments: control, heat, rain shelter, and field.

starch accumulation. Nutritional profiling revealed that quinoa seeds were enriched in flavonoids, phenolics, and saponins, as well as in iron, whereas amaranth contained higher levels of phytic acid, potassium, glycine, and aspartate. Multivariate analyses demonstrated strong trait-environment interactions alongside clear species-specific metabolic signatures.

Overall, our findings reveal distinct adaptive and nutritional strategies in C3 and C4 pseudocereals and provide a robust framework for selecting superior genotypes to enhance food and nutritional security under a changing climate.

Relevant Publications:

- Plant, Cell & Environment. (2026), 1–22.
- Chemical and Biological Technologies in Agriculture. (2026), 13, 19
- Critical Reviews in Biotechnology. (2025), Oct 3;45(7):1454-77

Research group: Dr Avriti Ranjan, Dr Sachin Ashok Tharot, Dr Lokesh Thakur, Dr Komal Goel, Dr Pravesh Kundu, Dr Madhushree Dutta, Vidhi Raturi, Surbhi Mali, Kirti Pandey, Ritika Rana, Sanjeet Kumar, and Narender Kumar.

Rajesh Kumar Singh, Principal Scientist
rajesh.singh@csir.res.in
Plant Adaptation and Developmental Biology

Our lab research focus lies in plant developmental biology and metabolic engineering. Several important plants undergo activity-dormancy cycles in the Himalayan region, which is required to survive under unfavorable conditions. Also, critical developmental processes such as flowering, metabolite synthesis, tuber/corm/bulb formation etc., are regulated by photoperiod and temperature. Thus, we aim to decipher the molecular regulation of seasonal growth, development and dormancy in economically important underground vegetative tissues.

In *Crocus sativus* L., flowering represents a tightly regulated developmental transition that is highly synchronized with seasonal cues, particularly temperature fluctuations following summer dormancy. Unlike many model plants, saffron exhibits a hysteranthous habit, where flowering precedes leaf emergence, indicating a strong reliance on stored reserves within the corm. Floral initiation occurs during the dormant phase, but floral organ elongation and anthesis are triggered by a drop in temperature in early autumn. This process is governed by the integration of environmental signals with endogenous regulators, including carbohydrate mobilization, phytohormone dynamics (notably gibberellins and abscisic acid), and the expression of key flowering genes such as *FT-like* homologs. Understanding the molecular control of saffron flowering is critical for improving yield, as flowering directly determines stigma production, the primary economic component of this crop (Fig. 1).

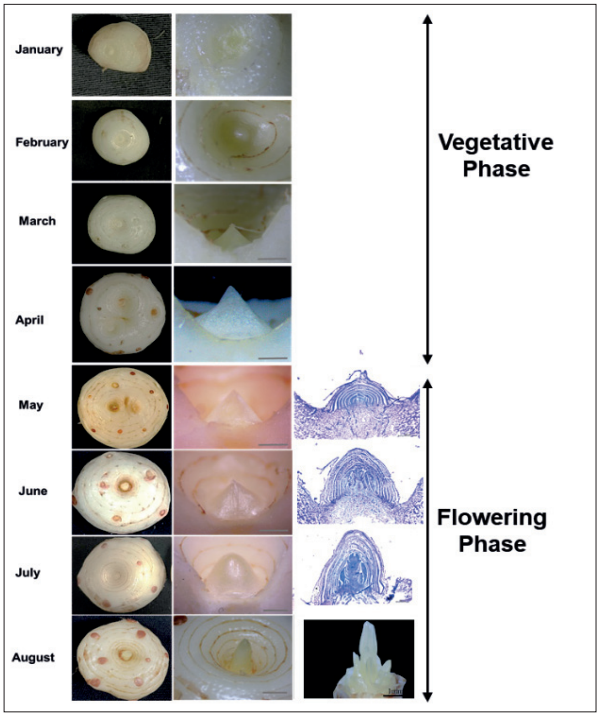


Fig. 1 Morphological Stages of Apical Bud Differentiation Leading to Flowering in Saffron.

Elucidating molecular network, underlying temperature-dependent flowering regulation in saffron

Our study identifies key regulators of saffron's flowering, focusing on the Florigen Activation Complex (FAC) components: *FLOWERING LOCUS T* (FT), bZIP transcription factor-FD and *TERMINAL FLOWER*-1 (TFL-1) and demonstrates their temperature-dependent roles in floral regulation. Spatiotemporal expression analyses suggested that *CsatFT3* and *CsatFD2*, expressed in the floral meristem, promote floral induction, while *CsatTFL1*-3 acts as a floral repressor. Protein interaction studies showed that CsatFT3 and CsatTFL1-3 compete for binding to CsatFD2, and their balance modulates floral induction (Fig. 2). Functional validation in Arabidopsis and Saffron confirmed these findings. Furthermore, we identified *CsatSVP2*, an ortholog of *SHORT VEGETATIVE PHASE* (*SVP*), as a low temperature-

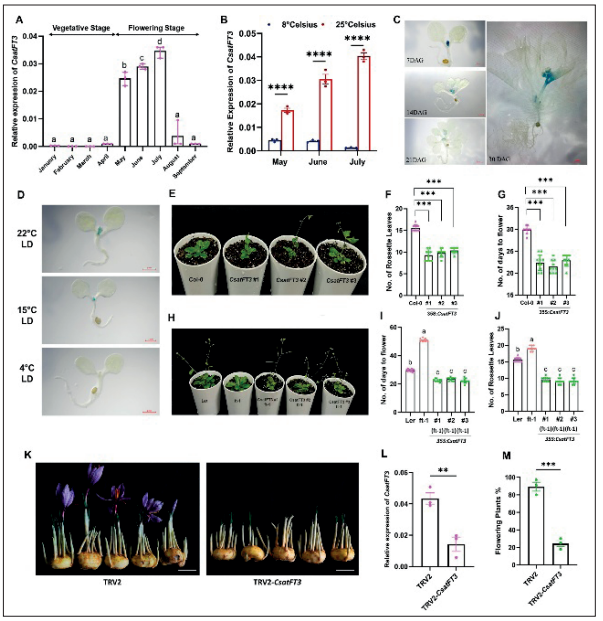


Fig. 2 CsatFT3 is involved in temperature-mediated floral induction in saffron.

responsive repressor that directly binds the *CsatFT3* promoter to inhibit its expression (Fig. 3).

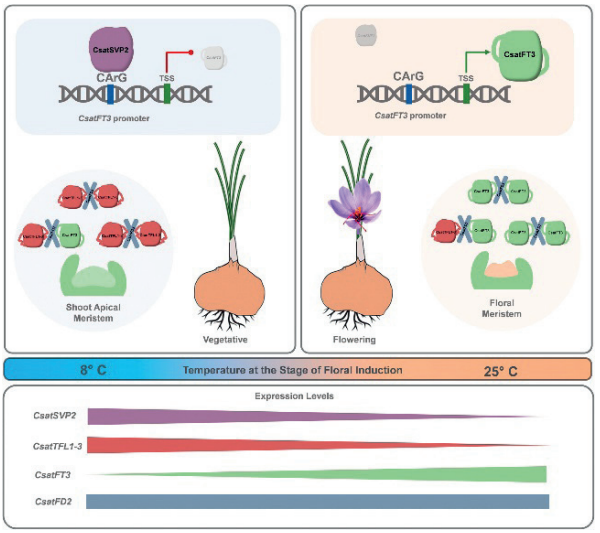


Fig. 3 Proposed model of temperature-mediated flowering regulation in saffron, emphasizing the key roles of *CsatFT3*, *CsatFD2*, *CsatTFL1-3/CEN1* and *CsatSVP2* in transitioning from vegetative to reproductive growth.

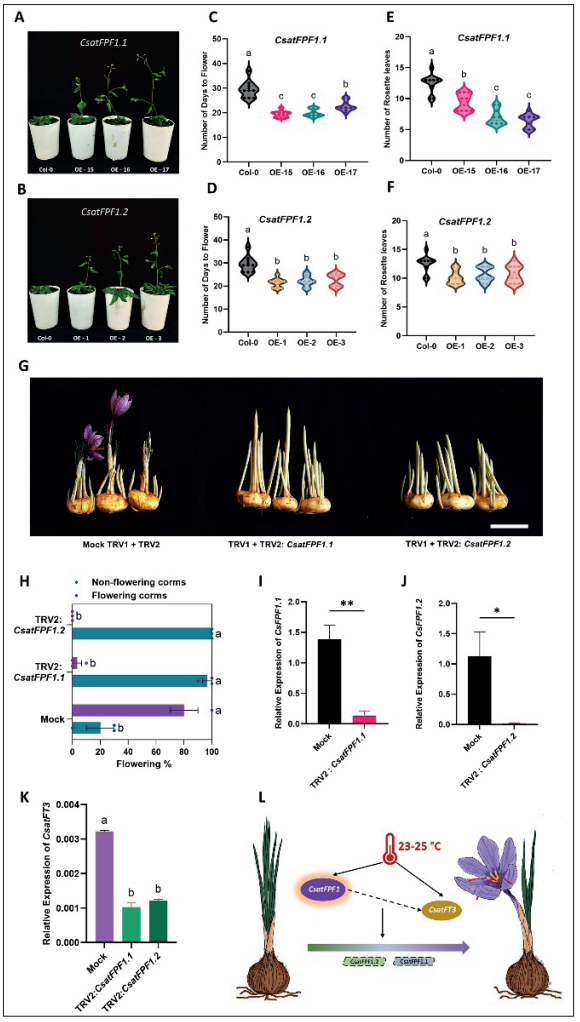


Fig. 4 Functional Characterization of CsatFPF1.1 and CsatFPF1.2 in Floral Transition.

Our study also establishes CsatFPF1.1 and CsatFPF1.2 as critical floral meristem-specific and thermo-responsive regulators of floral initiation in saffron. Their functional validation through heterologous overexpression in Arabidopsis and in planta silencing via VIGS provides the first direct evidence of their essential role in temperature-mediated flowering. The results suggest that CsatFPF1 may regulate flowering at least in part through modulation of *CsatFT3* expression. These findings not only advance our understanding of molecular regulation of flowering in saffron but also offer promising targets for future biotechnological strategies to improve saffron yield and adaptability to changing environmental conditions (Fig. 4).

Relevant Publications:

- Plant Biotechnology Journal. (2026), 24(3): 1133-1151.
- South African Journal of Botany. (2026), 192: 253-262.
- Journal of Plant Growth Regulation. (2025), 44(9): 5160-5176.

Research group: Dr. Hrishi, Dr. Upasana, Varnika, Sonali, Jhanvi, Avishek, Diksha, Dr. Rajesh, Dr. Keshav, Joel, Sukriti, Nirupma, Firdous, Shini, Arushi.

Vandana Jaiswal, Senior Scientist
vandana.jaiswal@csir.res.in
Biotechnology

Glyceraldehyde-3-phosphate dehydrogenase 7 (*FtGAPDH7*) confers heat stress tolerance in buckwheat [*Fagopyrum tataricum* (L.) Gaertn]

Glyceraldehyde 3-phosphate dehydrogenase (GAPDH) is an essential enzyme of the glycolytic pathway that helps in the production of energy in living cells. GAPDH is a multifunctional enzyme that performs several roles including participation in plant growth and development, enhancing resilience to biotic and abiotic stress, and safeguarding genome integrity. A total of 13 GAPDH genes were identified across the eight chromosomes in buckwheat [*Fagopyrum tataricum* (*Ft*)], comprising eleven GAPDH genes and two GAPN genes. The *cis*-regulatory element analysis elucidated that the *FtGAPDH* genes may regulate diverse biological processes and exhibit responses against various biotic and abiotic stressors. *FtGAPDH* gene expression analysis was conducted in different abiotic stresses, including heat, cold, salt, and drought stress, to comprehend the functions of these genes in mediating abiotic stress responses (Fig. 1). In cold stress, *FtGAPDH8/10* and 11 showed significant upregulation by 13.6-fold, 4.8-fold, and 25.3-fold, respectively. Under drought stress, significant downregulation was observed in *FtGAPDH6/8* and 9. Similarly, salt stress led to the downregulation of maximum genes, and *FtGAPDH1/2/10* and 11 showed significant downregulation. Under heat stress, *FtGAPDH2/3/6/7/9/10* and 11 exhibited significant upregulation, with the most pronounced increase observed in *FtGAPDH7*, which was upregulated up to 66-fold. Furthermore, the overexpression of *FtGAPDH7* in buckwheat and in *Nicotiana benthamiana* resulted in higher chlorophyll content, *Fv/Fm* and reduced malondialdehyde (MDA) and electrolyte leakage levels under heat stress as compared to the wild type, indicating enhanced photosynthetic efficiency and reduced oxidative damage, which provides evidence that this gene might be involved in thermotolerance. The study highlights the potential roles of *FtGAPDH7* genes in heat stress responses, providing a foundation for their functional validation to understand the regulatory mechanism and eventually to develop heat stress-tolerant buckwheat cultivars.

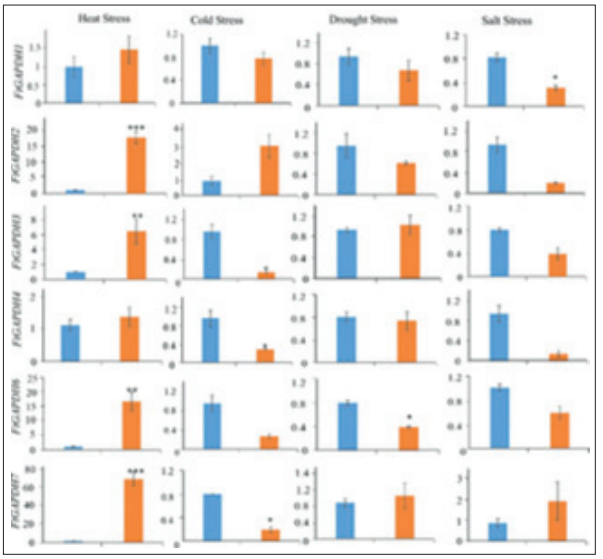


Fig. 1 The relative expression level of *FtGAPDH* genes in response to heat stress, cold stress, drought stress, and salt stress. According to the results of the Student's *t test*, the symbols *, **, and * denote statistically significant differences at $p<0.05$, $p<0.01$, and $p<0.001$, respectively.**

Identification of a natural *RcLOG1* allele linked to prickle development in Rose (*Rosa* spp.)

Roses, one of the most important ornamental crops, face challenges due to the presence of prickles. Recent studies have highlighted the important role of the *LONELY GUY 1* (*LOG1*) gene in prickle formation in the eggplant. The *LOG* (*LONELY GUY*) genes are involved in plant cytokinin biosynthesis, converting inactive cytokinin precursors into their active forms. This activation is essential for various physiological processes, including cell division, organogenesis, and stress responses. We have identified and investigated the *RcLOG* genes and their involvement in prickle formation in roses. A total of eight *RcLOG* genes were identified in rose, with coding sequence (CDS) lengths ranging from 648 to 921 bp, encoding proteins between 215 and 306 amino acids. qRT-PCR analysis revealed distinct expression patterns of *RcLOG* genes in prickled and prickle-less rose genotypes, suggested their involvement in prickle development (Fig. 2). During prickle development, *RcLOG1* expression was absent in prickle-less roses, while it was significantly upregulated in prickled roses. This indicated

that *RcLOG1* plays a crucial role in prickle formation, and its downregulation was likely responsible for the prickle-less phenotype. Interestingly, a single nucleotide polymorphism (SNP), Affx-86787307 (G/A), was identified in the seventh exon of *RcLOG1* (Fig. 3A-B). The homozygous AA genotype was associated with the prickle-less phenotype. This SNP was non-synonymous, and G to A transition resulted in an amino acid substitution from aspartic acid (D) to asparagine (N), which reduced the protein stability. In summary, the Affx-86787307-AA allele led to the incorporation of asparagine, potentially destabilizing the protein and contributing to the absence of prickles. These findings provide valuable insights into the molecular mechanisms underlying prickle development in roses and could facilitate the breeding of prickle-less rose varieties.

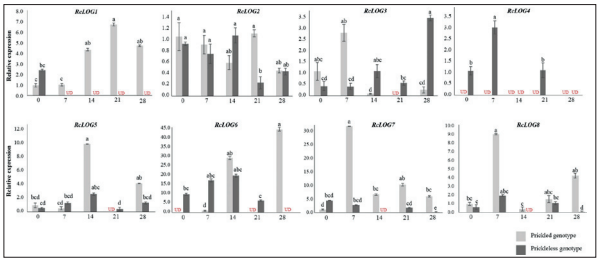


Fig. 2 Expression profile of *RcLOG genes* in stem of prickled and prickle-less genotypes at early and final stage. *Y*-axis represents the relative expression value. Bars represent the mean values of three biological replicates±SE. The different letters (a, b, c, d and e) indicating statistically significant differences according to Tukey's HSD test ($p<0.05$). UD in red color indicate undetermined.

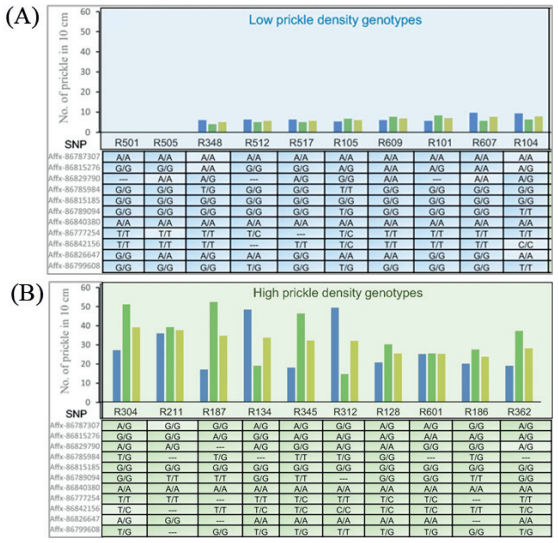


Fig. 3 No of prickles in contrasting genotypes (A) low and (B) high prickle density. Blue, green and yellow bar represents phenotype in 2022 (E1), 2023 (E2) and pooled data, respectively. Table represents SNPs identify in *RcLOG* genes and their allelic distribution in contrasting genotypes. SNP Affx-86787307 present in *RcLOG1* shows distinct allelic pattern in contrasting genotypes.

Complete Chloroplast Genomes of two medicinal orchids from the Himalaya *Habenaria intermedia* and *Herminium edgeworthii*: Implications for DNA barcoding, phylogenetics, and conservation

Habenaria intermedia and *Herminium edgeworthii* are ecologically and medicinally important terrestrial orchids of the Himalayas and key members of the Astavarga group, traditionally used in Ayurveda for their rejuvenating and immunomodulatory properties. Despite their significance, validated DNA barcodes and phylogenetic placements for these species remain unresolved due to morphological convergence and limited genomic data. We report the complete chloroplast map and genome sequences of *H. intermedia* (153,035 bp) and *H. edgeworthii* (152,937 bp), both exhibiting the typical quadripartite structure with LSC, SSC, and IR regions (Fig. 4A-B). The genomes encode 133 and 134 genes, respectively, including 86 protein- coding genes, 8 rRNA genes, and 39–40 tRNA genes, with GC content of 36.6 % (*H. intermedia*) and 36.7 % (*H. edgeworthii*). Comparative plastome analysis of ten *Habenaria* species identified five hypervariable regions (*matK–rps16, rps16–psbK, trnC–petN–psb*M, *ndhF–rpl32*, and *ycf1*) as potential plastid DNA barcodes. Due to the lack of available plastomes, comparative analyses could not be performed for *Herminium*. Phylogenomic analysis based on complete chloroplast genomes provided robust support for genus-level relationships within subtribe Orchidinae and highlighted the evolutionary distinctiveness of *Habenaria* and *Herminium*. This study represents the first plastome-level resource for these taxa, contributing to DNA barcode reference libraries and offering insights into their phylogenetic placement. These findings provide a foundation for accurate taxonomic identification, molecular authentication, and the prioritization of conservation strategies for these threatened Himalayan orchids.

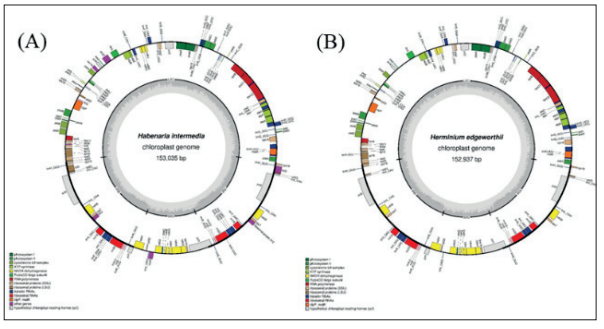


Fig. 4 Circular map of the plastome (A) *Habenaria intermedia* (B) *Herminium edgeworthii*. Genes located outside the circle are transcribed counterclockwise, while genes shown inside are transcribed clockwise.

Relevant Publications:

- Planta. (2025), 262(5): 101.
- Plant Cell Reports. (2025), 44(12): 285.
- South African Journal of Botany. (2026), 1;188: 472-83.

Research group: Dr. Narender Kumar, Priya Kumari, Vishek Choudhary, Himanshi Gangwar, Anita Choudhary, Reeta Devi, Ayushi Kukreti, Ninakshi, Mohini.

CHEMICAL TECHNOLOGY DIVISION

Pralay Das, Senior Principal Scientist and Head
pralay.das@csir.res.in
Chemical Technology

Our research group is focused on the valorization of lignocellulosic biomass into value-added chemicals, semi-synthetic modification of himachalenes, a sesquiterpene compound obtained from Cedrus deodara oil into novel benzosuberene analogues with diverse biological activities and the development of processing approaches for scalable production of cyclohexane-1,3-dione derivatives and 4-alkyl resorcinols. In addition, we are also working towards the design and development of nanocomposite materials and investigation of their potential as catalysts in sustainable synthetic methodologies along with the development of other heterogeneous transition-metal catalyst mediated challenging carbonylative approaches employing oxalic acid as CO surrogate.

Lignocellulosic biomass valorization to high-value chemicals

Driven by increasing demand for sustainable energy and chemicals, lignocellulosic biomass has gained significant attention in the recent years. In particular, lignin, the second most abundant biopolymer after cellulose (20–40 wt%), holds significant potential for its valorization to value-added phenolic compounds. Herein, we have developed a novel, one-step strategy for the efficient conversion of structurally complex and chemically recalcitrant lignin to high-value bio-based phenolic compounds employing manganese dioxide (MnO_2) as a catalyst in combination with sodium percarbonate ($Na_2H_3CO_6$) as a stable oxidant (**Fig. 1**). The reaction progressed under a hydrothermal reaction setup, resulting in oxidative depolymerization of various biomass-derived lignins (kraft lignin, bamboo lignin, lemon grass lignin, pine needle lignin, and rice straw lignin) for the selective synthesis of valuable phenolics such as vanillin, vanillic acid, and acetovanillone with the catalyst showing high recyclability over multiple catalytic cycles.

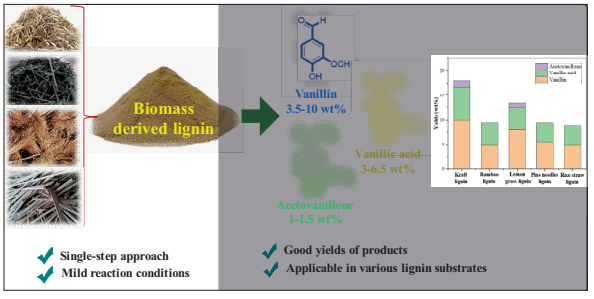


Fig. 1 Oxidative depolymerization of biomass-derived lignin to vanillin, vanillic acid, and acetovanillone.

Development of heterogeneous Pd-catalyzed approaches for green and sustainable synthesis

In our pursuit of sustainable waste-to-wealth transformation via the conversion of biomass into value-added biopolymers, we have developed an unprecedented strategy for the valorization of biomass-derived furfural to 2,5-furandicarboxylic acid (FDCA), a monomer of the polyethylene furanoate (PEF) polymer, following sequential bromination, oxalic acid mediated polystyrene-supported palladium nanoparticle (Pd@PS) catalyzed carbonylative esterification, and oxidative hydrolysis strategy (**Fig. 2**).

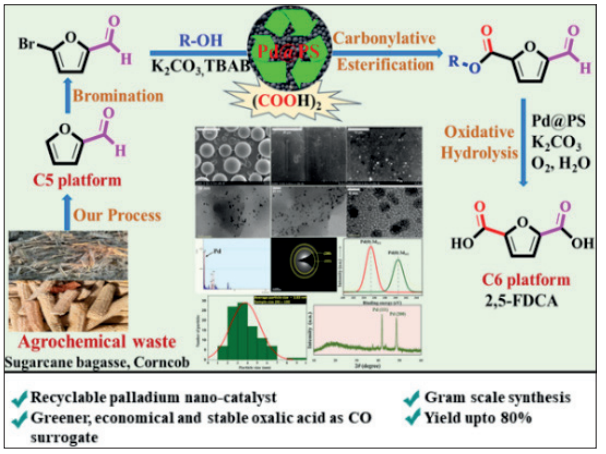


Fig. 2 Pd@PS catalyzed conversion of biomass-derived furfural to FDCA.

Furthermore, considering the ubiquity of indole analogues in medicinal chemistry and drug discovery, a highly efficient Pd/C-catalyzed approach for the direct synthesis of differently functionalized indole-3-carboxylic acids and esters via regioselective hydrocarboxylation as well as carbonylative esterification of indoles with aliphatic alcohols has been developed employing oxalic acid as CO surrogate (**Fig. 3**). Further, the phosphine-ligand-free conditions, high catalyst recyclability, and gram-scale applicability are the additional advantages of the developed protocol.

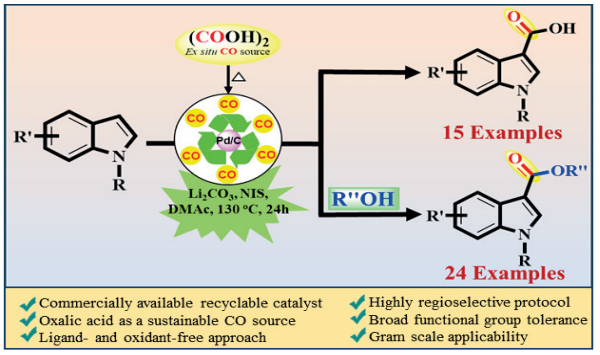


Fig. 3 Pd/C-catalyzed hydrocarboxylation and carbonylative esterification of indoles to indole-3-carboxylic acids and esters.

In addition, we have contributed to sustainable carbonylation chemistry through scholarly publications. These include a personal account that highlights our group's research contributions towards the establishment of oxalic acid as a versatile, bench-stable C1 and hydrogen surrogate, capable of generating CO, CO_2, and H_2 under mild conditions, while demonstrating its utility across diverse carbonylative transformations and innovative reaction system designs (**Fig. 4**).

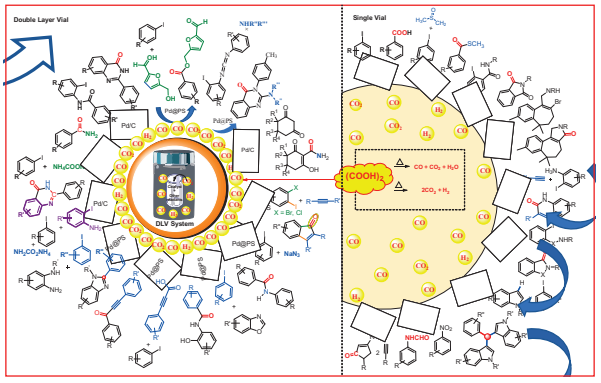


Fig. 4 Multifaceted role of oxalic ccid as a sustainable gaseous surrogate.

In addition, a review article on recent advances in transition metal-catalyzed carbonylative approaches for the synthesis of *a,β*-unsaturated carbonyl compounds has also been reported, emphasizing atom-economical strategies, mechanistic insights, and key challenges such as selectivity and scalability (**Fig 5**).

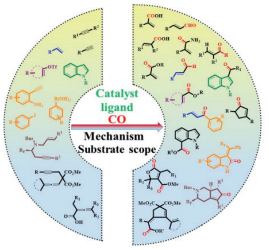


Fig. 5 Transition metal-catalyzed carbonylation reactions for the synthesis of *aβ*-unsaturated carbonyls.

Process development for the synthesis of cyclohexane-1,3-diones and 4-alkyl resorcinols

Furthermore, our group is working on process development for the scalable production of cyclohexane-1,3-dione derivative as well as 4-alkyl resorcinols. Further, the synthesized compound has been successfully applied to enhance the shelf life of cut flowers.

Relevant Publications:

- Bioresource Technology Reports. (2026), 34, 102676.
- Catalysis Science & Technology. (2025), 15, 5514.
- Organic Letters. (2025), 27, 10974-10979.

Research group (Left to Right): Mahender Kumar, Ritik Sharma, Ankita, Anjali Sharma, Dr. Pralay Das, Poonam Sharma, Dr. Sheetal, Ayushi Walia, Naresh Kumar.

Vijai K. Agnihotri, Senior Principal Scientist
vijai.agnihotri@csir.res.in
Natural Product Chemistry

Our research group is dedicated to Natural Products Chemistry, with particular emphasis on aromatic and medicinal plants of the Himalayan region. We specialize in comprehensive aroma profiling, alongside the isolation and structural characterization of novel bioactive compounds. The biological and therapeutic potential of essential oils and purified constituents was systematically evaluated to identify promising leads for further development.

Integrative network pharmacology and *in vitro* antimicrobial assessment of *Cryptomeria japonica* essential oil from North-western Himalaya

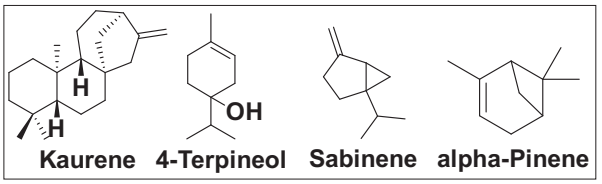


Fig. 1 Major Chemical Constituents

Cryptomeria japonica, commonly known as "Sugi" or "Japanese cedar," is one of the most commercially important plantation species in Asia, valued for its durable heartwood and essential oil (EO) used in pharmaceuticals and cosmetics. In this study, the leaves (L) EO was extracted and characterized, followed by chromatographic separation of EO (L) by using column chromatography. A total of 56 compounds were identified, with major constituents in the EO (L) being sabinene (19.72%), *a*-pinene (19%), and kaurene (11.51%). Fraction "A" was enriched with kaurene (72.08%), neo-cembrene (5.81%), and sandaracopimaradiene (5.08%).

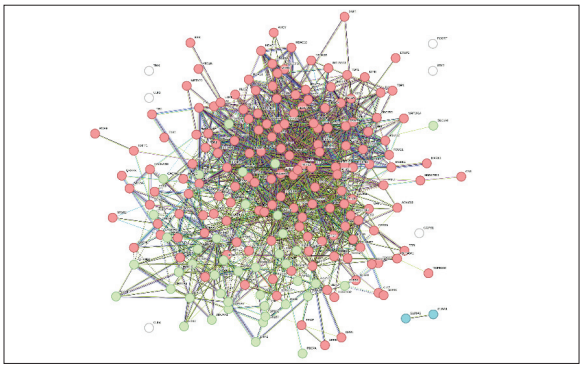


Fig. 2 K-means cluster of obtained essential oil.

The EO (L) showed strong antibacterial activity, particularly against gram-positive strains. Leaves EO displayed the highest zone of inhibition against *Micrococcus luteus* (27.67 mm) and *Fusarium graminearum* (28.67 mm). This study indicates that Fraction "A" is more potent than the pure EO, likely due to its high diterpene content. A network pharmacology analysis revealed that the STAT3 protein was crucial in bacterial immune response with the highest-scoring target.

Chemical profiling and *a*-glucosidase activity of *Artemisia maritima* and *Artemisia dracunculus* from Northwestern Himalayas, India

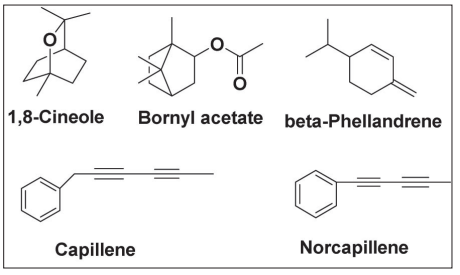


Fig. 3 Major chemical constituent.

The aim of this work was to investigate the chemical composition and *a*-glucosidase inhibitory activity of essential oils (EOs) isolated from *Artemisia maritima* and *Artemisia dracunculus* aerial parts. Nineteen compounds in *A. maritima* and 24 compounds in *A. dracunculus* were identified, representing 90.7% and 94.9% of the total essential oils, respectively. The major components of *A. maritima* essential oil were 1,8-cineole, bornyl acetate and borneol, while *β*-phellandrene, norcapillene, capillene and *a*-terpinolene were found to be the most abundant components in essential oil of *A. dracunculus*.

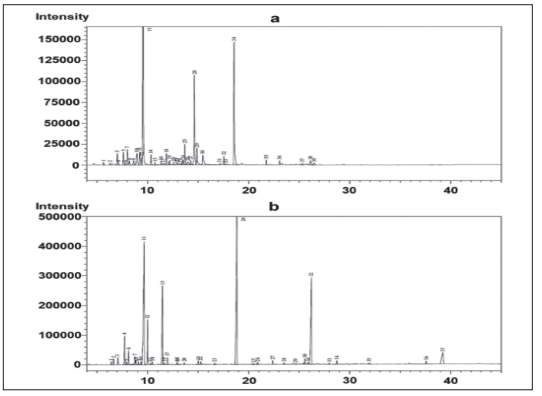


Fig. 4 GC-FID Chromatograms of the Essential Oils of *A. Maritima* (a) and *A. Dracunculus* (b).

The phytoconstituents varied across different samples depending on the species. The extracted EOs showed strong *a-glucosidase* inhibitory activity, which was close to the reference standard, acarbose.

Comparative essential oil composition and bioactivity profiling of *Junipers* berries from North-western Himalaya, India

The genus *Juniperus* L. (*Cupressaceae*) comprises about seventy-five aromatic evergreen species. In the Indian Himalayas, *Juniperus communis* L., *Juniperus indica* Bertol, and *Juniperus polycarpos* K. Koch are widely distributed in high-altitude cold desert regions, particularly in the Lahaul–Spiti district of Himachal Pradesh.

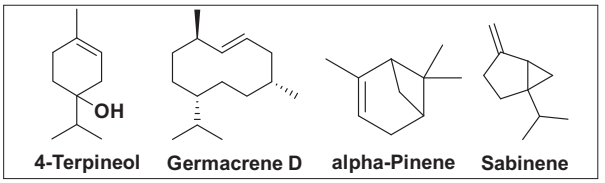


Fig. 5 Major Chemical Constituents

This study compares the chemical composition, antioxidant activity, and therapeutic potential of EOs from these three species. Thirty-two compounds were identified, accounting for 95.63%, 96.02%, and 91.16% of the EOs of *J. communis*, *J. polycarpos*, and *J. indica*, respectively. Limonene was the predominant compound in *J. communis* (37.27%), whereas sabinene dominated *J. polycarpos* (71.19%) and *J. indica* (52.91%).

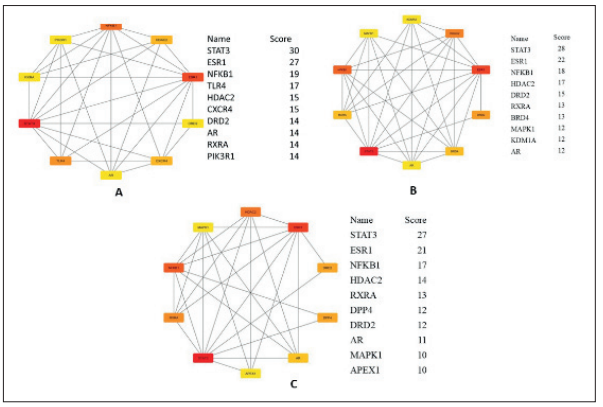


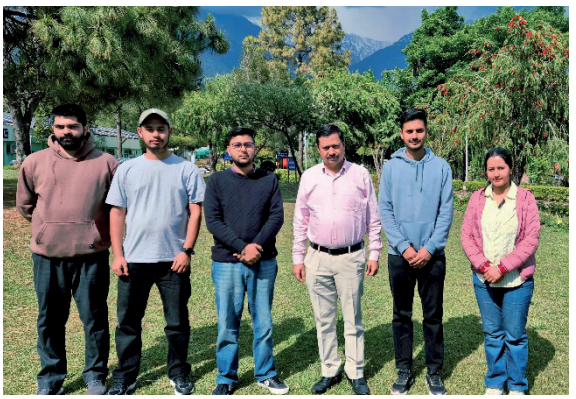
Fig. 6 Top 10 in network string interactions short (1) ranked by Degree method of (A) *J. communis*; (B) *J. indica*; (C) *J. polycarpos* berries EO.

Antioxidant assays revealed notable activity, with *J. communis* showing the strongest DPPH scavenging (IC_{50} = 607.36 ± 9.40 µg/mL) and *J. indica* exhibiting the highest ABTS activity (IC_{50} = 545.28 ± 2.7 µg/mL). Network pharmacology highlighted key targets, including STAT3, ESR1, and NFKB1, linking the EOs to inflammation, neuroprotection, and metabolic pathways.

Relevant Publications:

- Journal of Biologically Active Products from Nature. (2025), 15(2), 138-155.
- Journal of Essential Oil Research. (2025), 37(3-4), 239–248.
- Journal of Essential Oil Research. (2026), 38(2): 211–220.

Research group: Ritesh Sharma, Rishabh Bhardwaj, Kapil Dev, Saizal Jamwal, Rohit Pradhan.



Mohit Sharma, Senior Principal Scientist
mohit.sharma03@csir.res.in
Chemical Technology

Our group's focus is on the development, design, and upscaling of improved technologies for processing bioactive materials from medicinal and aromatic plants, Studies on supercritical fluid extraction, biopolymer extraction, and their value addition. Preparation of techno-economic feasibility and project reports for prospective entrepreneurs and mentoring start-ups

Green Extraction Strategies for volatile/ nonvolatile bioactive compounds from *Nardostachys jatamansi*: Assessing SFE and NADES for Sustainable Bioactive Production

In pursuit of adopting environment-friendly methodologies to amplify the essential oil (EO) yield of industrially important aromatic plants, an experimental Study on supercritical fluid-assisted extraction of a volatile/non-volatile concentrate from *Nardostachys jatamansi* (D.Don) DC was conducted. Herein, supercritical fluid extraction (SFE) was employed to extract the volatile concentrate (VC) from *Nardostachys jatamansi*. The SFE yielded two distinct fractions from its roots: a volatile concentrate (SFE-VC) with a yield of 6.06% (v/w) and a polar fraction (SFE-P) with a yield of 1.91% (w/w). The VC was subjected to gas chromatography (GC) and compared with our previous study for yield and phytochemical composition, which used conventional hydrodistillation (C-HD) and natural deep eutectic solvent–assisted hydrodistillation (N-HD). Ultra-high-performance liquid chromatography-mass spectrometry (UHPLC-MS) was used to analyze the composition of the polar fraction. Furthermore, all the fractions [extracted using SFE, C-HD, N-HDs (six EOs obtained using six different NADES combinations)] and the polar fraction (SFE-P) were evaluated for their antimicrobial potential,

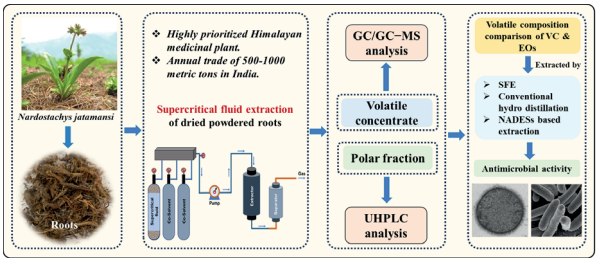


Fig. 1 A comparative analysis of SFE, hydrodistillation, and NADES-assisted extraction for *Nardostachys jatamansi* bioactive.

showing comparable inhibition percentages against E. coli and B. subtilis strains. Overall, SFE proved to be an innovative, clean, and environmentally friendly method, demonstrating high extraction efficiency for volatile constituents from *N. jatamansi*. (Fig. 1)

Development of a simultaneous UPLC-based method for analysis of 17 Stevia Metabolites in Diverse Products

The benchmark UPLC-based method for the concurrent analysis of seventeen *Stevia rebaudiana* metabolites is the first reported technique to quantify fifteen key steviol glycosides (SGs) alongside their two precursors, steviol and isosteviol, in a single analytical run. As we know, *Stevia rebaudiana* is a popular plant-derived noncaloric sweetener with numerous health benefits. The steviol glycosides (SGs) are regarded as primary sweetening components of this plant, having diverse flavour profiles and individual significance. Numerous ongoing research studies focusing on enhancing specific SGs' yields, improving sweetness, and reducing bitter aftertaste require a simple and efficient method involving SG precursors and as many of its glycosides in one go. The simultaneous analysis of SG precursors (steviol and isosteviol) and its glycosides are vital to ensure the quality, safety, and regulatory compliance of stevia-based products. This highlights the need for the development of an easy, reliable, and efficient method involving as many SGs and its precursors in one go. With this aim, a UPLC-PDA-based method was developed that included fifteen key SGs, along with their precursors, steviol and isosteviol, making this the first report to include both precursors and fifteen SGs in a single analytical run. This UPLC-PDA method is the first to simultaneously quantify 15 steviol glycosides and their two precursors (steviol and isosteviol) in one run. Validated by ICH guidelines, it demonstrates high sensitivity (LOD 0.18–3.60 µg/mL), excellent accuracy (94.45–102.10% recovery), and strong linearity ($R^2 \geq 0.998$). The technique is highly versatile, proving effective for analyzing diverse matrices, including raw plant extracts and finished commercial products like tablets and liquids. (Fig. 2)

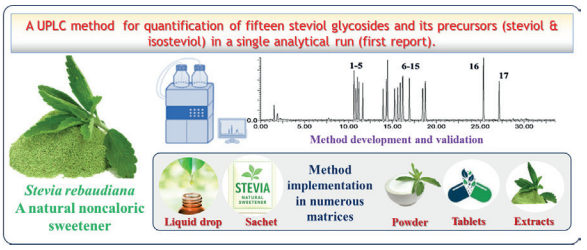


Fig. 2 A benchmark UPLC-based method for concurrent analysis of seventeen Stevia rebaudiana metabolites (steviol, isosteviol, and fifteen steviol glycosides).

UHPLC-PDA method for monitoring catechins and caffeine in tea samples and assessment of postharvest-associated variability across multilocation samples

Herein, a UHPLC-PDA-based quantification method has been developed for the simultaneous analysis of eight major catechins, namely gallocatechin, epigallocatechin, catechin, epicatechin, epigallocatechin gallate, gallocatechin gallate, epicatechin gallate, and catechin gallate, along with caffeine. The developed method was validated using linearity studies, detection and quantification limits, accuracy studies, theoretical plate count, asymmetric factor, tailing factor, and resolution, demonstrating its reliability and efficiency for analysing the chemical composition of tea samples. To maximize overall yield, the extraction protocol was optimized by varying solvents, extraction methods, duration, and temperature. The developed method has been applied to investigate multilocation effects and postharvest influences on caffeine and catechin content in tea leaves collected from 17 different locations. A wide chemical diversity was observed among the samples; for example, among eight samples from Himachal Pradesh, caffeine content ranged from 13.97 to 23.25 mg/g, while catechin content ranged from 4.76 to 110.10 mg/g. Results highlighted the need for stringent protocols for post-harvest handling of unprocessed teas to avoid autooxidation during comparative analysis. Further, the developed method was applied to various marketed teas, demonstrating its efficacy for quantifying tea metabolites across diverse matrices (Fig. 3).

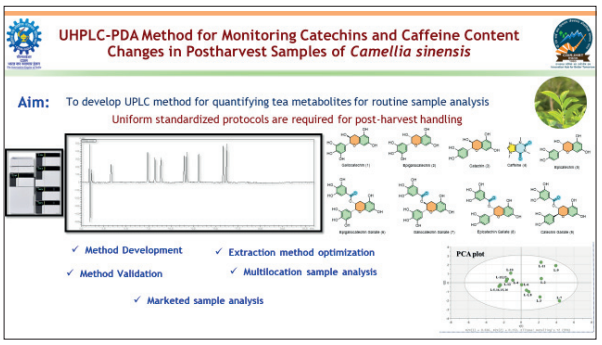


Fig. 3 UHPLC-PDA Method for Monitoring Catechins and Caffeine Content Changes in Postharvest Samples of *Camellia sinensis*.

Production of Natural Non- nutritive sweetener from Stevia rebaudiana at M/s RJ Saints, Una:

Demonstration cum commissioning of the entire steviol glycoside production plant was done, and two steviol glycoside-based solid and liquid formulations were also developed by M/s RJ Saints as per the technical know-how transferred. These two products were launched by distinguished dignitaries, chief guest Dr. Shekhar C. Mande, and guest of honor Prof. S.K. Sopory, and Speaker Dr. Sridevi Annapurna Singh, in the presence of the Director CSIR-IHBT and staff on National Science Day celebrations, 6th March 2025 **(Fig. 4)**.

Fig. 4 Launch of stevia-based formulation developed by M/s RJ Saints, Una, in collaboration with CSIR-IHBT at National Science Day celebrations on 6th March, 2026.

Tannins from Regenerable Parts of Plants for Vegetable Tanning (CLP Theme: Specialty Chemicals Mission):

A multistep process has been developed to produce enriched tannin from tea processing waste. The samples were tested for leather tanning at CSIR-CLRI, Chennai. Preliminary results show positive results in comparison to other vegetable tannin sources.

Design, fabrication, and setting up of distillation units and catalyzing the setting up of farmers' cooperatives for marketing of the produce: Mission Aroma phase-III):

Design of Mobile Essential Oil Distillation Unit

CSIR-IHBT is implementing the CSIR-Aroma Mission in the country's hill regions. To address the challenging terrain, the institute has developed an innovative, improved design for a truck-mounted mobile essential oil distillation unit, as part of the CSIR-sponsored Aroma Mission III. The unit is designed to demonstrate the production of essential oils directly in farmers' fields in hilly areas. Its design helped increase awareness among farmers through training sessions and practical demonstrations on extracting essential oils from aromatic plants. Farmers need training on distillation techniques

and post-processing to improve product quality and increase profits. The unit will successfully provide on-site training and demonstrations, raise awareness among farmers, and process aromatic crops in the most remote, hilly regions of Chamba, Mandi, Kullu, Kangra, Lahaul & Spiti, and other states with limited road and farm connectivity (**Fig. 5)**.

Fig. 5 Design fabrication of Mobile Essential Oil Distillation Unit under Mission Aroma Phase-III.

Relevant Publication:

- Journal of Essential Oil Research. (2025), https://doi.org/10.1080/10412905.2025.2509310.
- Food Research International. (2025) https://doi.org/10.1016/j.foodres.2025.117931.

Research group: Er. Vivesh Sood, Monu Kumar, Vikas Kumar, Er. Mohit Sharma, Arvind Sharma, Sahil Guleria, Chanchal Bhatt, Shekhar Minhas

Dinesh Kumar, Senior Principal Scientist
dineshkumar@ihbt.res.in
NMR, Metabolomics Natural Product Chemistry and Value addition

Himalayan biodiversity, especially medicinal and aromatic plants, has great potential and high demand in the drug, cosmetic, food, and nutraceutical industries. Due to this rising demand, unethical and illegal practices like adulteration and substitution have increased. There is also a lack of proper chemical markers, quality control methods, and scientifically developed products in the market, which is a serious concern. To support researchers, innovators, startups, MSMEs, and industries, our group has worked on identifying chemical markers, developing quality control methods, and creating chemical signatures. Under CSIR missions, several products have been developed and some are still in progress. This year, four products have been licensed to their respective stakeholders. In addition, our group is studying how medicinal plants and their products work at a mechanistic level. We also focus on process development, formulation, and value addition, and we continue to work actively in these areas.

Metabolomics studies

The group has conducted the metabolome analysis of medicinally important plants under different conditions and also these plants were evaluated for potential health benefits. The investigation clearly showed the differentiation and similarities among the targeted samples, which showed their respective trade off benefits.

Metabolome analysis and functional activities of *Euphorbia royleana*.

Euphorbia royleana (Euphorbiaceae) is an important succulent species and commonly known as Royle's spurge. It is used to treat inflammation, paralysis, and brain-related problems. The literature revealed that E. royleana was not well explored for phytochemical diversity and health benefits. Therefore, the current study was focused on investigating solvent-dependent chemical diversity and bioactive properties across stems, leaves, and reproductive tissue (flowers and seeds). Ethanol, 50% ethanol, and water extracts were prepared, in which the water extract of leaves showed the highest extraction efficiency (16.97%). Total phenolic content was found higher in 50% ethanol extract (112.65 ± 3.27 mg GAE/g), while flavonoid content was found higher in ethanol extract (217.31 ± 13.55 mg RE/g) of reproductive parts. Further, UPLC-PDA-based targeted polyphenol profiling showed gallic acid (23.658 ± mg/g) as the most abundant polyphenol among different parts. UHPLC-QTOF-IMS-based non-targeted metabolite profiling revealed 74 metabolites (terpenoids, flavonoid glycosides, and phenylpropanoids). Multivariate statistical analysis of identified metabolites further suggested clear organ- and solvent-specific variations (Fig. 1). Moreover, antioxidant and tyrosinase inhibition activities were performed, and the highest activity was found in the ethanol extract of reproductive tissues. The current study provides new insights into the chemical diversity of E. royleana, highlighting its ecological significance and chemotaxonomic value within Euphorbiaceae.

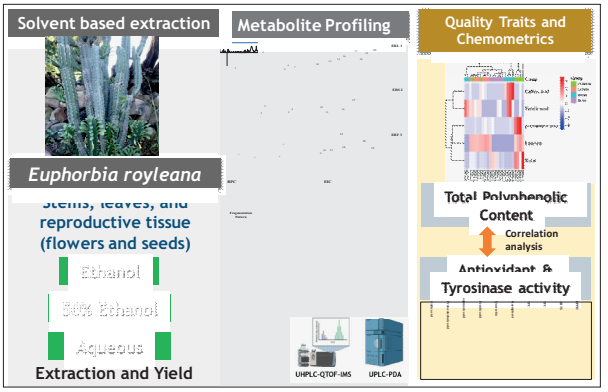


Fig. 1 Metabolome analysis and antioxidant potential of *E. royleana*.

Comprehensive metabolome analysis of *Rhynchostylis retusa*.

Rhynchostylis retusa (R. retusa) is an epiphytic medicinal orchid native to tropical and subtropical regions, including Western Himalayas. Pharmacological reports suggested its antimicrobial, anti-inflammatory, and antioxidant activities. Indian western Himalayas, especially Himachal Pradesh, provide a unique environment to grow *R. retusa* due to distinct ecological conditions, known to influence biosynthesis of metabolites. Thus, this study was focused to find out the chemometric variations using UHPLC-Q-TOF-IMS among differential geographical roots

of R. retusa. Comprehensively, *R. retusa* roots of four distinct locations (Hamirpur, Mandi, Bilaspur and Kangra) revealed the identification of 43 compounds, belonging to polyphenols, flavonoids, stilbenes etc. Further, identified metabolites were found varied at different locations due to the ecological conditions. These variations were clearly observed with chemometric analysis of different samples. The principal component and hierarchical clustering analysis showed abundance of polyphenols, similarities and discrimination, including their metabolites among the locations (Fig. 2). This is the first report on the comprehensive metabolite profiling of *R. retusa* and that will be helpful to differentiate or assess the quality of material based on chemical makeup. Moreover, chromatographic coupled with mass spectrometry identified chemical makeup of *R. retusa*, that could be the responsible key components of traditional health benefits and reported therapeutic activities. In netshell Environmental and geographical factors in Western Himalayas significantly influences metabolite profile of *R. retusa*. Study sets a foundation for conservation, quality assessment, and phytopharmaceutical valorization.

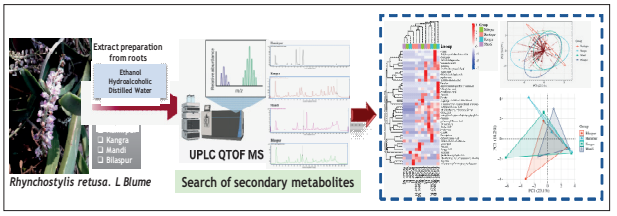


Fig. 2 Metabolome analysis of *R. retusa*.

Isolation and characterization of acetylcholinesterase, tyrosinase enzyme, and free radical inhibitors from aerial part of *Allium semenovii* Regel.

Seven compounds [palmitaldehyde (1), daucosterol (2), 24-propylcholesterol (3), asperin (4), vanillic acid (5), paprazine (6), and cycloalliin (7)] were isolated and characterised from aerial part of *Allium semenovii* Regel for the first time (Fig. 3). Extract, fractions, and isolated compounds were assessed for antioxidant, acetylcholinesterase and tyrosinase enzyme inhibition activities. A maximum antioxidant potential was observed in compound 6 (IC50 =12.45±0.69 µM, ABTS•+ and 377.67±0.10 µM, DPPH•) followed by ethyl acetate (IC50 = 95.00±0.15 µg/mL, ABTS•+) and chloroform fraction (IC50 = 370.00±0.6 2 µg/mL, DPPH•). Chloroform fraction (IC50 = 172.50±0.70 µg/mL) and compound 4 (IC50 = 108.01±1.99 µM) showed higher acetylcholinesterase enzyme inhibition. Whereas, Compound 5 was found significant to inhibit tyrosinase enzyme (IC50 = 11.37±0.16 µM). Hence, study suggested therapeutic potential of A. semenovii which could be due to presence of diversified compounds.

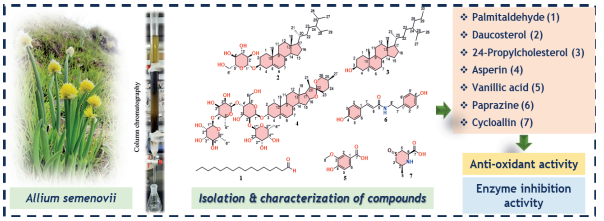


Fig. 3 Isolated molecules from *A. semenovii*.

Relevant Publications:

- Chemistry & Biodiversity. (2026), 23(3): e03217.
- Biochemical Systematics and Ecology. (2025), 123:105092.
- Natural Product Research. (2025) 1-7.

Research group: Dinesh Kumar, Bindu Rawat, Anil Kumar, Manish Kumar, Rishabh Kaundal, Sachin Vishisath, Iva, Pallavi, Sweety

Technical Staff: Mr. Shiv Kumar, Mrs Vijaylata Pathania, Mr. Ramesh Kumar, Mr. Pawan. Mr Virat Abhishak

Upendra Sharma, Principal Scientist
upendra@ihbt.res.in; upendraihbt@gmail.com
Catalysis; C-H Activation; Natural Product Chemistry; Analytical Chemistry

Phytochemical Investigation of Medicinal Plants

Our lab focuses on phytochemical investigations of medicinal plants, emphasizing: (1) isolation and structure elucidation of specialized metabolites, (2) development of quality assessment methods, and (3) evaluation of biological activities aligned with traditional medicinal claims. Innovative green extraction techniques using Natural Deep Eutectic Solvents (NADES) are employed as alternatives to conventional solvents. Both targeted and untargeted metabolomics, combined with chemometric tools, are used for quality assurance. A modern biochemometrics approach is applied for the scientific validation of medicinal properties. Our continuous efforts to isolate diverse phytoconstituents resulted in the isolation of more than thirty-five compounds from *Achyranthes bidentata*, *Aconitum heterophyllum*, *Ageratina adenophora, Ageratum conyzoides*, *Cissampelos pareira*, *Cocculus hirsutus*, *Cyperus rotundus*, *Ferula assa-foetida*, *Fritillaria cirrhosa*, *Rauwolfia serpentina*, *Taxus contorta*, and *Trillium govanianum*. Additionally, we work to scientifically validate the traditional uses of these medicinal plants, bridging the gap between ancient knowledge and current scientific research.

Isolation and Characterization of New Natural Products: This year our group has isolated and characterized four new molecules.

A new sesquiterpenoid from the roots of *Nardostachys jatamansi* (D.Don) DC: Five molecules, including a new sesquiterpenoid (3aR,5R,8aR)-5-isopropyl-8a-methyl-8-methyleneoctahydroazulen-3a(1H)-ol (1), valeranone (2), 4β,5β-dihydroxy-10-epi-eudesmane (3), halanpinol (4) and β-sitosterol (5), have been isolated from the roots of *N. jatamansi* (D.Don) DC. Compounds 2 and 3 have been reported for the first time from this plant species.

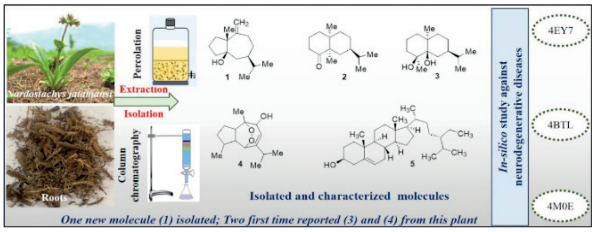


Fig. 1 Isolation of bioactive secondary metabolites from *Nardostachys jatamansi*.

Quality control analytical method development: This year our group has developed four new analytical methods.

Monitoring catechins and caffeine in tea samples and assessment of postharvest-associated variability across multilocation samples: Herein, a UHPLC-PDA-based quantification method has been developed for the simultaneous analysis of eight major catechins, namely gallocatechin, epigallocatechin, catechin, epicatechin, epigallocatechin gallate, gallocatechin gallate, epicatechin gallate, and catechin gallate, along with caffeine. A wide chemical diversity was observed among the samples from different locations; for example, among eight samples from Himachal Pradesh, caffeine content ranged from 13.97 to 23.25 mg/g, while catechin content ranged from 4.76 to 110.10 mg/g. Further, the developed method was applied to various marketed teas, demonstrating its efficacy for quantifying tea metabolites across diverse matrices.

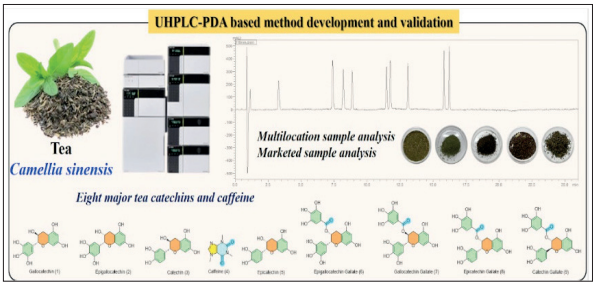


Fig. 2 UHPLC-DAD based quantification of major catechins and caffeine in *C. sinensis* (Tea) and market products.

Concurrent analysis of seventeen *Stevia rebaudiana* metabolites (steviol, isosteviol, and fifteen steviol glycosides) in a single analytical run and its implementation in diverse products: UPLC-PDA based method was developed involving fifteen key SGs along with their precursors steviol and isosteviol, which is the first report having both precursors and fifteen SGs in a single analytical run. The developed method was applied to plant extracts and stevia-based market products, including tablets, sachets, liquid drops, and powder, to demonstrate its efficacy in estimating metabolites across diverse sample matrices.

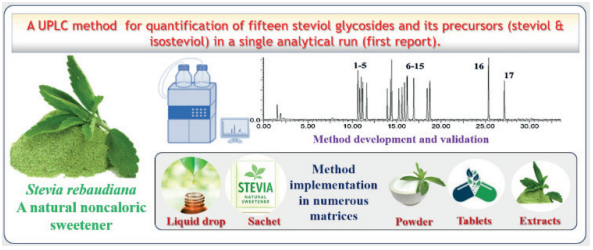


Fig. 3 UHPLC-DAD based quantification of major metabolites in *S. rebaudiana* and its market products.

UPLC-IM-Q-TOF-MS/MS-based biochemometrics and bioactive leads from Natural Products

Our group have also made a significant influence towards bio-chemometrics based scientific validation of traditionally known pharmacological potential of medicinal plants with *in vitro* bioactivity analysis. This further aids in development of ready-to-use bioactive formulations.

A hyphenated approach of chemical profiling, anti-bacterial assays, and molecular docking to validate the traditionally claimed anti-bacterial (Krimiroga) potential of *Cyperus rotundus* L.

This present work focuses on systematic validation of antibacterial potential (krimiroga) of this plant by evaluating its extract, fractions, and essential oils against Gram-positive (Bacillus subtilis, Staphylococcus aureus), and Gram-negative (Escherichia coli, Salmonella typhimurium) bacterial type strains. Anti-bacterial assay revealed potent activity of n-butanol fraction (81.67–100 %) and Eos (81.20–100 %) against targeted bacterial type strains. UHPLC-QTOF-MS/MS and GC-MS-based chemical profiling led to the identification of fifty major metabolites. Molecular docking study revealed potent docking scores (kcal/ mol) against different bacterial proteins (higher than positive control), such as rotunduside H (− 11.32), scirpusin B (− 11.62) against E. coli.

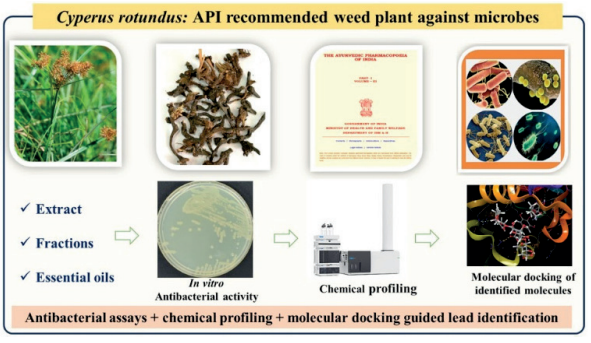


Fig. 4 Scientific validation of Krimiroga potential of *C. rotundus* and identification of key metabolites.

Synthesis of Bioactive Molecules *via* C-H Activation

One of the primary objectives of our group is to develop green and efficient catalytic methods for synthesizing bioactive molecules through C-H activation and functionalization. Mainly, we focus on the functionalization of N-heterocycles by employing novel catalytic techniques with in-depth study of the reaction mechanism. We have also initiated work on atroposelective C-H activation.

C-H activation

Ru(II)-Catalysed, Inherent-Directing Group Enabled Site-selective C-H Vinyltrifluoromethylation of Isoquinolones and Benzamides: In this study, we unveil an efficient and site-selective Ru(II)-catalysed route for synthesizing vinyltrifluoromethylated arenes by utilising amide carbonyl as an inherent directing group. 2-Bromo-3,3,3-trifluoropropene has been utilized as a sustainable surrogate of vinyltrifluoromethylation to provide diversely decorated isoquinolones and benzamides. Mechanistic studies have been performed to articulate the plausible mechanism. A vast array of substrates is amenable to this transformation, and post-synthetic modification of the products demonstrates the importance of the developed approach.

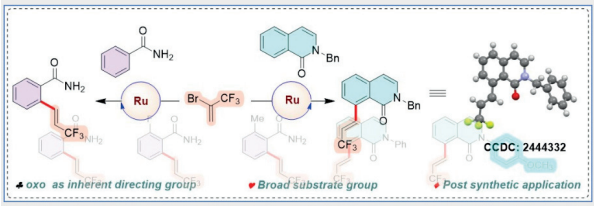


Fig. 5 Ru(II)-catalysed route for synthesizing vinyltrifluoromethylated arenes by utilising amide carbonyl as an inherent directing group.

Relevant Publications:

- Natural Product Research. (2025), 1-7.
- Journal of Food Composition and Analysis. (2026), 109031.
- Food Research International. (2025), 117931.

Research group: Aadarsh Shrivastav, Aryan Bhardwaj, Chetan Paul Singh, Gaurav Aggarwal, Harsh Kumar, Mehak Sharma, Prateek Singh Bora, Priyanka, Sachin, Sahil Awasthi, Sarthi, Shankar, Shivani, Shivani Puri, Shourabh Rav, and Tamanna Sharma.

Pamita Bhandari, Principal Scientist
pamita.bhandari@csir.res.in
Natural Product Chemistry; Natural colors/dyes

In Natural Products Chemistry this year, we have unveiled the pharmacological and phytopharmaceutical aspects of *S. chirayita*, *S. purpurascens*, and *S. cordata*, which could be crucial for both prevention and therapeutic intervention of T2D by improving insulin resistance. The extracts and fractions of *Swertia* species were evaluated to understand their impact on ROS production, MMP stability, and cellular apoptosis. Besides that, the impact on glucose uptake and glucose transporter type 4 (GLUT4) expression under oxidative stress was also evaluated to ascertain their potential to improve insulin sensitivity. Additionally, mRNA expression of myogenic regulatory markers, critical transcription factors involved in muscle development, regeneration, and homeostasis, were assessed to determine their role in counteracting the detrimental effects of diabetes on skeletal muscle using qRT-PCR.

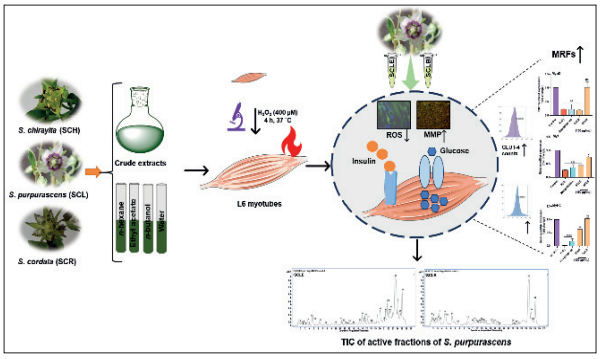


Fig. 1 Screening of Swertia species for anti-diabetic potential.

This study provides the first evidence of the anti-diabetic potential in three *Swertia* species on differentiated myotubes, a widely recognized skeletal muscle model for studying glucose uptake. *S. purpurascens* extract (SCL), and its fractions (SCLE and SCLB) have shown promising effects on intracellular glucose uptake. The finding indicates that the *n*-butanol fraction of *S. purpurascens* enhanced GLUT-4 expression, suggesting its potential to improve insulin sensitivity under oxidative stress (Fig.2). Additionally, the mechanistic study revealed that extracts and fractions of *S. purpurascens* have significant potential in reducing ROS generation and improving mitochondrial health by reversing apoptosis under oxidative stress. UHPLC-QTOF-IMS analysis further identified xanthones and iridoids as likely contributors to these effects. However, the present study represents an initial mark to evaluate the anti-diabetic potential of *S. purpurascens* through *in vitro* screening and phytochemical profiling, but is limited to cell culture. The findings provide a preliminary foundation for future *in vivo* and mechanistic studies to further clarify the biological relevance.

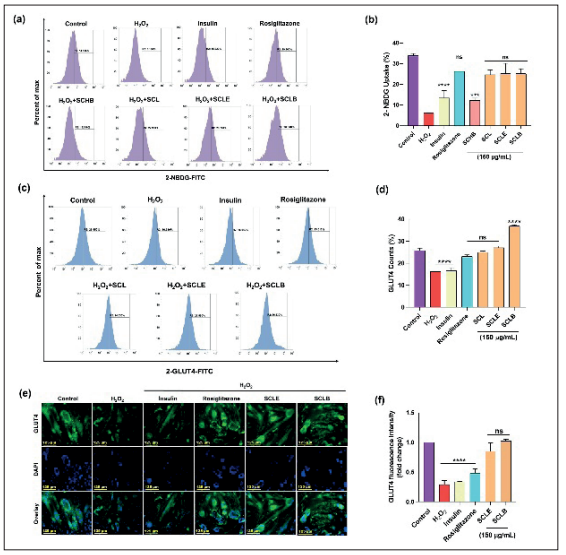


Fig. 2 *n*-butanol fraction of S. purpurascens improves insulin sensitivity by promoting 2-NBDG uptake (a, b) and facilitating GLUT4 expression (c, d) in differentiated myotubes under oxidative stress (e) Representative immunofluorescence images of GLUT4 in myotubes, and (f) quantification of fluorescence intensity. The values are expressed as mean ± standard deviation (n=3). Here, *, **, *, and **** indicate statistically significant differences with p<0.05, p<0.01, p<0.001, and p<0.0001, respectively, compared to non-treated cells.**

Insecticidal activities of agro waste of *Carya illinoinensis* (Wangenh.) C for the management of sucking pests

Aphis craccivora and *Planococcus lilacinus* are key polyphagous pests of agricultural and horticultural crops. Continuous application of synthetic insecticides for pest control led to resistance, harm to non-target organisms, the environment, and human health. Therefore, botanicals in pest management are the best alternatives to synthetic pesticides. In this study, *Carya illinoinensis* (Wangenh.) C plant extracts/fractions/compounds were evaluated for their insecticidal and enzyme inhibition activities against *A. craccivora* and *P. lilacinus.* Results showed that higher quantities of daucosterol (37.07 µg/g), galeon (27.75 µg/g), and myricatomentogenin (16.43 µg/g) were present in the methanol extract of *C. illinoinensis,* followed by the ethyl acetate fraction, than the butanol and water fractions. Among extracts/fractions, the ethyl acetate fraction was superior against *A. craccivora* (LD_{50} =1.05 µl/nymph). However,

ethyl acetate fraction (LD_{50} = 0.52 µl/crawler) and methanol extract (LD_{50} = 0.53 µl/crawler) were effective against *P. lilacinus* after 96 hours of treatment. Among isolated pure compounds, galeon and myricatomentogenin (LD_{50} = 0.29 - 0.39 µl/insect) for *A. craccivora*, betulinic acid and daucosterol against *P. lilacinus* (LD_{50} = 0.21-0.24 µl/insect) showed promising toxicity than other compounds. Methanolic extract, fractions, and pure compounds at higher concentrations reduced the reproductive/inhibitory rate of *A. craccivora* (93.56-100%). All test concentrations of methanolic extract demonstrated a significant decrease/inhibition of glutathione-S-transferase (GST) and carboxyl esterase (CES1) in test insects (Fig. 3).

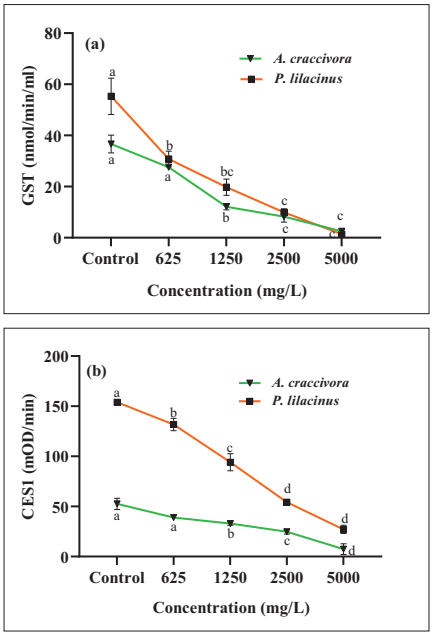


Fig. 3 Enzyme inhibition of methanolic extract from *C. illinoensis* fruit husk against *A. craccivora* and *P. lilacinus* (a) GST and (b) CES 1. Mean (±SE) of three replications. The same letters in the figures do not differ significantly by Tukey's HSD ($p \geq 0.05$).

Valorization of temple flower waste into high value compounds

Recently, there has been a noticeable trend towards valorizing temple floral waste to address environmental challenges, resulting in the transformation of waste material into valuable products. In India, approximately 4.74×10^6 tons of floral waste is generated per day from activities such as worship, decoration, and festivals. The used flowers are frequently discarded into waterways, garbage, or left open, leading to significant environmental problems. Conventionally, flower waste has been used for dyes, essential oils, and vermicomposting; however, turning it into value-added products provides a more sustainable waste-to-wealth strategy. The current study presents a sustainable method for transforming floral waste, particularly *Tagetes erecta*, into valuable products by encapsulating carotenoids via spray drying with different wall materials, including gum arabic, maltodextrin, pectin, whey protein, casein, and their blends. Further, physicochemical characteristics were assessed by analyzing water activity, moisture content, particle size, morphology, and water solubility of microencapsulated carotenoids. The stability of microcapsules was assessed by evaluating the effectiveness of wall materials, thermal resistance, storage at different temperatures (-20˚C, 4˚C, 25±2˚C,) and in the presence of sunlight & oxygen over 12 weeks. The results revealed that GA/MD-O (3/2-1) and GA-O (5-1) exhibited highest carotenoid content (4678.76±1.01 µg/g & 4508.06±1.01 µg/g respectively) and enhanced the water solubility upto 5.25±0.40 mg/mL. Overall, the results indicate that microencapsulation of carotenoids effectively enhances the water solubility of carotenoids, thereby expanding their potential applications in the food and nutraceutical industries (Fig. 4).

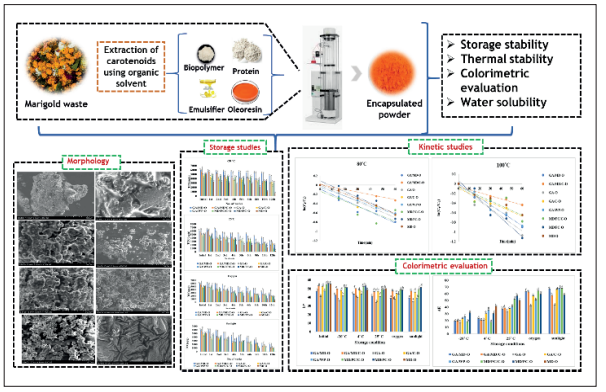


Fig. 4 Overall approach for extraction, encapsulation and stability studies of marigolds waste.

Relevant Publications:

- Bioorganic Chemistry. (2025), DOI:org/10.1016/j.bioorg.2025.109362.
- Biocatalysis and Agricultural Biotechnology. (2025), DOI: 10.1016/j.bcab.2025.103837.
- Microchemical Journal. (2025), DOI: 10.1016/j.microc.2025.113244.

Research group: Dr Nitisha Sendri, Dr Bhagatsing Devidas, Km Swati, Ms Pooja Bhatt, Mr. Sarvpreet Singh, Ms Nivedita Thakur, Ms Taniya Sharma, Ms Parul, Mr Nitin Kumar

Amit Kumari, Senior Scientist
amit.kumari@csir.res.in
Separation, SLE study, Process and Product Development

My research is focused on developing indigenous, scalable technologies for value addition of bioresources, with an emphasis on bridging laboratory innovation and industrial application. A key initiative involves the establishment of an indigenous processing facility for Siraitia grosvenorii, aimed at enabling efficient extraction and purification of natural sweeteners, thereby supporting domestic production and reducing import dependence. In parallel, we place strong emphasis on the fundamentals of separation science, aiming to efficiently isolate economically important compounds such as aroma constituents and floral waxes (both aromatic and non-aromatic) from biomass. This integrated approach not only enhances resource utilization but also supports the development of sustainable, value-added solutions aligned with emerging industrial needs.

Natural Sweetener (Monk Fruit)

A research article was published titled Comparative evaluation of mogroside extraction parameters in fresh and dried *Siraitia grosvenorii* fruits using a validated UPLC-DAD method" in Journal of food measurement and characterization. A validated UPLC-DAD method was developed for key marker compounds in Siraitia grosvenorii. Fresh fruits showed significantly higher mogroside yield than dried ones, with water at 70 °C identified as the most effective extraction condition. Analysis of commercial products revealed negligible Mogroside V in powdered sweeteners, highlighting concerns regarding product authenticity and quality in the market (Fig. 1 & 2).

Fig. 1 Comparative evaluation between Yellow and Brown fruits.

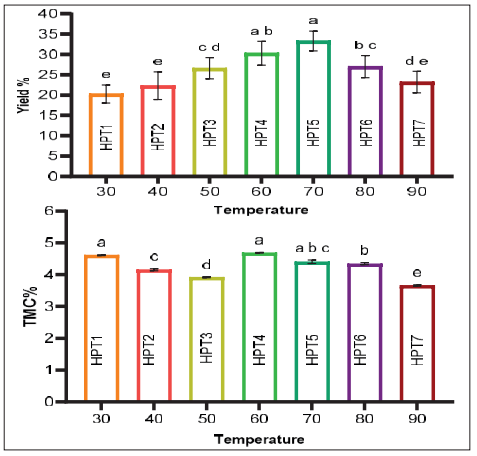


Fig. 2 Optimization of extraction temperature for maximum yield and enrichment.

Floriculture Mission

Aromatic oils and absolutes are highly valued for their fragrance and therapeutic properties; however, their extraction generates substantial quantities of floral wax, often treated as industrial waste despite constituting over 70% of the biomass. Addressing this gap, an eco-friendly approach was developed to purify and valorize floral wax into naturally scented candles.

These candles are free from toxic additives and exhibit excellent performance characteristics, including a stable flame, longer burn time, and minimal soot formation. They present a sustainable alternative to paraffin-based candles derived from fossil fuels, which release harmful emissions during combustion.

Importantly, floral wax also offers a viable substitute for beeswax, reducing pressure on natural pollination systems. Under the Floriculture Mission, this work has led to the development of integrated technologies for natural perfumes, floral wax, and candles from floral waste, fostering circular economy practices and enabling women-led microenterprises (Fig. 3).

Fig. 3 Floral Wax/Floral Candle using flowers/waste flowers.

Fig. 4 TOT signed.

Process for Separation of Geraniol from Palmarosa oil

A novel, solvent-free process was developed for the efficient enrichment of Geraniol from Palmarosa oil using an optimized Vacuum Fractional Distillation (VFD) approach. The process successfully enhanced geraniol purity from 75% to 91% in the targeted fraction, with an overall yield of 80–82%. The innovation lies in the precise control and selective combination of temperature and pressure conditions, enabling high selectivity without the use of hazardous solvents. This makes the process safer, environmentally sustainable, and aligned with green chemistry principles. Importantly, the developed methodology is economically viable and scalable, offering strong potential for industrial adoption in the fragrance and aroma chemical sectors. This work has led to a patent filing (0265NF2025), marking a significant step toward indigenous technology development and value addition in essential oils.

Collectively, these innovations support *Make in India*, *Swachh Bharat*, and *Atmanirbhar Bharat*, enhancing sustainability, rural employment, and India's presence in global green product markets.

Research group: Shivani, Anmol Sharma and Karishma Devi.

Sandopu Sravan Kumar, Scientist
sravan.kumar@csir.res.in
Phytochemistry, Natural Product Chemistry, Value Addition

Our lab is focused on phytochemicals investigation, characterization and herbal finger printing of marker compounds from Medicinal and Aromatic Plants (MAPs) of Western Himalayan region for value added product development. This validated approach will prove the traditional claims and scientific research.

Phytochemical's extraction and characterization from *Urtica* spp. for value addition

Urtica spp. (Urticaceae) is an herbaceous perennial flowering plant of Himalayan region with several of traditional uses that grows in high (*Urtica dioica*) and low (*Urtica ardens*) altitudes. The foliage is a rich source of phytochemicals such as terpenoids, phenolic acids, carotenoids, phytosterols and fatty acids (Kregiel et al., 2018). The current study aimed to investigate and compare the fractions and bioactive compounds in foliage of both the species of *Urtica*.

The extraction yields of bioactive compounds from the foliage of *U. dioica* and *U. ardens* using 80% ethanol showed 12.65% and 13.91% respectively. The liquid-liquid partitioning of the obtained extract yielded high phenolic content in *U. dioica* butanol fraction (80.78 mg GAE/g) followed by ethyl acetate fraction (78.13 mg GAE/g). The flavonoids were highest in *U. dioica* ethyl acetate (68.06 mg QE/g), followed by butanol (49.27 mg QE/g). The ferric reducing antioxidant power (FRAP) assay revealed that the *U. dioica* butanol fraction showed the highest activity (49.60 µmol Fe^{2+}/g), followed by ethyl acetate (38.79 µmol Fe^{2+}/g). Similarly, the same fraction exhibited the strongest ABTS radical scavenging activity in butanol fraction (IC_{50} = 52.00 µg/mL). In case of *U. ardens*, the ethyl acetate fraction showed the best activity (487.11 µg/mL), with the sequence being: ethyl acetate < chloroform < hexane < butanol < water. Further detailed characterization studies are in progress.

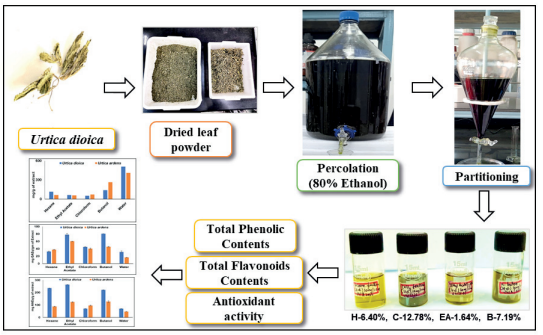


Fig. 1 Graphic showing the extraction, partitioning, and bioactivities profiling.

Relevant Publication:

- Journal of Food Science and Technology. (2026), 63: 401-417.

Research group: Athrinandan S. Hegde, Meenakshi Sharma, Ashish Kumar, Shivani Barathi, Pooja Panthari, K. R. Mohan, Aprajita, Nirali Choudhary, Anushriya Goma.

Jyoti, Scientist
Jyoti.26@csir.res.in
Nanomaterials, Biomaterials, Polymers

The current global demand for the renewable energy, effective energy storage and precise detection of the biological and environmental analytes leads to the research of novel nanomaterials with remarkable functional properties. The utilization of novel nanomaterials and bio-based materials have emerged with the technological advancements owing to their unique physical, electrochemical, optical, magnetic, sensing and biocompatible properties.

In this regard, synthesis of the biomaterials by the utilization of the plant bioresources which is considered as greener approach with cost effective methodology and lower energy consumption, has been of special focus. Plant extract derived sustainable nanomaterials have been acknowledged as safe Generally Recognized As Safe (GRAS) due to their biodegradable and ecofriendly properties. It constitutes of terpenoids, flavonoids, polyphenols and carbohydrates which provides stabilization to the prepared nanomaterials. Plant derived biomaterials have numerous applications in the health care, cosmetics, biomedical science, energy science, drug delivery and environment sensing. Plants extracts exhibit antibacterial, anticancer and photocatalytic properties making them potential candidates for the future modifications in the drug development process and environment applications. Pollutants including pesticides, heavy metals, toxins and organic pollutants have deteriorated the soil and water significantly. Therefore, novel, sensitive and economic methods for their sensing need to be developed.

My research activities will focus on preparation, characterization and applications of novel materials for sensing and drug delivery aspects having environmental and health care significance.

DIETETICS AND NUTRITION TECHNOLOGY DIVISION

Mahesh Gupta, Senior Principal Scientist & Head
mgupta@ihbt.res.in
Dietetics & Nutrition Technology Division,
Food & Nutraceutical Lab

In our expedition, we focus on nutraceutical and functional food development by utilizing diverse Himalayan bioresources to promote health and wellness through innovative product formulation. The outcome of the study mention below.

Development of a probiotic soup mix based on finger and barnyard millets, enriched with bioactive compounds derived from Himalayan floral waste.

The increasing demand for sustainable food systems has highlighted the application of underutilized crops and edible floral waste. Millets, recognized as resilient nutri- cereals, and edible flowers from the Himalayan region, such as rhododendron and marigold, are rich in bioactive compounds. The incorporation of floral waste into millet-based food products offers a promising approach for value addition and waste valorization. In this study, two probiotic millet-based soup formulations. Finger Millet Rhododendron Soup (FMRS) and Barnyard Millet Marigold Soup (BMMS) were developed and standardized. The results revealed significant differences ($p < 0.05$) in their nutritional and functional properties. Rheological and sensory analyses confirmed the acceptability of both formulations, with high hedonic scores of 7.22 for FMRS and 7.18 for BMMS. FMRS demonstrated superior viscoelastic properties compared to BMMS, indicating variations in structural and textural characteristics. The incorporation of edible flower waste enhanced the polyphenolic composition of the soups, with FMRS exhibiting a total anthocyanin content of 2.14 mg/g, while BMMS showed a total carotenoid content of 62.55 µg/g. Additionally, the optimization of probiotic sorghum millet flakes in reconstituted soups identified 6% inclusion as optimal, resulting in improved protein and dietary fiber content, along with enhanced probiotic viability (10.21 log CFU/g), without compromising sensory acceptability. Overall, these findings demonstrate the potential of millet-based soup formulations enriched with edible flower waste as functional, nutritionally superior, and health-promoting food products, contributing to sustainable food innovation **(Fig. 1)**.

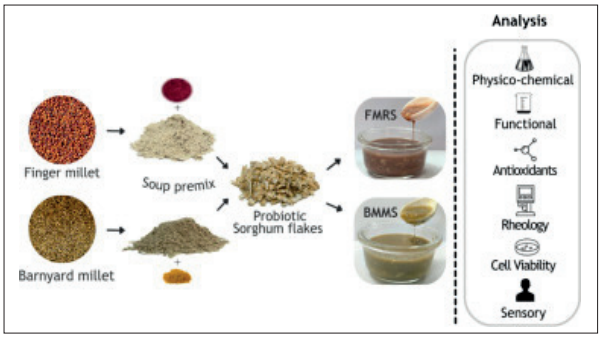


Fig. 1 Ready-to-reconstitute millet-based probiotic soup mixes. © Elsevier, 2025.

Assessment of Sustainable Processing on Nutritional, Functional, Phenolics, In Vitro Protein Digestibility, and Antioxidant Bioavailability of Himalayan Peas

This study systematically investigates the effect of four processing techniques autoclaving, roasting, boiling, and sonication on the nutritional composition, functional properties, protein digestibility, and phenolic profiles of Himalayan green pea (*Pisum sativum* L.) and green chickpea (*Cicer arietinum*). The results demonstrated that processing significantly enhanced protein content (by 23%–26%) as well as dietary fiber levels, with roasting showing the greatest improvements (15.74% in peas and 11.03% in chickpeas). Protein digestibility increased markedly, reaching up to 98% following autoclaving and roasting, indicating improved bioavailability due to high-temperature and pressure treatments. Phenolic profiling revealed an increase in catechin content after processing (170.93 µg/100 mg in peas and 132.72 µg/100 mg in chickpeas), suggesting enhanced antioxidant potential. However, a decline in rutin and gallic acid levels was observed, particularly in green chickpeas (raw values: 274.43 µg/100 mg rutin and 58.74 µg/100 mg gallic acid). In contrast, esterified trans-ferulic acid content increased in autoclaved green peas (93.91 µg/100 mg), while roasting facilitated the accumulation of bound catechin, gallic acid, and trans-ferulic acid. Conversely, esterified trans-ferulic acid increased in autoclaved green peas (93.91 µg/100 mg), and roasting promoted accumulation of bound catechin, gallic acid, and trans-ferulic acid. Essential amino acids such as leucine and lysine were also elevated after

roasting (GPW: 7.26 and 6.51 mg/100 g; GCW: 5.98 and 5.50 mg/100 g, respectively). Overall, these findings highlight the potential of targeted processing methods to improve the nutritional and functional attributes of Himalayan legumes, supporting their application in functional food development. Further studies are needed to optimize processing conditions for maximum retention of bioactive compounds **(Fig. 2)**.

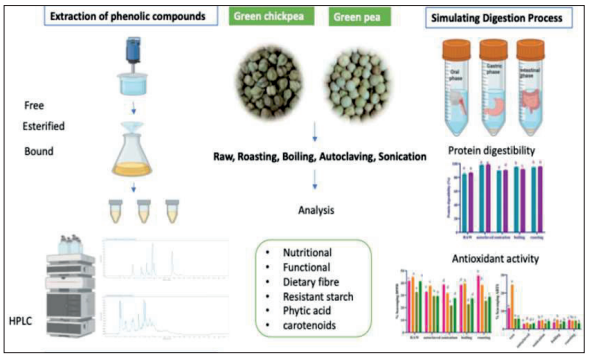


Fig. 2 Representation of nutritional, functional, *in vitro* simulating digestion and extraction of bioactive compound of (*Pisum sativum L.*) and (*Cicer arietinum L.*) before and after sustainable processing. © AOCS, 2025.

Development and optimization of a nutritionally enriched, functionally enhanced, and shelf-stable beverage mix incorporating kodo millet.

The increasing popularity of plant-based and whole-grain millet-based traditional beverages is attributed to their health benefits, contribution to dietary diversity, and potential role in improving food security. In this study, a ready-to-reconstitute beverage mix was developed using kodo millet, a nutritionally rich and climate-resilient minor millet. Response Surface Methodology (RSM) was used to optimize the formulation by evaluating the effects of three independent variables: soaking time (4–12 h), roasting time (15–30 min), and soaked millet proportion (50%–70%).A Central Composite Design (CCD) was used to analyse the influence of these variables on key response parameters, including pH, color difference (ΔE), browning index, tannin content, sedimentation value, and overall acceptability. The optimized formulation was further characterized for its nutritional composition, functional properties, antinutritional factors, bioactive compounds, free amino acids, and fatty acid profile. The developed beverage mix exhibited 16.34% protein, 17.83% fat, 16.83% dietary fiber, and 1.55% ash content, along with appreciable levels of iron (15.26 mg/100 g) and zinc (6.23 mg/100 g), and a rich profile of bioactive compounds. Significant amounts of fatty acids were observed, including omega-9 (1.994 g/100 g), omega-6 (1.055 g/100 g), and palmitic acid (1.892 g/100 g). Furthermore, the product demonstrated low moisture content (0.31%) and water activity (0.04 aw), ensuring shelf stability for up to six months. Overall, the formulated kodo millet-based beverage mix represents a nutritionally dense, functional, and sustainable alternative for promoting healthy dietary practices, enhancing food security, and supporting tainable food systems **(Fig. 3)**.

Fig. 3 Process flow of kodo mix beverage. © WILEY, 2026.

Relevant Publications:

- Food Chemistry Advances. (2025), 101084.
- Sustainable Food Proteins. (2025), 3(4), e70045.
- Food and Humanity. (2025), 4, 100610.

Research group: Mr. Manoj S Aroor, Mr. Rahul Dev, Ms. Pallavi Phian, Ms. Shambhvi, Ms. Sakshi Verma, Ms. Shivani, Ms. Simran Kamal, Ms. Sagun, Ms. Bharti and Ms. Ananya Singh

Yogendra Shantaram Padwad, Senior Principal Scientist
Yogendra.padwad@csir.res.in
Pharmacology & Toxicology

Pharmacology and toxicology lab works in the area of safety/toxicity and efficacy evaluation of phyto-formulations, natural and bioactive active molecules by addressing their underlying molecular mechanism with specific emphasis on inflammation, aging, diabetes and cancer.

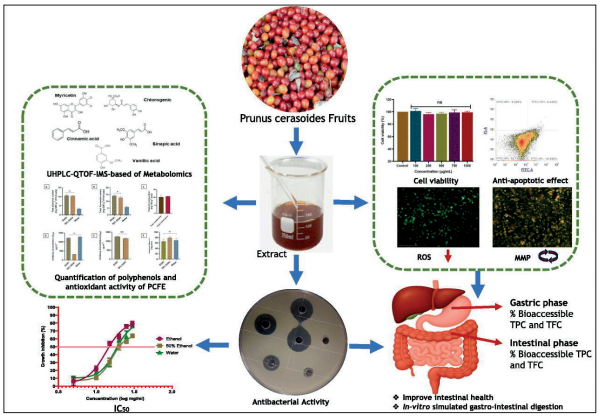


Fig. 1 Extraction, phytochemical characetrization, antibacterial activity assessment of *Prunus cerasoides* fruits extract.

Infectious gastrointestinal disorder is a major disease burden in developing countries. Indiscriminate antibiotics usage has resulted in antimicrobial resistance (AMR) causing reduced treatment efficacy. Plant bioactives serve as complementary and alternative therapeutic opportunity in addressing AMR in gastroenteritis. In this context, the present study comprehensively characterized the nutritional and phytochemical composition of *Prunus cerasoides* (Wild Himalayan Cherry) fruits, an indigenous edible plant of Western Himalayas. The *P. cerasoides* fruit extracts (PCFE) was evaluated for its antibacterial activity against clinical isolates of enterotoxigenic *E. coli* (ETEC). The fruit pulp is a rich source of carbohydrates and potassium while the extracts possessed ample amounts of phenolics (10–11 mg g^{-1}) and flavonoids (12–14 mg g^{-1}). Twelve polyphenols were quantified using targeted metabolomics followed by identification of 38 putative metabolites belonging to flavonols, flavones, flavanols, anthocyanins and phenolic acids classes through non-targeted approach (Fig. 1). *In-vitro* gastrointestinal bioaccessibility of phenolics, flavonoids, and anthocyanins is ranges from 24% to 67%. The hydroalcoholic extracts exhibited strong free radical scavenging activity while the ethanolic extracts showed moderate antibacterial activity with a minimum inhibitory concentration (MIC) of 12–21 mg/mL against the clinical ETEC isolates. The cellular viability and efficacy of PCFE on intestinal epithelial cells (IEC-6) was assessed. PCFE extracts demonstrated dose-dependent antioxidant activity in H_2O_2 challenged IEC-6 cells. Furthermore, PCFE stabilized mitochondrial functions by preventing depolarization and providing significant cytoprotection against oxidative stress-induced apoptosis. Although PCFE exhibited lower anti-bacterial activity compared to conventional antibiotics, the synergistic antioxidant activity could be further explored for the development of nutraceuticals in the management of bacterial gastroenteritis (Fig. 2).

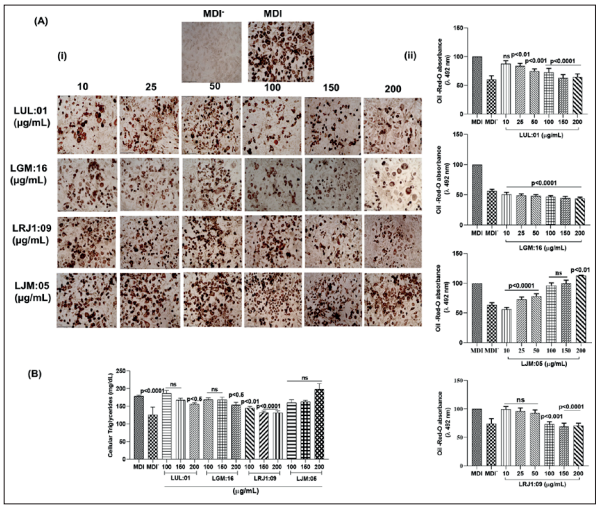


Fig. 2 Comparative assessment of different CLA producing strains for anti-diabetic, and anti-obesity effects of conjugated linoleic acid (CLA) by Oil Red O Staining and its quantification.

Conjugated linoleic acid (CLA) has been linked to various health benefits, including anti-cancer, anti-diabetic, and anti-obesity effects. Obesity, marked by abnormal fat deposition, increases the risk of metabolic disorders such as cardiovascular diseases and type-2 diabetes. Natural anti-adipogenic modulators with insulin sensitivity are one of the approaches to address the issue. In the present study, four distinct CLA-producing probiotic strains (*Lacticaseibacillus paracasei* LUL:01, *Latilactobacillus curvatus*

LGM:16, *Lactiplantibacillus paraplantarum* LRJ1:09, and *Enterococcus faecalis* LJM:05) were assessed in vitro for their potential anti-adipogenic properties using 3T3-L1 preadipocytes. Out of four strains, LGM:16 inhibited lipid accumulation (100.27%), reduced intracellular triglyceride content (168.42, 168.16, and 153.66 mg/dL in a dose-dependent manner), and enhanced insulin sensitivity (32.23%) by increasing glucose uptake. Quantitative reverse-transcription polymerase chain reaction revealed the expression genes (PPARγ, C/EBPα, and GLUT-4) in LGM:16 strain. Consequently, LGM: 16 was used to develop a non-dairy probiotic formulation incorporating honey and *Pleurotus ostreatus* mushroom, ensuring a probiotic count above the minimum recommended level of 6 Log10 CFU/mL. Further, response surface methodology optimized probiotic beverage formulation to achieve favorable nutritional, good sensory profile, antioxidant, and anti-obesity activity, making it a promising candidate for health benefits.

Relevant Publications:

- Probiotics and Antimicrobial Proteins. (2026) 395-410.
- Food Research International. (2026), 233: 119025

Research group: Dr. Rajneesh, Mr. Ravi Kumar Thakur, Ms. Ankita Kumari, Ms. Shweta Sharma, Mr. Ravi Raj, Mr. Suresh Kumar, Ms. Shagun Kaushal, Ms. Arooshi Sharma

Damanpreet Singh, Senior Principal Scientist
damanpreet.singh@csir.res.in
Pharmacology

Our lab is validating the therapeutic efficacy of medicinal plants of the Himalayan regions with ethnomedical claims for neurological conditions.

Neuroprotective efficacy of *Urtica dioica* L.

Urtica dioica L. (family Urticaceae) has been used traditionally both as a dietary component and a medicinal plant to manage various health conditions. In our study, we investigated the neuroprotective potential of a hydroalcoholic leaf extract of *U. dioica* (Ud) in a zebrafish larval model of aluminium-induced neurotoxicity. The phytochemical profile of the extract was carried out using high-performance liquid chromatography (HPLC) coupled with photodiode array detection. In silico molecular docking was performed to evaluate the interactions of identified compounds with relevant targets.

Zebrafish embryos were exposed to aluminium chloride ($AlCl_3$) in the presence and absence of Ud. Oxidative stress and neuronal integrity were assessed in developed larvae through whole-mount imaging using dichlorofluorescein diacetate (DCFDA) and NeuN staining, respectively. Gene and protein expression levels were evaluated using quantitative real-time PCR and western blotting. Neurotransmitter levels were determined via HPLC with electrochemical detection. HPLC analysis identified and quantified 12 essential flavonoids and phenolic constituents in the extract. The benchmark dose lower confidence limit (BMDL) was determined for Ud to be 127.63 µg/mL. Treatment with Ud significantly improved locomotor activity in aluminium-exposed larvae and alleviated oxidative stress as well as neuronal damage, particularly in the cephalic region of the larvae. Furthermore, Ud modulated the expression of genes associated with oxidative stress, inflammation, apoptosis, and β-catenin signaling. Protein analysis revealed increased levels of β-catenin, phosphorylated GSK-3β (Ser9), and phosphorylated CREB (Ser133), with restoration of brain γ-aminobutyric acid (GABA) and glutamate levels. Overall, these findings suggested that *U. dioica* leaf extract exerts a protective effect against $AlCl_3$-induced neurotoxicity in zebrafish larvae.

Medium-chain triglycerides for epilepsy and associated comorbidities

There is an increasing interest in dietary-based strategies as an alternative approach for managing the chronic neurological disorders such as epilepsy. Medium-chain triglycerides (MCTs), which consist of three fatty acid chains esterified to a glycerol backbone, have demonstrated therapeutic potential in several neurological conditions. Our work evaluated the effects of MCT supplementation on seizure progression and related neurobehavioral alterations in pentylenetetrazole (PTZ)-induced kindling model in mice.

Kindling was established by administering PTZ (35 mg/kg, i.p.) on alternate days. Following kindling induction, animals received MCT supplementation for 25 days, with seizure severity assessed after every fifth PTZ injection. The Behavioural assessments were then conducted at the end of the supplementation period. Subsequently, hippocampal tissues were isolated for the biochemical and molecular analyses, including lipid peroxidation assays, as well as gene and protein expression studies.

MCT supplementation significantly reduced seizure severity scores when compared to the kindled control group. It also decreased immobility time in both the forced swim test and tail suspension test, indicating an improvement in the seizure-associated depressive-like behaviour. In the T-maze test, kindled control mice showed a marked reduction in spontaneous alternation percentage, which was not significantly improved by MCT treatment. Additionally, MCT supplementation did not produce any notable changes in locomotor activity or anxiety-related behaviour in kindled mice.

At the molecular level, MCT treatment mitigated hippocampal lipid peroxidation and modulated the altered expression of key signaling molecules, including mTOR and GSK-3β, both at mRNA and protein levels.

Overall, these findings suggested that MCT supplementation attenuates seizure severity and associated depressive-like behaviour in PTZ-kindled mice, potentially through the modulation of mTOR and GSK-3β signaling pathways.

Relevant Publications:

- Molecular Neurobiology. 62:16431-16447.
- Zebrafish. 22: 2023-2029.
- Journal of Neuroimmune Pharmacology. 20, 93.

Research group : Dr. Damanpreet Singh, Savita Kumari, Poonam Dhiman, Rajneesh Kumar, Amit Kumar, Shiv Kumar Saini, Pooja Sharma and Jagdish Bhuyan.

Vikram Patial, Principal Scientist
vikrampatial@ihbt.res.in
Dietetics and Nutrition Technology

Rising global interest in natural products, nutraceuticals, and novel synthetic compounds underscores the need for rigorous evaluation of their safety and efficacy. We conduct comprehensive assessments using validated animal models, and this approach provides critical insights into their pharmacological and toxicological profiles.

Malnutrition induces steatohepatitis by altering hepatic lipid metabolism and gut-liver axis

Protein and essential nutrient malnutrition in children can cause profound metabolic disturbances and liver dysfunction. Our study investigated the mechanisms underlying malnutrition-induced steatohepatitis using a rat model. Weanling rats were fed a low-protein diet for eight weeks to induce malnutrition. A protein-deficient diet significantly reduced body and liver weights and caused marked alterations in blood biochemical parameters. Serum markers of liver injury were elevated, while glucose, albumin, and total protein levels were decreased. Indicators of iron metabolism, including total iron-binding capacity and transferrin saturation index, were reduced, while Hamp gene expression increased. Histological analysis revealed severe lipid accumulation in hepatocytes, accompanied by inflammation and early fibrogenesis. Malnutrition upregulated genes involved in de novo lipogenesis, including Srebp1c, Fas, Acc, and Scd1, and increased oxidative stress in liver tissue. Concurrently, downregulation of mitochondrial regulators, including Pgc1α, Tim23, and Tfam, indicated impaired mitochondrial function. Transcriptomic profiling identified upregulation of genes, primarily associated with metabolic dysfunction-associated steatotic liver disease (MASLD), β-oxidation, AMPK signaling, and oxidative phosphorylation pathways. Lipidomic analysis further demonstrated the accumulation of multiple lipid species in the liver. Additionally, malnutrition disrupted the gut microbiome, reducing the abundance of beneficial bacterial populations. Overall, the findings suggest that protein malnutrition induces steatohepatitis by dysregulating hepatic lipid metabolism, impairing mitochondrial function, and disrupting the gut–liver axis (Fig. 1).

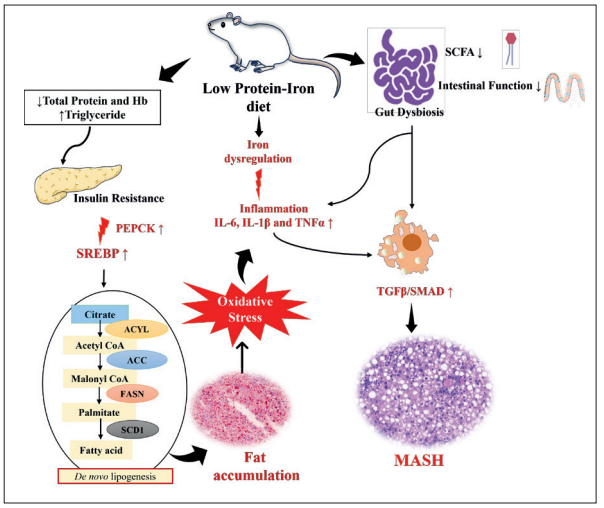


Fig. 1 Graphical representation of the molecular mechanism of Malnutrition-induced steatohepatitis.

Protective effect of *Ophiocordyceps indica* in IgA nephropathy

IgA nephropathy (IgAN) is one of the major causes of chronic kidney disease and renal failure. In a study, the therapeutic potential of *Ophiocordyceps indica*, a newly identified species from the Indian Himalayas, was evaluated. Hot-water extract of *O. indica* showed the presence of key nucleosides. *In vitro* studies in mesangial cells showed that *O. indica* extract improved cell viability and reduced inflammation and oxidative stress without toxicity. In IgAN-induced mice, extract treatment improved body and kidney weights and reduced serum creatinine, urea, and urine microalbumin levels. It also decreased galactose-deficient IgA1 and the levels of inflammatory cytokines (TNF-α, IL-6, IL-18). Histological analysis showed protection against glomerular damage and fibrosis, along with downregulation of fibrogenic markers. Overall, *O. indica* demonstrated significant renoprotective effects against IgA nephropathy.

Phenome India CSIR Health Cohort Knowledgebase Project:

A sampling camp was organized for the CSIR-IHBT staff. The program involves testing for hematology, serum biochemistry, and gut microbiome, and testing for oscillometry, spirometry, ECG, liver fibroscan, and whole-body composition analysis using a well-

established protocol. Based on testing results, the age-adjusted prevalence of MASLD was 38.9% among 10,267 individuals..

Collaborative work

The nutraceutical potential of phloretin in restoring the intestinal barrier, maintaining a beneficial gut microbial population, and ameliorating colitis-associated colorectal cancer was evaluated in mice. Similarly, the hepatoprotective potential of Saussurea costus (falc.) Lipsch., Glycyrrhiza glabra and Inula racemose in rodent models.

Regulatory studies:

As an important activity of our lab, we have evaluated the oral (acute and subacute) toxicity of various institutional products, e.g., Mogroside-based formulation, ayurvedic herbo-mineral formulations, and industrial products. In addition, histopathology and clinical pathology services were provided to outside parties.

Relevant Publications:

- Journal of Physiology and Biochemistry. (2025), doi: 10.1007/s13105-025-01125-3.
- Journal of Integrative Medicine. (2026), https://doi.org/10.1016/j.joim.2026.01.008.

Research group (Left to right): Sheetal, Shagun, Vivek, Dr. Vikram Patial, Prakriti, Swati, Sahiba and Vinesh

Narendra Vijay Tirpude, Principal Scientist
narendra@ihbt.res.in
Animal Science and Veterinary Pathology

Inflammation is a defense mechanism used by body thorugh the immune system to identify and eliminate deleterious and foreign agents and allows healing to commence. It can be categorised as acute as well as chronic inflammation. An infection induced acute inflammation is a normal reaction to tissue damage compelled by trauma, microbial invasion, or noxious compounds, which is characterized by a fast onset, severe progression, and symptoms that last for a few days, like acute pneumonia and cellulitis. The state that occurs between acute and chronic inflammation lasts up to 2 to 6 weeks, known as subacute inflammation. On the contrary, chronic inflammation with slow progression acts as long-term inflammation, which exists for several months to even years. Primary symptoms of inflammation are redness, heat, pain, swelling, and loss of function. However, when inflammation becomes chronic, it can lead to dysregulation of theadaptive immune response, which turns the inflammation process into a pathological phenomenon, resulting in the emergence of several autoimmune disorders includingrheumatoid arthritis. We study two such pathologies allergic asthma and rheumatoid arthritis. Allergic asthma is the most common form of asthma, where breathing in allergens—such as pollen, pet dander, or mold—triggers an immune system overreaction that causes airway inflammation, swelling, and mucus production. Whereas RA is a systemic inflammatory autoimmune disorder that is identified by persistent pain, synovial hyperplasia, and progressive destruction of cartilage and bone. Though various drug treatments are available for symptomatic treatment of these diseases, considering their side effects, the attention of researchers is diverting towards alternate therapies like medicinal plants and their products. From ancient times, our ancestors have used medicinal plants to cure various disorders like respiratory, cardiovascular disease, obesity, diabetes, rheumatism, etc. Different plants of Himalayan origin has various therapeutic properties like to reduce burn pain and promote healing.

In vivo validation of the role of *Linum usitatissimum* extracts in mitigating inflammation.

Efficacy of the Flax as well as its molecular mechanisms of action governing the protective effect during RA progression in an animal model of RA, which was developed by immunizing the mice with Collagen II +CFA+LPS as a stimulant. Our results revealed that Flax was responsible for the maintenance of articular architecture, inhibition of MMPs and Th1/Th17 inflammatory cytokines during the course of the disease. However, it also suppresses the activation of inflammasome markers (NLRP3, AIM2) and autophagy markers (Arg1, Mrc-1, iNOS, and COX-2). Additionally, inhibition of macrophage polarization towards M1 and P13K/AKT/MAPKs/NF-KB/ERK/JNK signaling mechanism accompanied by enhanced proliferation of splenic Tregs contributed to healing features of Flax (Fig. 1).

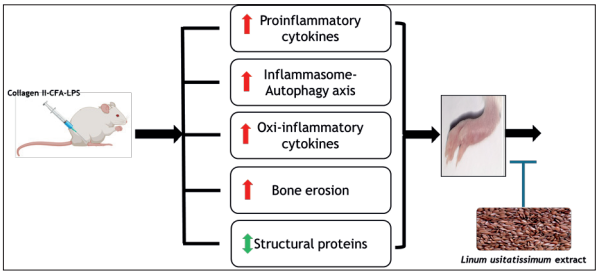


Fig. 1 Schematic representation of effect *Linum usitatissimum* extracts in mitigating Collagen II-CFA-LPS induced RA

Relevant Publications:

- Colloids and Surfaces B: Biointerfaces. (2025), 254, p.114836.
- Food and Humanity. (2025), p.100790.

Vidyashankar Srivatsan, Principal Scientist
v.shankar@csir.res.in
Microalgae biotechnology, Food and nutraceuticals

Our lab (Applied Phycology and Food Technology) focuses on the utilization of microalgae, Himalayan bioresources such as Wild edible plants (WEPs) and indigenous food crops such as millets for the development of nutraceuticals and functional foods with applications in the amelioration of iron deficiency anemia, protein deficiency and metabolic disorders.

Microalgae as a source of antioxidants and nutraceuticals

We have been working on utilization of microalgae for the production of specialized nutraceuticals such as edible grade proteins, carotenoids and Polyunsaturated fatty acids (PUFAs). *Arthrospira platensis* (Spirulina), *Chlorella pyrenoidosa,* and *Tetradesmus* sp., have been characterized for their nutritional and phytochemical composition. *Arthrospira platensis* produces antioxidant pigments phycocyanin (7.083 ± 0.04 g 100^{-1} d.c.w.) and beta-carotene (xx mg g-1 d.c.w.), and unique omega-6-PUFA, gamma-linolenic acid (GLA), constituting 12-13% of total lipids. *Chlorella pyrenoidosa* is a rich source of carotenoid lutein (2.76 mg g^{-1} d.c.w.) and omega-3-PUFA, alpha-linolenic acid (ALA), constituting 27% of total lipids. *Tetradesmus* sp., consisting of *Tetradesmus acutus, Tetradesmus obliquus* and *Tetradesmus abundans,* possessed carotenoids in the range - 1.0 - 2.5 mg g^{-1} lutein and up to 1.15 mg g^{-1} beta-carotene. *Tetradesmus* ssp., particularly *T. acutus* and *T. abundans,* exhibited alpha-amylase inhibitory activity. Oleic acid (C-18:1, n-9) was the predominant fatty acid in Tetradesmsus sp., constituting between 32 and 37% of total lipids. *A. platensis, C. pyrenoidosa* and *Tetradesmsus* sp., possessed >80% protein digestibility, superior to cereals and at par with soy. Among the three different microalgae species, *A. platensis* could be targeted for protein production, *C. pyrenoidosa* for carotenoids and *Tetradesmus* sp. for lipids and hydrocarbons.

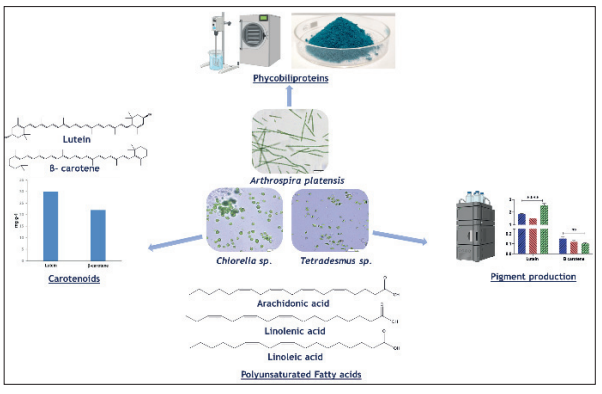


Fig. 1 Nutritional and Nutraceutical Applications of Microalgae.

Cataloguing ethnic foods and wild edible plants (WEPs) of Western Himalayas

The dietary habits and indigenous foods of the cold-desert regions of the Western Himalayas were surveyed and characterized. Barley-based foods, particularly roasted barley (sattu), were the predominant food, rich in carbohydrates (~80% w/w), specifically dietary fibre (~17% w/w). Secondary processing, such as roasting and cooking, reduced antinutritional factors in barley, particularly phytic acid and tannins. Fermented foods were predominantly consumed in the region, specifically dairy products. Chhurpe, a high-protein (~57% w/w) cheese derived from cow and yak milk, was characterized. Chhurpe was a rich source of sulphur amino acids (methionine) and possessed gastro-intestinal digestibility >85%.

In addition to staples, several wild edible plants (WEPs) were consumed by the indigenous communities. We characterized unique WEPs, such as *Prunus cerasoides* (Wild Himalayan Cherry). The fruit pulp is a rich source of carbohydrates and potassium, while the extracts possessed ample amounts of phenolics (10–11 mg g^{-1}) and flavonoids (12–14 mg g^{-1}). Twelve polyphenols were quantified using targeted metabolomics, followed by identification of 38 putative metabolites belonging to flavonols, flavones, flavanols, anthocyanins and phenolic acids classes through a non-targeted approach. *In-vitro* gastrointestinal bioaccessibility of phenolics, flavonoids, and anthocyanins ranges from 24% to 67%. The hydroalcoholic extracts

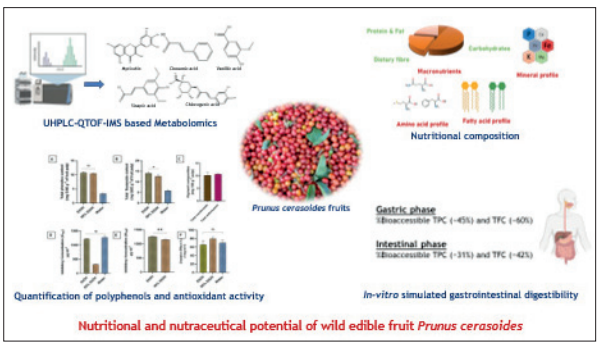


Fig. 2 Nutritional and phytochemical characterization of wild edible plant *Prunus cerasoides.*

of fruit pulp exhibited strong free radical scavenging and reducing power activity.

Value-added millet products

Millets (SHRI-Anna) are emerging as a staple food, specifically in combating malnutrition and lifestyle diseases. In this context, various millet-based value-added & convenience products were developed and evaluated for their nutritional, and phytochemical and bioefficacy. Panjeeri, a traditional wheat-based dish, is widely consumed in the Western Himalayas. We developed millet-based panjeeri towards combating iron deficiency anemia and protein malnutrition. The product has a lower glycemic index and higher protein, dietary fibre and micronutrients, specifically iron. The product meets nearly 40% recommended dietary allowances (RDA) of proteins, dietary fibre and 15% RDA of iron. Millet panjeeri promoted recovery from iron deficiency anemia by improving the growth, hematology and tissue antioxidant status of malnourished rats.

Additionally, other ready-to-cook convenience products such as millet beverage mix, millet pan cake mixes, millet kheer (pudding mixes), millet chilra mix and porridge premixes were developed and characterized for their nutritional quality. The salient features of these products are i. Gluten free ii. Source of protein and dietary fibre (> 10 g per 100 g of food product), iii. Source of iron (meets >10% RDA of iron per 100 g food product) for children aged 3 to 10 years and iv. Free from preservatives.

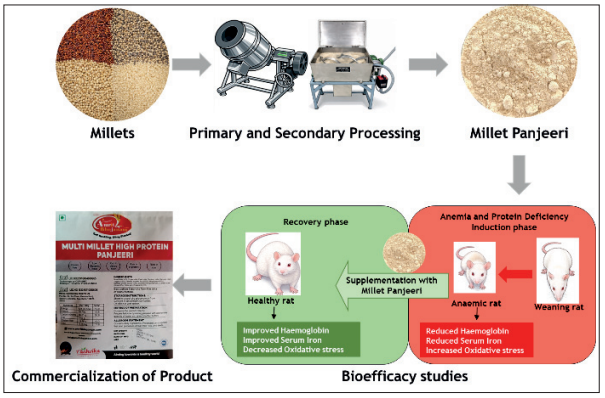
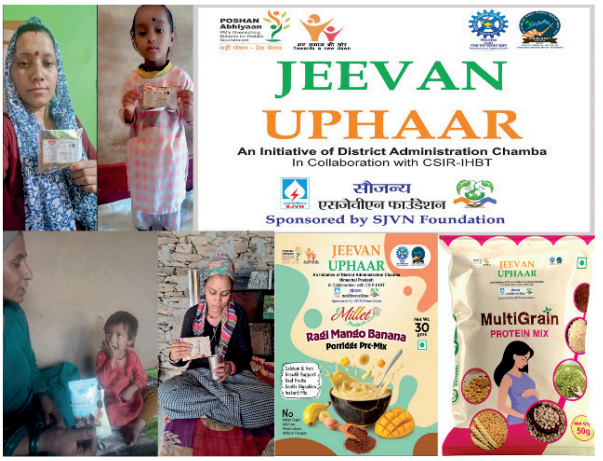


Fig. 3 Development of value-added millet products – Millet panjeeri towards amelioration of protein and iron deficiency anemia.

Integration of protein and micronutrient fortified value-added products in POSHAN Abhiyaan

Protein and micronutrient-enriched food products, including value-added millet products, have been integrated in the large-scale nutrition supplementation program under the auspices of POSHAN Abhiyaan. A special nutrition supplementation program, "*Mission Jeevan Uphaar*", was launched in the Aspirational district, Chamba, Himachal Pradesh. The program targeted children aged 6 months to 3 years, children aged 3 to 6 yearsattending anganwadi centres, and lactating mothers. The total number of beneficiaries receiving the fortified food products was 6000. in phase 1

The products were well accepted by beneficiaries, and the prevalence of severely acute malnourished (SAM) and moderately acute malnourished (MAM) children decreased significantly after 4 months of continuous supplementation.



Relevant Publications:

- Food Research International. (2026), 233(2), 119025.
- Indian Journal of Traditional Knowledge. (2025), 24 (11), 1043-1054.
- ACS Food Science and Technology. (2025), 5(5), 1841–1857.

Research group: Sh. Ravindra Kumar, Raman Kumar, Priyanka Parmar, Athrinandan S Hegde, Smriti Gupta, Neha Yograj, Aditi Guleria, Priyanshu Sharma, Babita Kaundal, Prajwal Jakhmola, Karan Saini, Parul Bhardwaj, Anika Samyal, Akanksha Parashar, Kishan Kharka, Amit.

Ankit Saneja, Senior Scientist
ankit.saneja@csir.res.in
Dietetics & Nutrition Technology

Our laboratory integrates synthetic, supramolecular, and formulation approaches with nanotechnology to develop advanced delivery systems and sustainable biomaterials. We design nanoemulsions, liposomes, nanofibers, and inclusion complexes to enhance solubility, stability, and bioavailability of bioactive compounds. Using conjugation and host-guest strategies, we improve molecular performance for therapeutic and nutraceutical applications.

β-Cyclodextrin Nanosponges to improve Solubility and Anticancer Efficacy of Formononetin

Formononetin, a bioactive isoflavone from red clover, shows promising anticancer properties but suffers from extremely low water solubility. This study presents β-cyclodextrin nanosponges crosslinked with diphenyl carbonate as an innovative delivery system to overcome this limitation. The optimized formulation exhibited nanoscale size, high stability, and porous morphology, enabling efficient drug encapsulation in an amorphous state. Physicochemical analyses confirmed enhanced thermal stability and strong drug–matrix interactions. In vitro studies demonstrated significantly improved dissolution and cytotoxicity against lung (A549) and pancreatic (MIA PaCa-2) cancer cells. Mechanistically, enhanced ROS production and apoptosis highlight the system's potential as an effective nanocarrier for poorly soluble therapeutics.

Active Sodium Alginate/PVA-PEG Bioplastic Films Enriched with Syringic Acid for Sustainable Postharvest Mushroom Preservation.

In another study, we have developed biodegradable bioplastic films using sodium alginate and a PVA-PEG copolymer incorporated with syringic acid for improved food packaging. The films exhibited enhanced mechanical strength, thermal stability, and smooth surface morphology. Syringic acid significantly boosted antioxidant and antibacterial properties, effectively inhibiting microbial growth and reducing mushroom spoilage, including weight loss and browning. Improved barrier properties limited oxygen and moisture permeability. Biocompatibility tests confirmed safety, while soil burial studies showed complete degradation within 14 days. These findings highlight the films as an eco-friendly and efficient alternative to conventional plastic packaging for postharvest preservation.

Self-Assembling Liposomal Nanofibers: A New Frontier in Neuroprotection

α-Lipoic acid (LA), a potent antioxidant with promising neuroprotective and anti-epileptic properties, faces significant limitations in clinical application due to its poor aqueous solubility and heat sensitivity. These drawbacks reduce its stability, bioavailability, and overall therapeutic effectiveness, especially in neurological conditions like epilepsy where efficient brain delivery is critical. To address these challenges, a novel electrospun amphiphilic nanofiber-based proliposomal system was developed using PVP K90, phosphatidylcholine, and β-sitosterol. These nanofibers rapidly self-assemble into stable, nanosized liposomes upon hydration, enabling efficient LA delivery. The system showed controlled biphasic release, good stability, safety in zebrafish, and significantly reduced seizure activity in a PTZ-induced model.

Smart Delivery for Plant Defense: MeSA-Cyclodextrin Complex Enhances Heat and Cold Resilience

Extreme temperature stress severely limits plant growth and productivity, while methyl salicylate (MeSA), though effective, suffers from volatility and poor solubility. To address this, a methyl-β-cyclodextrin inclusion complex was developed to enhance stability and delivery. This formulation significantly improved MeSA solubility, controlled release, and reduced its inhibitory effects on germination. Treated plants showed improved growth, photosynthetic efficiency, and reduced oxidative damage under heat and cold stress. Molecular analysis revealed enhanced expression of stress-responsive and antioxidant genes. Overall, this encapsulation strategy offers a sustainable and efficient solution to improve plant resilience against climate-induced temperature fluctuations.

Relevant Publications:

- Bioresource Technology. (2026), 134077.
- International Journal of Biological Macromolecules. (2025), 147961.
- Chemical and Biological Technologies in Agriculture. (2026), 19.

Research group : Ms. Neha Rana, Mr. Navneet Kumar, Mr. Ankit Kumar Singh, Mr. Parveen Kumar

Ashok Kumar Pathera, Scientist
ashok.pathera@csir.res.in
Food Technology

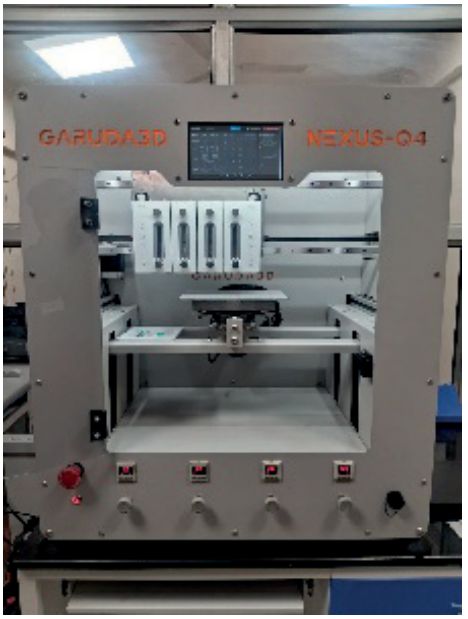
The demand for high-protein foods has been growing in India, and it is essential to eradicate malnutrition. The Indian Council of Medical Research has issued dietary guidelines for Indians and recommends a protein intake of 0.8-1.0 g/kg/day for healthy adults. Livestock products are a traditional source of high-quality protein. The production of animal protein is resource-intensive and has a substantial impact on environmental sustainability. Consequently, it is imperative to replace the currently used animal-derived protein with new alternative protein sources. In this context, pulses are important alternative protein sources that provide adequate nutrition for humans and have a lower environmental impact.

Our lab research focuses on developing smart protein-based food products from Himalayan bioresources. This includes the development of high-performance smart protein Ingredients using advanced food processing technologies. For this work, two new research facilities have been recently established

Cold plasma processing: Plasma is considered the fourth state of matter after solids, liquids, and gases. When a gaseous substance is subjected to a high energy level, the gas molecules or atoms lose their outer electrons and transform into an ionized state of matter known as "plasma." Cold plasma is maintained at temperatures below 40°C, enabling its application to food, biomaterials, and living organisms. It can be used for dietary proteins to improves its functionality while retaining their nutritional content.

Cold Plasma Reactor

3D Food Printing: This process enables the design and production of one-of-a-kind products made of food materials. It creates three-dimensional objects from a digital model by adding material together, usually layer by layer. 3D food printing is strongly dependent on the material properties and binding mechanisms. 3D food printing permits the digitization and personalization of the nutrition and energy requirements of an individual person



3D Food Printer

Research group (left to right): Saket Kumar Ranjan, Ashok Kumar Pathera and Sakita Rapria

Prashant Kumar, Scientist
prashant.kumar@csir.res.in
Traditional Knowledge

The focus of our lab is to do research and development focused on the area of Sports Health. Various challenges faced by sportspersons before, during and after their training have been planned to be addressed with a focus on translational research, which can be brought to the industrial level and applied in the field of sports.

Developing Ayurveda Herbs-based Sports Health bar

In recent times, there has been a growing interest countrywide for sports, which is evident from the country's athletes increasingly participating in global sports events. Athletes' nutritional and dietary needs differ significantly from the individuals (who lead a lifestyle having lack of physical activity) due to the intense physical demands of their training, especially in endurance sports such as boxing, football, sprinting, basketball, and hockey, leading to elevated levels of certain pro-inflammatory markers e.g., cytokines (TNF-α, IL-6, IL-1β, IFN-γ), acute-phase proteins (CRP, CK) and oxidative stress (DPPH activity). These factors impair recovery, increase fatigue, and elevate injury risk. Micronutrients like iron, magnesium, and B vitamins are critical for athletes, as they support oxygen transport, energy metabolism, and muscle health. For instance, iron deficiency can severely impact endurance athletes' performance.

Similarly, athletes need significantly higher levels of macronutrients: carbohydrates (6–10 g/kg body weight) to fuel glycogen stores, protein (1.2–2.0 g/kg) for muscle recovery and repair, and sufficient fats to support energy needs and hormonal balance. Conventional sports nutrition products primarily focus on macronutrients (proteins, carbohydrates) and micronutrients (vitamins, minerals), but often don't include the potential of bioactive compounds to mitigate inflammation and oxidative damage. In order to attain these requirements for athletes to train properly, a well-tailored diet and nutrition plan becomes essential. To address this gap area in sports, Ayurveda principles and herbs may pave the path to the development of a nutritional and pharmacologically potent sports nutrition product. Ayurveda describes the principles and herbs having Rasayana (Rejuvenation) potential like Guduchi (Tinospora cordifolia), Gokshura (Tribulus terrestris), Amalaki (Emblica officinalis), Ashwagandha (Withania somnifera), Shwet Musli (Chlorophytum borivilianum), and Kapikacchu (Mucuna pruriens). These herbs are known for their anti-inflammatory, antioxidant, and adaptogenic properties. This work aims to develop a sports nutrition bar that integrates these herbs with a balanced macronutrient and micronutrient profile, tailored for endurance athletes. The work includes phytochemical profiling of the herbs and analytical characterization of the final product using high-performance liquid chromatography (HPLC) and gas chromatography-mass spectrometry (GC-MS) to ensure efficacy, safety, and quality.

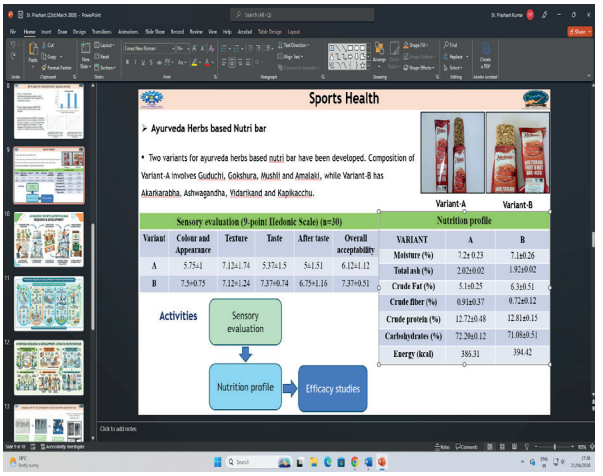


Fig. 1 Two variants for Ayurveda herbs-based nutri bars have been developed. Composition of Variant-A involves Guduchi, Gokshura, Mushli and Amalaki, while Variant-B has Akarkarabha, Ashwagandha, Vidarikand and Kapikacchu.

Development of a classical Ayurveda herb-based formulation for local application having antimicrobial activity

Sportspersons are more prone to developing certain skin infections including, fungal infections, as their training leads to profuse sweating, making the skin moist and ideal for microbial growth. Moreover, mechanical trauma from equipment or any injury leading to discontinuation of skin increase the chances of skin infections. In certain contact

sports like wrestling, there are high chances of contracting the skin infections from one person to another. Ringworm/Tinea corporis is particularly prevalent in contact sports like wrestling due to direct transmission and humid conditions that promote fungal growth, while in sports like running, baseball, cricket, and racket sports, which require repeated motions, may also lead to skin conditions and irritation due to continuous frictional changes. Other skin infections to which sportspersons are more prone include bacterial infections (e.g., impetigo) and dermatitis (Carr PC et al., 2019). Conditions like moderate temperature, high sun exposure (outdoor sports), humidity and moist surroundings are favourable for microbial growth (Qiu Y et al., 2022) (A.L. Pasanen et al., 1991), which may subsequently lead to various skin disorders like pruritis, fungal infections (Dermatophytosis, Pityriasis Versicolor) (Aditi Gadre et al., 2022), Atopic dermatitis (Sargen MR et al., 2014), etc. In the global burden disease (GBD) scenario, skin and subcutaneous diseases contributed 1.79% worldwide and were placed fourth among the leading causes of nonfatal disease burden and disability in 2013 (Karimkhani C et al., 2013). Skin diseases while, being nonfatal, are known to degrade the quality of life and lead to psychological distress. A study conducted across 13 European countries found that patients with skin diseases, including psoriasis, acne, and dermatitis, have a significantly higher prevalence of depression (10.1%) and anxiety (17.2%) compared to controls. Itching and visible lesions were major contributors to psychological distress, with 14% of patients reporting suicidal ideation. Conditions like ringworm, common in humid climates, were noted for causing social stigma, further impacting mental health (Dalgard FJ et al., 2015). Skin diseases or mechanically induced discontinuation of skin leading to skin diseases are common in athletes and may affect the training and performance (Carr PC et al., 2019). In order to address this issue at hand and to deal with the growing concern of antimicrobial resistance to the existing medications, which has rendered them ineffective to a great extent in skin diseases (Bandyopadhyay D et al., 2021), the current project proposal has been designed. The traditional knowledge from Ayurveda has been taken into consideration, as published peer-reviewed research articles establish the potential of Ayurvedic formulations in alleviating skin conditions like fungal infections (Singh NK et al., 2022). Panchvalkal Kwath (Ashish Pareek, 2022) possessess anti-microbial activity and is widely used in Ayurveda practice for the treatment of a wide range of skin conditions. Other ayurveda herbs like Daruharidra (Berberis aristata), Vidang (Embelia ribes) have also been proven to possess antimicrobial activity. Taking into consideration the frequent and easy-to-spread skin infections among sportspersons and the always lingering risk of mechanical injury during training, a moisturizer infused with Ayurveda herbs is being developed. **(Fig. 2)**.

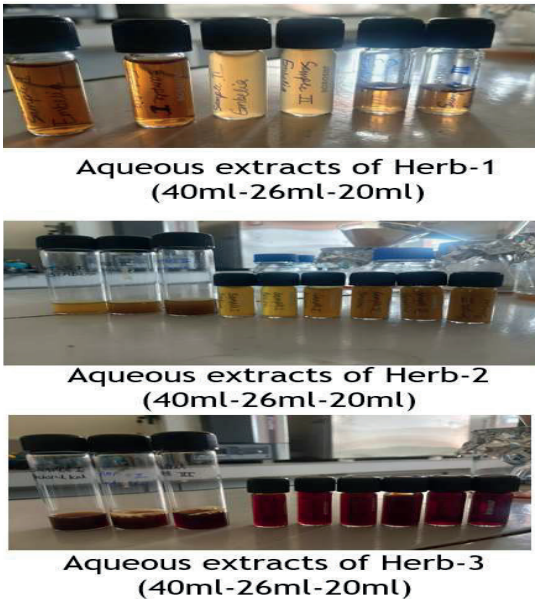


Fig. 2 Aqueous extract of Ayurveda herbs to be infused in the formulation.

The current research is focused on establishing the phytochemistry and antimicrobial activity of the selected herbs in order to ensure the highest efficacy.

Research group: Dr. Prashant Kumar, Mr. Vivek Thakur

ENVIRONMENTAL TECHNOLOGY DIVISION

Amit Kumar, Chief Scientist and Head
amit.kumar07@csir.res.in
Advance Remote Sensing and GIS

Our group specializes in advanced remote sensing and GIS applications for the mapping, monitoring, and database development of Himalayan bioresources, with a strong emphasis on hyperspectral analysis, drone-based multispectral remote sensing, and AI/ML-driven analytics.

Climate-Driven Landscape Change and Ecological Instability in the Western Himalayas

A study was conducted in the Lahaul region of western Himalayas **(Fig. 1)** as a fragile and climate-sensitive ecosystem, where accelerated warming, changing precipitation patterns, and increasing human pressure had been influencing landscape dynamics, but long-term integrated assessments remained limited.

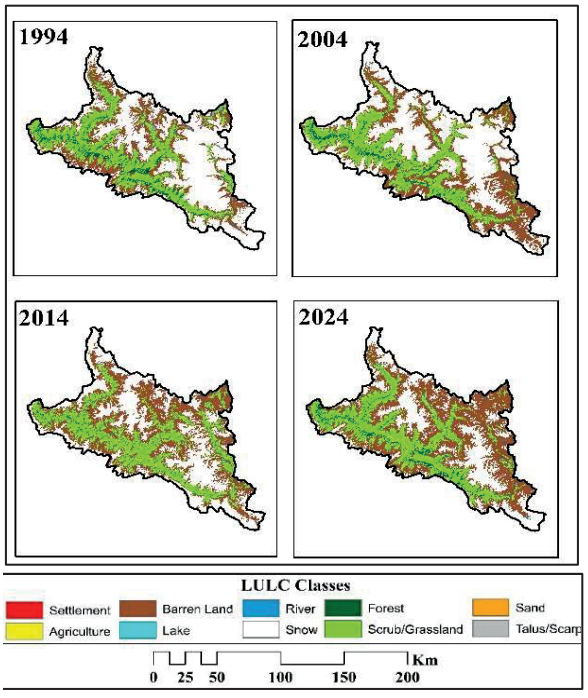


Fig. 1 Temporal land use land cover map of Lahaul, Himachal Pradesh.

It was found that the mean temperature increased from ~0.53°C to 0.67°C, maximum temperature from ~10.81°C to 12.37°C, and precipitation from ~2.30 to 2.97 mm/day, while forest cover declined from ~207 to 133 km² and surface albedo rose from ~0.21 to 0.43, indicating vegetation loss and increasing landscape fragmentation.

HimMedCrop: Geo-Tagged Database of Himalayan Medicinal Crops

This study was undertaken in the backdrop of the Indian Northwestern Himalayas as a rich center of medicinal plant diversity, where the lack of a standardized, geo-referenced database had limited systematic documentation, monitoring, and sustainable utilization of cultivated medicinal resources.

Fig. 2 Graphical User Interface of *HimMedCrop*.

As an outcome we developed *HimMedCrop*, a digital geo-tagged database **(Fig. 2)** documenting medicinal crops cultivated across multiple locations, integrating spatial, taxonomic, and cultivation data, thereby enabling improved resource mapping, conservation planning, and decision-making for Himalayan bioeconomy development.

Precision Yield Mapping of Basil via Hyperspectral Data

Recognizing the need for accurate, non-destructive yield prediction in *Ocimum basilicum*, an economically important aromatic crop, the study explored hyperspectral remote sensing **(Fig. 3)** combined with machine learning to overcome limitations of conventional estimation methods.

Fig. 3 Hyperspectral Remote Sensing Image Acquisition of *Ocimum basilicum*.

The result showed that a hyperspectral-ML model (ridge regression with PLSR) achieved strong prediction performance ($R^2 \approx 0.71$ training and 0.88 testing), identified key spectral regions (474-936 nm), and estimated yield with ~19% deviation, enabling reliable prediction up to 15 days before harvest.

Hyperspectral ML-Based study of Tea Health

Leveraging hyperspectral remote sensing for early and non-invasive detection of blister blight in *Camellia sinensis* (tea), a crop of high economic importance, the study applied advanced machine learning approaches to overcome the limitations of conventional visual disease assessment **(Fig. 4)**.

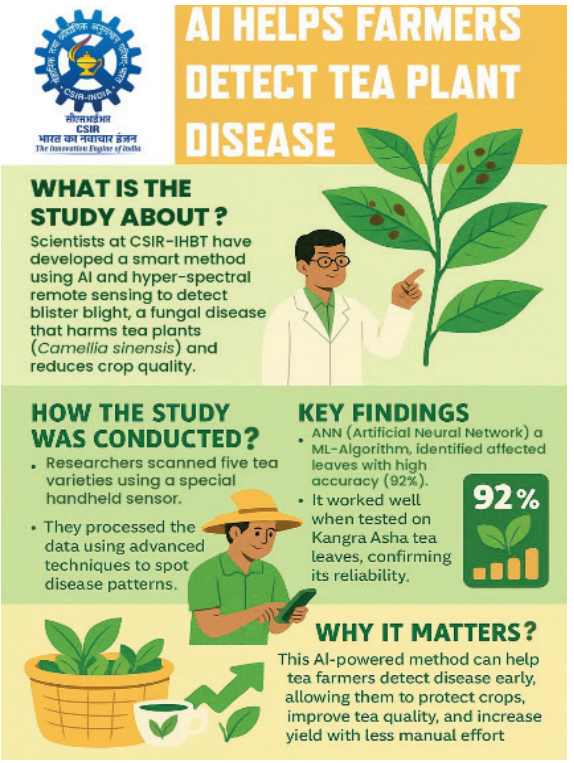


Fig. 4 AI Meets Tea Farming.

It achieved high detection performance (overall accuracy >90% with strong model robustness) by identifying key disease-sensitive spectral regions in the visible–NIR range, enabling reliable early-stage discrimination between healthy and infected plants and demonstrating strong potential for precision disease monitoring and smart plantation management.

Relevant Publications:

- Theoretical and Applied Climatology. (2026), 157: 2
- National Academy Science Letters. (2025), https://doi.org/10.1007/s40009-025-01839-4
- International Journal of Remote Sensing. (2025), 46(21): 8080–8105.

Research group: Vishant, Rakesh, Dipankar, Sidhharth, Sahil, Ashish, Deeksha, Meenakshi and Amit Kumar.

Sanjay K. Uniyal, Chief Scientist
sanjay.uniyal@csir.res.in
Forest, Ecosystem Services and Traditional Knowledge

Our team is dedicated to exploring biodiversity, sampling ecological characteristics, recording traditional Knowledge and maintaining databases of the same.

Field explorations

Nine field surveys were conducted to different locaties in the Himachal Pradesh and Ladakh, and a total of 400 specimens were collected **(Fig. 1).**

Fig. 1 Sample collection during field explorations.

Vegetation characteristics of Nubra Valley

A total of 129 vascular plant species representing 42 families and three growth forms were recorded from the Nubra valley of Ladakh **(Fig. 2)**. Herbs were the predominant lifeform (n=98) with Asteraceae and Fabaceae being the most species-rich families**.** Amongst vegetation, alpine meadows exhibited the highest herbaceous richness (47 species) while agroforestry showed the highest tree diversity (14 species). Shannon diversity varied from 1.24 to 1.84 across ecosystems.

Fig. 2 Vegetation recording of Nubra Valley.

Ecosystem Services of Cold deserts

Cultural ecosystem services (CES) refer to the non-material benefits such as aesthetic, recreational, spiritual and heritage that human derive from nature. CES were recorded and classified into seven categories **(Fig. 3)**. Further, they were evaluated for satisfaction and willingness to pay. Recreational and ecotourism services were found to be the most appreciated CES (38%), followed by aesthetic (25%) and spiritual values (15%). Tourists had a high average satisfaction score (9.12 ± 0.935).

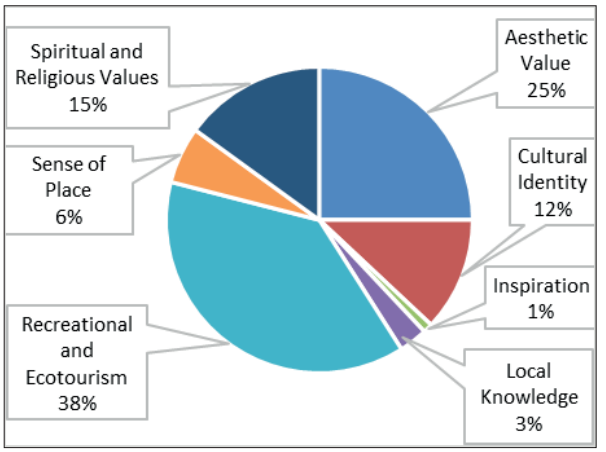


Fig. 3 Categorization of Cultural Ecosystem Services.

Traditional Food

Traditional food practices of the Pangwal and Bhot communities in Pangi Valley, Himachal Pradesh were compared. A total of 81 traditional cuisines that can be classified into 10 categories (Adjunct, Beverage, Flatbread, Fruit, Meat based, Pancake, Soup/Curry, Steam food, Sweet dish, and Vegetable) were identified (**Fig. 4**). Significant differences ($p<0.05$) were observed in

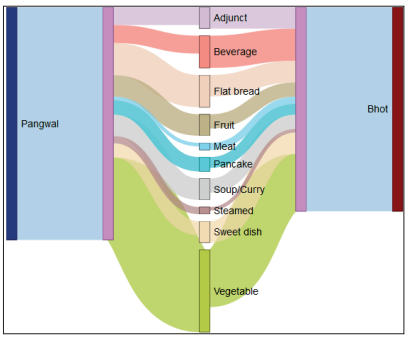


Fig. 4 The comparative flow of traditional food categories between two groups.

eight categories, while Pancakes and Vegetables showed non-significant variation ($p>0.05$) between the two communities. Wild edible plants contributed 49% towards the raw materials for the recipes. Among the total cuisines, 24 were unique to Pangwals, 16 to Bhots, and 41 were shared.

Phenolocical monitoring and sampling

The *Betula* phenology monitoring camera set-up continued to record photographs. A total of 600 auto clicked photographs were downloaded for analysis during this period. Also sampling of the species for identifying different growth stages was carried out (**Fig. 5**).

Fig. 5 Leaf growth stages of *Betula utilis*.

Citizen Science

As a part of citizen science initiative, school children of Tundru village were made aware and involved in documenting phenological observations on plant species (**Fig. 6**). They were apprised of the protocols and hand on training was provided.

Fig. 6 Involving school children as citizen scientists.

Relevant Publications:

- Discover Food. (2025), 5, 197.
- Ethnobotany Research and Applications. (2025), 31: 1–15.
- Indian Journal of Traditional Knowledge (2025), 24(11): 1043-1054.

Research group (Standing-Left to Right): Akshat Sood, Anchal Sharma, Robin, Abhinandan Thakur.

Sitting (Left to Right): Shweta Sharma, Tsering Dolma, Sanjay Kr. Uniyal, Vishal Kumar, Pranav Mishra

Amit Chawla, Senior Principal Scientist
amit.chawla@csir.res.in
Plant Ecology

(I) Studying Impacts of Climate Change on Alpine-Treeline ecosystem

(a) Monitoring of alpine vegetation

Continuing the research on studying impacts of early snow-melting in Himalaya on alpine vegetation, our results revealed the effect of changes in snow-melt timing on species and functional diversity of alpine plant communities. It was found that experimental early snow-melting caused increase in both species & functional diversities with more pronounced effects at upper elevations **(Fig.1).**

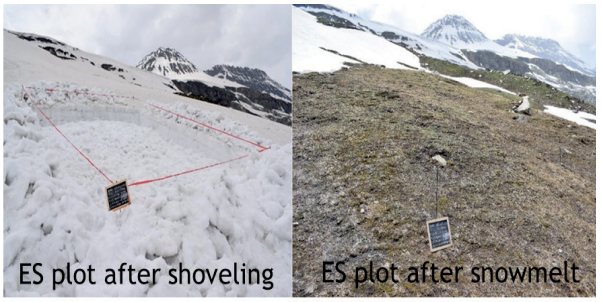


Fig. 1 (a) Control and treatment (Early Snowmelt (ES)) plots (b) Effect of early snow-melting on species diversity.

(b) Shrubification of Alpine Meadows

We provided strong arguments towards range expansion of alpine shrubs in alpine meadows. Supporting our previous results, which argued that alpine shrubs do not facilitate any herbaceous species but rather compete with them, we conducted studies on adaptation strategies of alpine shrubs (*Rhododendron anthopogon*, *Juniperus polycarpos* and *Caragana versicolor*) which form the shrublines at their upper limits **(Fig. 2)**. The spatio-temporal variations in non-structural carbohydrates (NSCs) in leaf, stem & root tissues of these suggested that at their upper limits, the plants maintain sufficient C reserves, implying that growth is unlikely to be limited by C supply, but is, instead, constrained by sink limitation, likely driven by lower temperature conditions, but future climate warming conditions may be conducive to facilitate shrub expansion. Further, these have higher carbon sequestration potential, particularly the evergreen shrubs, their encroachment into alpine meadows may boost carbon sink capacity with global warming.

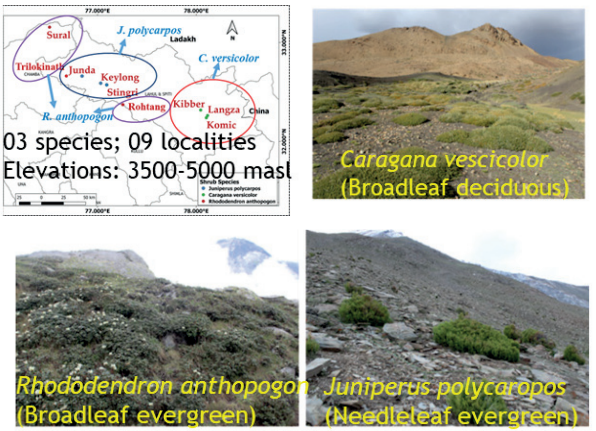


Fig. 2 Alpine shrubline forming species.

(II) Adaptation Strategies of High Elevation Plants

(a) Adaptation to high UV radiation

The UV attenuation experiment setup in a natural site on *Juniperus polycarpos*, a coniferous tree of Lahaul Himalaya, revealed interesting insights on adaptation of this species to high UV radiation & low temperature, particularly suggested that advanced freezing tolerance due to full exposure to intense UV-A/B stressors under ambient conditions **(Fig.3)**. Our preliminary observations suggest that UV-B exposure might act as a cue for early cold acclimation in *J. polycarpos*.

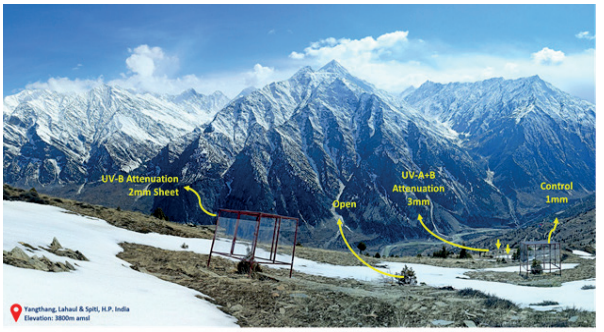


Fig. 3 Field experiment setup with UV attenuation chambers placed over trees.

(b) Thermo-tolerance of alpine plants

Infra-red thermography was utilized to estimate the field leaf temperature of alpine species. The leaf thermal tolerance of 52 species representative of the alpine region of Trans-Himalaya was found to range from 44.9°C to 65.9°C, with the highest in graminoids, followed by forbs and rosettes. Further, thermal safety margins

(TSMs) ranged from 20.3°C (*Malva neglecta*) to 40.5°C (*Calamagrostis emodensis*) for most of the species, with a few species under 20°C, except for *Rosularia alpestris*, which showed at 9.7°C. The TSMs of studied species were found to be much higher than the daily maximum leaf temperature recorded through thermal imaging during the study period. This unique & pioneering study in Himalaya suggests that alpine flora is robust against global warming **(Fig. 4).**

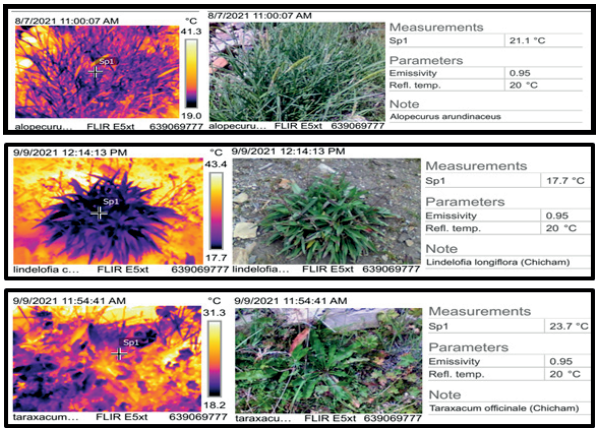


Fig. 4 Plant canopy & leaf temperature estimation using thermography.

(III) Ecological studies on high altitude vegetation

We studied how elevation & aspect shape key plant traits related to resource use and competition and investigated 113 species occurring in high elevation eco-region of western Himalaya. The trait covariation was examined to identify dominant ecological strategies & tested effects of elevation, aspect, & their interaction on individual traits & multivariate trait space. Our results revealed that in high-elevation Himalayan region, aspect outweighs elevation in shaping plant functional traits **(Fig. 5).**

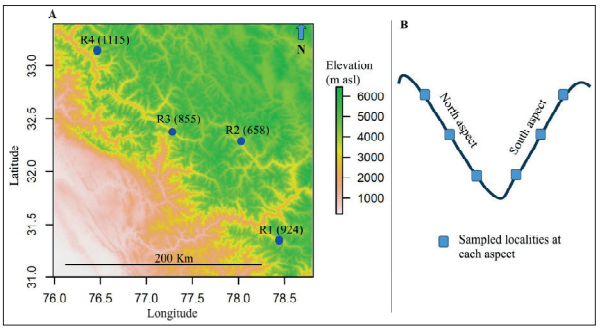


Fig. 5 Study area & slope aspect.

(IV) Conservation of threatened medicinal plants

Collection of germplasm- Numerous accessions of *Colchicum luteum* were collected from various localities and added to the field genebank at CeHAB.

(V) Assessment of Ecosystem Services, Environmental Impacts & Ecological Restoration

The Ecological Restoration work was initiated at a landslide-hit site in Lahaul and Spiti district. Large quantities of seeds of native plant species including grasses, forbs and legumes were collected and tested for viability and germination **(Fig. 6)**. Besides, cuttings of woody shrubs such as *Salix* sp., *Crataegus* sp., *Rosa* sp. *Fraxinus* sp. etc. were collected for forming field nurseries.

Fig. 6 Collection of seeds of native plant species.

Relevant Publications:

- Environmental Monitoring and Assessment. (2026), 198: 471.
- Plant Physiology Reports. (2026), 34: 83–97.
- Frontiers in Plant Physiology. (2025), 3:1652412.

Ashok Singh, Principal Scientist
ashok.singh@csir.res.in
Plant Ecology, Biodiversity Conservation

Our group mainly works on the generation of data related to ecology, population assessment of important medicinal plant species, habitat niche modelling, and their characterization in the Trans Himalayas. Furthermore, studies are also being conducted on *ex-situ* conservation and propagation of high quality planting material of important species at the *Centre for High Altitude Biology* (CeHAB), Ribling, Lahaul and Spiti (HP). In addition, we also focus on studies related to environmental issues like water management, night-soil fertilizers and their applications.

High Altitude Ecological Research

Focused ecological studies on the targeted medicinal and aromatic plants of high altitude areas were carried out. The surveys were conducted in different habitats in the high-altitude areas of Himachal Pradesh to record ecological and phenological parameters. A total of 50 sites were surveyed at elevation ranging from 2276 to 4544 amsl. Population assessment of the species Eremurus himalaicus, Arnebia euchroma, Allium carolianum, A. negianum were performed and their associated plant diversity was recorded. To develop a field gene bank, the planting materials of different accessions were collected from the surveyed sites.

Eremurus himalaicus Baker

15 sites representing 4 habitats and 6 aspects were surveyed for *Eremurus himalaicus*. Bouldery habitats and south-west facing aspect were found to be most dominant for this species **(Fig. 1 & 2).**

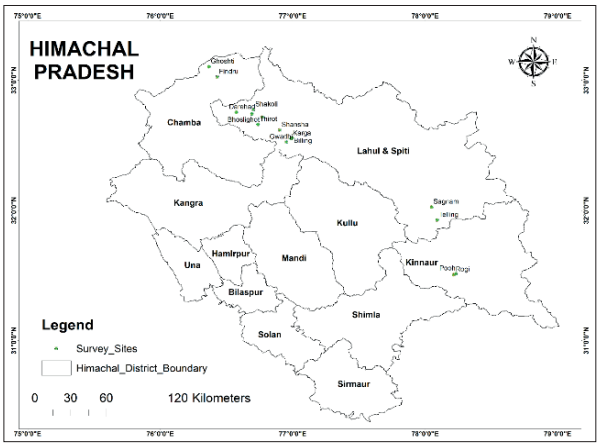


Fig. 1 Distribution of *Eremurus himalaicus* in the Himachal Pradesh.

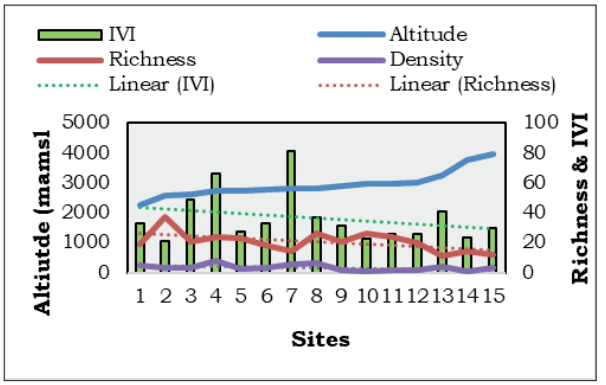


Fig. 2 Altitude wise dominance pattern and species richness of *E. himalaicus* under different sites (Abbreviations: 1= Findru; 2= Gwadhi; 3= Darehad; 4= Udaipur; 5= Rogi; 6= Thirot; 7= Bhoslighot; 8= Ghoshti; 9= Karga; 10= Billing; 11= Shakoli; 12= Shansha; 13= Pooh; 14= Teling; 15= Sagnam).

Arnebia euchroma (Royle ex Benth.) I.M. Johnst.

A total of 13 sites covering 6 aspects and 3 habitats of *A. euchroma* were identified. The species thrives best in the north/northwest facing aspects and dry slope habitats **(Fig. 3).**

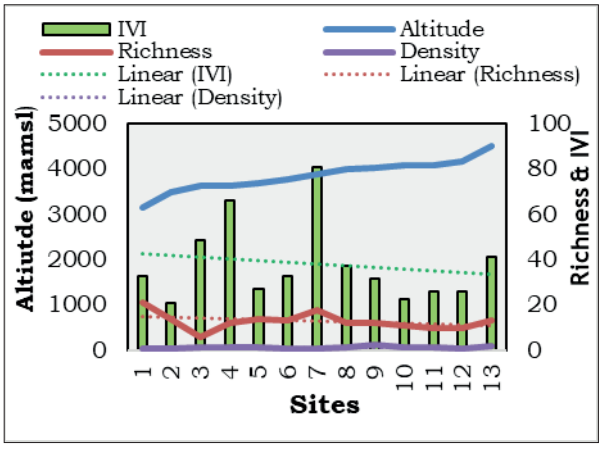


Fig. 3 Altitude-wise dominance pattern and species richness of *A. euchroma* in Himachal Pradesh (Abbreviations- Site1= Rohtang; Site2= Sagnam; Site3= Chubrang; Site4= Rarik; Site5= Drilbu; Site6= Kewang, Site7= Dalang maidan; Site8= Lossar; Site9= Kibber, Site10= Hikkim; Site11= Langza; Site12= Dhankar; Site13= Sarchu).

Allium carolinianum Redoute

The population of *Allium carolinianum* was studied across different altitudes and the species was found between the altitudinal range of 3005–4544 amsl **(Fig. 4).**

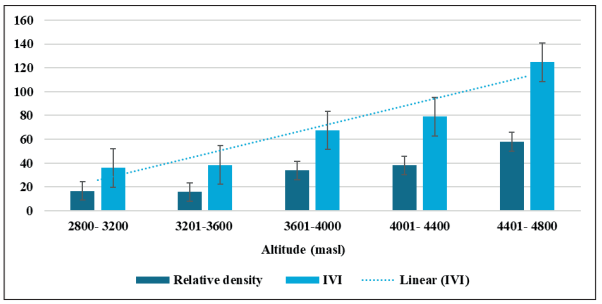


Fig. 4 Altitude wise dominance of Allium carolinianum.

Allium negianum A. Pandey, K.M..Rai, Malav & S.Rajkumar

The *Allium negianum* species was present between the altitudinal zone of 2883 to 3858 amsl **(Fig. 5 & 6).**

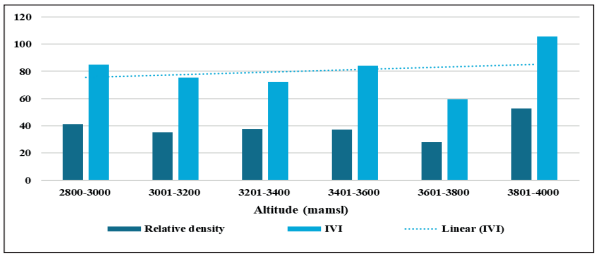


Fig. 5 Altitude wise dominance of Allium negianum.

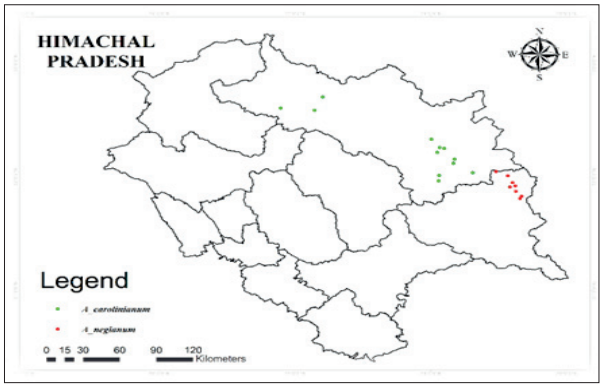


Fig. 6 Map of Himachal Pradesh indicating locations of *Allium carolinianum* and *Allium negianum*.

Field Genebank Conservatory

***Arnebia euchroma* (Royle ex Benth.) I.M. Johnst.**

The seedlings of 10 accessions were raised at CSIR–IHBT, Palampur, and were successfully transplanted at CeHAB in May 2025 (**Fig 7**).

Fig. 7 Arnebia euchroma.

***Eremurus himalaicus* Baker:** Rooted cuttings from 15 accessions were earlier planted at CeHAB, which showed bud emergence and vegetative growth during the current season. The best early growth performance was recorded under a 75% shade net. However, in open conditions, full flowering achieved after two years, indicating requirement for a multi-year stage establishment pattern **(Fig. 8).**

Fig. 8 Eremurus himalaicus.

Status of Field Gene-bank and Seed Repository at CeHAB, Ribling

Conserved the different accessions of *Arnebia euchroma, Eremurus himalaicus, Allium carolinianum* and *A. negianum*. The elite accessions of *Arnebia euchroma* and *Eremurus himalaicus* were selected based on their superior physical appearances. Besides, seeds of about 10 species were also preserved at seed repository.

Relevant Publications:

- Indian Forester. (2025), 151(4): 345-351.
- Proceedings of Indian National Science Academy. (2026), https://doi.org/10.1007/s43538-026-00699-w
- *Journal of Asia-Pacific Biodiversity.* (2026), https://doi.org/10.1016/j.japb.2025.12.009

Research group (from left to right): Aniket, Rajat Bhardwaj, Ashok Singh, and Sachin Negi.

Vikas Kumar, Senior Scientist
vikas.kumar01@csir.res.in
Plant Taxonomy

Our team is working on taxonomic studies in the Himalayan region. Regular field surveys are conducted to document, collect, and identify a diverse range of Himalayan plant species. The specimens collected during these surveys are processed and incorporated into the PLP herbarium of CSIR-IHBT, thereby contributing to its enrichment. Additionally, we also promote scientific awareness through herbal garden, which serves as a living repository of medicinal and economically important plants.

Floristic survey: For the floristic survey in Kangra, regular and repeated field tours were conducted across various localities, including the Dhauladhar Wildlife Sanctuary (DWLS), Dehra, Palampur, Nurpur, and adjoining areas of the district. Approximately 620 plant specimens were collected, of which 515 were identified and processed for the herbarium. Among the recorded taxa, the family Asteraceae was dominant with 82 species, followed by Rosaceae with 65 species and Fabaceae with 40 species. In addition, for conservation purposes, a few propagules of medicinal plants were also collected and propagated in the Herbal garden. Similarly, botanical exploration of Kugti Wildlife Sanctuary (Chamba) was also conducted, and 290 specimens were collected, of which 219 were identified.

Taxonomic studies of the genus *Cremanthodium*: For the taxonomic revision of the genus *Cremanthodium* Benth. in the Indian Himalaya, field tours were conducted in Uttarakhand, Arunachal Pradesh, and Himachal Pradesh, and four species were collected. For molecular phylogenetic analysis, DNA was extracted from the leaf samples, amplified, and sequenced using the ITS and *trnC-PetN* intergenic spacers. In addition, GC-MS studies have been completed for volatile organic compounds, providing insight into their chemical constituents, and polyphenolic profiling of plant secondary metabolites has also been carried out through the UPLC-PDA method.

Taxonomic novelties:

New species: During our exploration of the Eastern Himalayas, two new plant species were discovered and described: *Taraxacum diluculorum* Vik. Kumar, Kirschner & Štěpánek, collected from the alpine meadows of Tawang, and *Cremanthodium kalaiselviae* Vik. Kumar & Rahul Kumar, identified from the Dibang Valley district of Arunachal Pradesh **(Fig. 1)**. In addition, another threatened and endemic species was also seen during the survey, further highlighting the floristic richness of the Eastern Himalayan region.

New record for India: Similarly, *Allium rosenbachianum* Regel (family Amaryllidaceae) was also discovered for the first time from Himachal Pradesh, India.

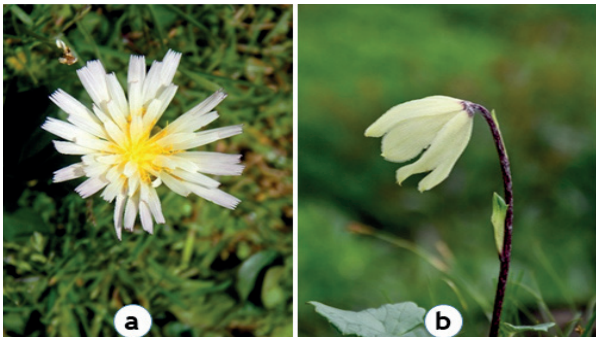


Fig. 1 New species discovered from Indian Himalayan Region- a. *Taraxacum diluculorum* ;b. *Cremanthodium kalaiselviae.*

Conservation of medicinal plants in the Herbal Garden: As part of *ex-situ* conservation efforts, a garden named 'Jaivsampada Udyan' has been established under the CSIR Bioresource Conservation and Prospection Mission, where more than 50 species of edible, aromatic, ornamental, dye-yielding, spice, and medicinal plants were planted **(Fig.2)**.

Fig. 2 Jaivsampada Udyan.

Relevant Publications:

- Annales Botanici Fennici. (2025), 62: 183-188.
- Phytotaxa, 2025, 270(3): 263-271.

Research group (Left to right): Rahul Thakur, Amnish Singh, Rahul Kumar, Vikas Kumar, Kamini Thakur and Dimple Kumari.

FERMENTATION AND PHYTOFARMING TECHNOLOGY

Shashi Bhushan, Chief Scientist & Head
shashi.bhushan@csir.res.in
Fermentation and Phytofarming Technology

The group's research advances sustainable production of phytoconstituents using Plant Cell and Organ Culture Technology. By developing eco-friendly bioprocesses, it generates regenerative resource material for high-value metabolites to meet the industrial requirment of food, pharma and cosmetic industries, thus reducing dependence on wild-harvested Himalayan plants. This directly supports India's BioE3 Policy and contributes to global sustainability by strengthening SDG 9 (Industry, Innovation, and Infrastructure), SDG 12 (Responsible Consumption and Production), and SDG 15 (Life on Land) through biodiversity conservation and *in vitro* valorization.

1. Cultivating natural pigments in bioreactors

Plant pigments are special compounds synthesized by them for their growth and survival in challenging environs that may be physiological, geographical and climatic. In addition, pigment molecules (**Fig. 1**) have a significant role in human life as natural colours and dyes, as well as in the management of health and wellbeing. High demand in industries (food, beverages, paper, textiles, cosmetics as well as in pharmaceuticals. This irresponsible harvesting of plant material from wild not only depletes natural resources but also fails to meet the growing industrial demand. Thus, it is important to establish more sustainable and ecologically friendly processes for the production of raw materials that can be used to extract pigments. In this context, scientific communities deployed plant cell and tissue culture technologies to produce certain plant-based constituents successfully on industrial scale. A number of reports are available that demonstrated the use of *in vitro* plant cultures as a sustainable method to get commercially valuable natural products (ginseng, berberin, rosmarinic acid, podophyllotoxins etc.) including pigments like anthocyanins and betacyanins. In this article, publications reported deployment of plant cell and tissues-based system for natural pigments are discussed. In addition, the information on strategies such as elicitation, precursor feeding, permeabilization, immobilization and two-phase cultivation system deployed to maximize the productivity, especially under *in vitro* condition. Emphasis is also done on extraction of plant pigments from conventional as well as green advanced techniques. It will not only eliminate the dependency on wild plants but will also help in meeting industrial demand and conservation of continuously depleting natural resources programmes.

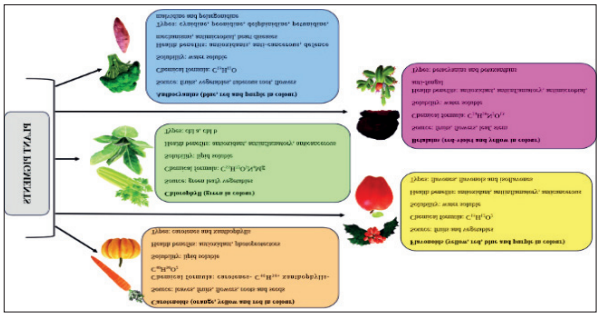


Fig. 1 Major classes of plant pigments.

2. Production of valepotriates from adventitious roots of *Valeriana jatamansi*

A sustainable and scalable biotechnological process has been developed for producing pharmaceutically valuable valepotriates using *in vitro* leaf induced adventitious roots of *Valeriana jatamansi*. Leaves pricking combined with melatonin treatment enabled rapid and 100% root induction. Optimization of medium volume, inoculum size, pH, agitation speed, and culture duration under submerged shake flask **(Fig. 2)** conditions enhanced root growth and multiplication. Melatonin supplementation further improved valepotriates yield. Scale up in bioreactors achieved industrially viable production, reducing timelines from 2–3 years to six weeks. The method avoids genetic transformation, ensures metabolic consistency, conserves biodiversity, and provides an environmentally friendly alternative for year round production of valepotriates.

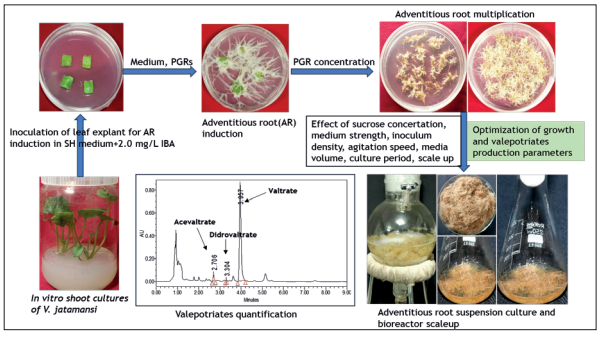


Fig. 2 Overall process for the production of valepotriates from *Valeriana jatamansi in vitro* adventitious roots.

3. *In vitro* production of pharmaceutically important picrosides

Picrorhiza kurroa is an endangered Himalayan medicinal plant valued for hepatoprotective picrosides but threatened by overharvesting. In this invention, the *in vitro* leaf-induced adventitious root cultures were evaluated as an alternative and sustainable source of picrosides. A standardized protocol achieved 100% adventitious root induction from leaf explants on Gamborg B5 medium augmented with 4.0 mg/L indole-3-butyric acid. Various parameters including hormone level, culture duration, medium strength, sucrose level, inoculum density, pH and agitation speed were optimized for adventitious root suspension culture, resulting in a significantly high biomass yield. UPLC/MS analysis showed considerable picroside content in 4-week-old adventitious roots **(Fig. 3)**. Nevertheless, the rapid growth cycle, scalability and year-round production highlight the potential of adventitious root culture as a sustainable alternative for picrosides and other phytochemicals production without depleting natural populations.

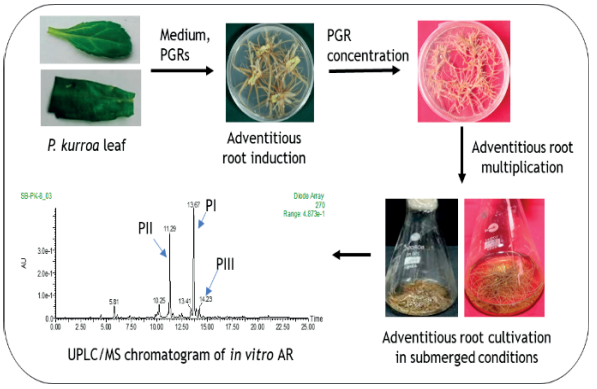


Fig. 3 Graphical representation of invented process for picrosides production through *Picrorhiza kurroa* adventitious roots.

Relevant Publications:

- Journal of Human Nutrition & Food Science. (2025), 13(2): 1198.
- Journal of Essential Oil Research. (2026), 38(2):1-10.

Research group (Right to Left): Ms. Deepika Choudhary, Mr. Prashant Kumar, Dr. Shashi Bhushan, Dr. Ashok Gehlot, Ms. Manjeet Singh Dhrek and Mr. Rohit

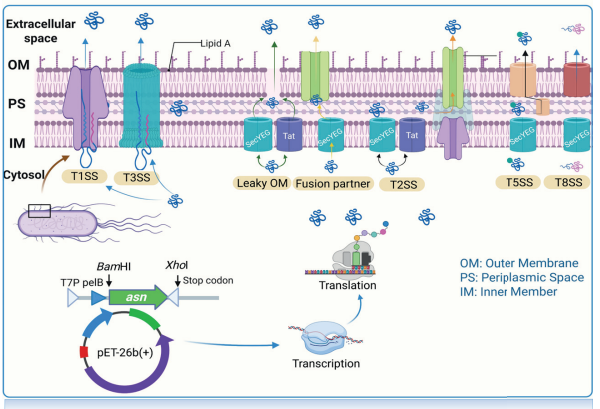
Dharam Singh, Senior Principal Scientist
dharam.singh@csir.res.in
Molecular Microbiology

Our research group is focused on functional genomics of high-altitude microbes with a major focus on extremozymes of industrial relevance. While studying the adaptation of microbes to extreme Himalayan niches, we bioprospects them for enzymes/biomolecules of industrial relevance. Mainly, we target enzymes/biomolecules from the bacteria of high-altitude regions for biofuels (Endoglucanase, Xylanase, Laccase, Glucosidase), therapeutics (L-asparaginase, anti-cancerous), and PHA-based bioplastics & violacein pigment. The highlights of research work carried out during the period is described as below: -

Type II L-asparaginase from *Pseudomonas* sp. PCH199 and its extracellular secretion:

L-asparaginase (L-ASNase; EC. 3.5.1.1) plays a crucial role as a therapeutic enzyme for the treatment of acute lymphoblastic leukemia (ALL) and acute myeloid leukemia (AML). It hydrolyzes L-asparagine, which is essentially required for the tumor cell's growth. Besides its therapeutic use, L-ASNase is also used to reduce acrylamide in baked and fried foods. It is also used in the analytical industry to develop biosensors for detecting L-asparagine levels in blood samples.

The recombinant L-ASNase II from *Pseudomonas* sp. PCH199 (Pg-ASNase II), previously cloned and expressed into an *E. coli* BL21(DE3), doesn't secrete extracellularly. Therefore, to produce it extracellularly, we employed the secretory expression using the pelB signal sequence of pET-26b vector to express Pg-ASNase II in *E. coli* BL21(DE3). Pg-asn II was successfully cloned and expressed in pET-26b(+) having pelB leader sequence for periplasmic expression **(Fig. 1)**. It led to the successful secretion of Pg-ASNase II in the supernatant. However, a significant amount of Pg-ASNase II was also left in the cytoplasmic space. The protein secretion increased from 0.33 to 0.77 mg/mL with 0.2% Tween 80 in the medium. Pg-ASNase II was purified in a single chromatographic step using a Q-sepharose column with 8.0 mg/L purified protein production and 60.0 U/mg Pg-ASNase II activity. It demonstrated a 75% yield and a 15-fold increase in purification. The current study reported an increased extracellular L-ASNase expression compared to the wild organism and helped reduce the cost of the downstream process. Hence, this research can contribute to upcoming investigations of periplasmic Pg-L-ASNase II for therapeutic applications.



Processes and features

T1SS: Well-characterized, Low complexity, Narrow substrate range, Low titers;
T3SS: Well-characterized, High complexity, Broad substrate range, High titers
Leaky OM: Well-characterized, Low complexity, Broad substrate range, High titers
Fusion partner: Poorly characterized, Low complexity, Broad substrate range, High titers
T2SS: Poorly characterized, High complexity, Narrow substrate range, Low titers
T5SS: Poorly characterized, Low complexity, Narrow substrate range, Low titers
T8SS: Well-characterized, Low complexity, Narrow substrate range, Low titers

Fig. 1 One-step and two-step secretion systems. T1SS (C-terminal tag required) and T3SS (N-terminal tag required) are one-step and translocate proteins (dark blue) directly from the cytosol to the extracellular space in an unfolded state, bypassing the inner and outer membranes (IM and OM, respectively). Leaky OM, Fusion partner, T2SS, T5SS, and T8SS are two-step secretion systems. Leaky OM: Proteins cross the IM via Sec or Tat and then diffuse into the extracellular space. Fusion partner: Some proteins are secreted through fusion partners; YebF, for example, is secreted only via Sec and likely passes the outer membrane (OM) through a porin. Other export pathways are unknown. T2SS: Proteins move through Sec/Tat into the pseudopilus, which transports them across the OM. T5SS: A Sec-exported fusion of translocation and passenger domains; the translocation domain anchors in the OM, while the passenger domain passes through the pore and is later released by autocleavage. T8SS: Curli-fused proteins are exported via Sec and cross the OM using a chaperonin-like structure.

In conclusion, we have established an extracellular expression system of L-ASNase II from *Pseudomonas* sp. PCH199. It helps to simplify downstream processing and increases the yield of enzyme production. The use of Tween 80 helps to enhance the extracellular production of L-ASNase II, which ultimately helps to reduce the downstream processing cost. The enhanced extracellular expression of the

recombinant protein was observed compared to the wild strain studied previously. Furthermore, optimization is needed for distinct periplasmic signal transporters, which will be helpful in the future for creating stable and enhanced extracellular secretion of L-ASNase that can be exploited for industrial applications.

Enzymatic potential of dairy microbes from high-altitude niches:

In our continuous efforts to explore the Himalayan niches for extremozymes, the current study investigated the untapped potential of high-altitude dairy microbes as a valuable resource for industrially significant enzymes and their applications in the food industry, using beta–galactosidase (previously investigated in our lab) as an example.

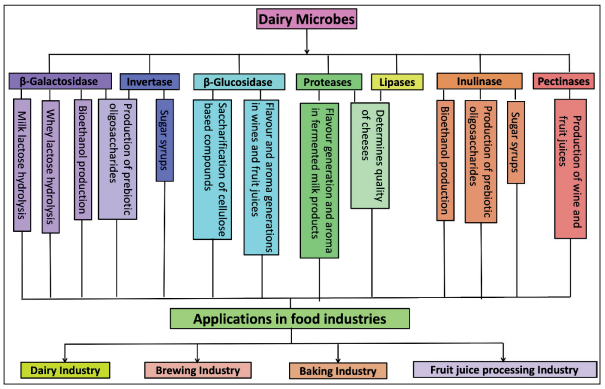


Fig. 2 Various enzymes produced by dairy microbes and their applications in the food industries.

High-altitude regions present various environmental challenges, yet the inhabitants living in these areas have adapted remarkably well, maintaining good health while living in close harmony with nature. A key factor contributing to this resilience is their dependency on dairy products as a primary part of their diet. These traditional dairy foods are rich in beneficial microbes with notable probiotic and enzymatic properties **(Fig. 2)**. Microbes from these products produce a variety of enzymes such as β-galactosidase, β-glucosidase, proteases, lipases, and pectinases. They exhibit high enzymatic activity and are in high demand in the food industry due to their effectiveness and acceptable nature. The growing need for stable, efficient enzymes with GRAS status and safe for consumption has fuelled interest in the exploration of dairy-derived microorganisms from high-altitude environments. These microbes, which are adapted to extreme and stressful conditions, exhibit strong enzymatic potential. Therefore, our investigation highlighted the emerging potential of high-altitude dairy microbes as a valuable resource for industrially significant enzymes, their potential applications in the food industry, and limitations and challenges of using high-altitude dairy-derived microbes.

Enzymes help to improve the quality of various dairy and food products and have become an essential part of the food industry. The food items are kept under cold or low-temperature conditions to avoid microbial contamination and prolong their shelf-lives. Cold-active or psychrophilic extremozymes have always been the preferred choice because they are active under low-temperatures. The main source of enzymes is psychrophilic/psychrotrophic microorganisms prevalent in cold atmospheres. High-altitude regions face extreme environmental conditions and thus are colonized by various extremophiles like psychrophiles and thermophiles. Dairy microbes have already shown a vast potential for microbial enzymes and their use in various food processing and synthesizing valuable products. The bioprospection of enzymes from microbes with GRAS status has a huge market potential due to their wider acceptability. Additionally, the enzymes from high-altitude sources are dynamic and robust with broader functionality. Despite some recent studies, high-altitude niches remain relatively underexplored in terms of dairy microbial diversity and enzymatic capabilities. Continued bioprospecting efforts are needed to uncover novel enzyme sources with potential industrial relevance. The underexplored nature of high-altitude dairy microbiomes presents a unique opportunity. Targeted efforts combining metagenomics, culture-omics, and collaborative partnerships with local communities could unlock novel enzymes while preserving ecological and cultural integrity.

Comparative genomics and functional analysis of *Rahnella* sp. PCH160:

The fundamental aspect of our lab research interest is to identify unique bacteria from the Himalayan niches and further investigate them at genomic level to dissect their uniqueness. In continuation of our past efforts, in the current study, a putative novel plant growth-promoting rhizobacterium (PGPR) *Rahnella* sp. PCH160, isolated from the Pangi-Chamba Himalayan region (PCH) was investigated. Whole-genome sequencing and comparative genomics identified unique genes associated with heavy metal tolerance, phosphate solubilization, siderophore production, nitrogen fixation, and indole-3-acetic acid (IAA) synthesis **(Fig. 3)**. The bacterium exhibits exceptional tolerance to heavy metals, even under chemically defined medium, particularly copper (Cu) and nickel (Ni), as well as multiple plant growth-promoting

traits. Additionally, PCH160 showed biocontrol potential through different enzymatic activities. Seed-based bioassays highlighted significant enhancements in root and shoot length and dry biomass under heavy metal stress.

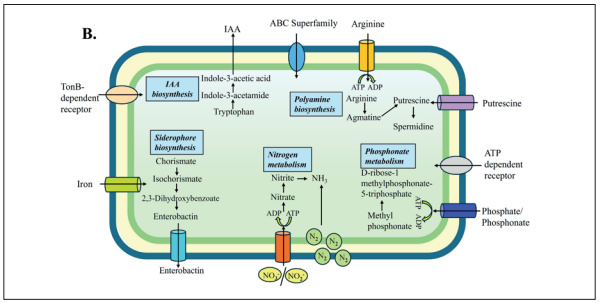


Fig. 3 Genomic features illustrate the predicted genes associated with plant growth-promoting traits. Genes encoding for (i) isochorismate synthase, (ii) isochorismatase, (iii) tryptophan synthase, (iv) amidase, (v) nitrate reductase, (vi) nitrite reductase, (vii) nif operon, (viii) phosphonate C-P lyase system protein PhnG, PhnH, (ix) arginine decarboxylase, and (x spermidine synthase were present.

This research highlights the promising capabilities of *Rahnella* sp. PCH160 as both a biofertilizer and a biocontrol agent. There are limited reports of the positive impact of PGPR on plant growth and development in the Himalayan regions. However, to the best of our knowledge, tolerance of PGPR to heavy metals has not been characterized from higher-altitude regions. In conclusion, this study provided an insight into sustainable agriculture practices in contaminated soils at high altitudes. It has also demonstrated that a PGPR isolated from the Pangi-Chamba Himalayan region has the potential to enhance plant growth and development in the presence of heavy metal stress **(Fig. 4)**.

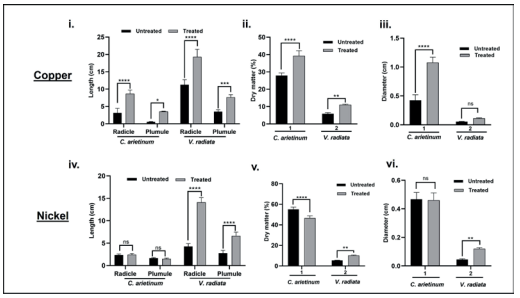


Fig. 4 Effect of bacterial inoculation and heavy metals on seeds of Cicer arietinum and Vigna radiata. Biopriming of seeds with bacterial inoculation is taken as untreated and with bacterial inoculum along with copper or nickel is referred to as treated. Effect on (i) radicle and plumule length, (ii) percentage dry matter, (iii) Diameter of the root in the presence of copper; and on (iv) radicle and plumule length, (v) percentage dry matter, (vi) Diameter of the root in the presence of nickel. Error bars denote standard errors (n = 4). The following symbols indicate statistically significant differences between untreated and treated: *p < 0.01, **p < 0.05, ***p < 0.001, ****p < 0.0001 and ns as non-significant.

In conclusion, the present study highlighted the genomic and functional attributes of a putative novel Himalayan bacteria, *Rahnella* sp. PCH160. A comparative genome study of *Rahnella* sp. PCH160 offered insights into the unique genes beneficial for plant growth. The comparative analysis and the functional validation of the strain provided evidence for the heavy metal tolerance and PGP traits. In particular, inoculating plant seedlings with PCH160 in the presence of Ni and Cu increased the growth of radicle and plumule, thereby increasing the weight of dry biomass of the plant. However, the need for extensive field validation, a deeper understanding of its regulatory pathways, and functional assessments under varied environmental conditions remains to be validated in the future. Such studies have opened up the prospective for large-scale greenhouse and field trials to assess its efficacy in different soil types, along with transcriptomic profiling to uncover gene expression dynamics under stress conditions. This initial investigation offers promising insights into the Himalayan microbes that could support the development of efficient bioinoculants and biofertilizers to enhance agriculture in areas contaminated with heavy metals.

Relevant Publications:

- Journal of Chromatography B. (2025), 1267, 124814.
- Extremophiles. (2025), 29, 41.
- Microbiological Research. (2025), 299, 128264.

Research group (From left side): Sneha, Tamanna, Shamli Chandel, Dr. Dharam Singh, Arushi Katoch, Paridhi Shrivas, Shubam Thakur.

Back row: Matruprasad Mohanty, Samiksha Rana, Bhavna Soni

Amitabha Acharya, Principal Scientist
amitabha@ihbt.res.in
Chemical Nanotechnology, Nanobiology and Biomaterials

In our efforts to explore the potential of nanomaterials in healthcare applications, we developed both metal-based and polymeric nanoparticles and evaluated their effects across various cell lines. The key outcomes and observations from these studies are summarized below.

Nanotechnology-Mediated Sequestration of Redox Copper Controls Lysozyme Aggregation and Maintains Lipid Homeostasis for Mitochondrial Protection

Amyloid deposition has long been regarded as a hallmark of multiple neurodegenerative diseases (NDs), yet therapeutic strategies aimed at directly targeting amyloid species have largely failed to deliver clinical benefit. This limitation highlights the urgent need for more precise and alternative intervention approaches. Emerging clinical and epidemiological evidence highlights the critical role of disrupted lipid metabolism, particularly the excessive accumulation of lipid droplets (LDs) in nervous system in the progression of NDs. Importantly, intracellular lipid homeostasis is tightly regulated by copper (Cu) levels, and also post-mortem analyses of diseased brains have consistently shown elevated Cu concentrations within amyloid deposits in affected regions. These findings suggest a complex, interconnected axis involving metal dyshomeostasis, protein aggregation, and lipid imbalance.

In this context, we engineered chemically modified, plant-derived fluorescent carbon dots (PEI@HCDPEG; size = ~12 nm) with strong and selective Cu-chelating properties. The synthesised PEI@HCDPEG effectively inhibited Cu-induced protein aggregation by ~2.8 fold. Beyond their anti-aggregation effects, PEI@HCDPEG treatment significantly reduced intracellular LD accumulation (~1.25 fold), potentially by inhibiting lipid peroxidation and regulation of lipid metabolic pathways. Furthermore, lipidomic profiling by LC/MS analysis revealed a notable decrease in neutral lipid species, including cholesteryl esters (~1.5-fold) and triglycerides (~1.2-fold) after PEI@HCDPEG treatment. Additionally, the average LD diameter was markedly reduced from ~7 µm to ~3 µm, indicating restoration of lipid homeostasis. Comparable outcomes were also observed in in vivo C. elegans models. Collectively, these findings highlight the potential of multi-dentate, metal-specific chelating nanoparticle systems such as PEI@HCDPEG as promising therapeutic candidates for NDs, supporting the advancement of strategies aligned with the "metal hypothesis" of neurodegeneration. (**Fig. 1**).

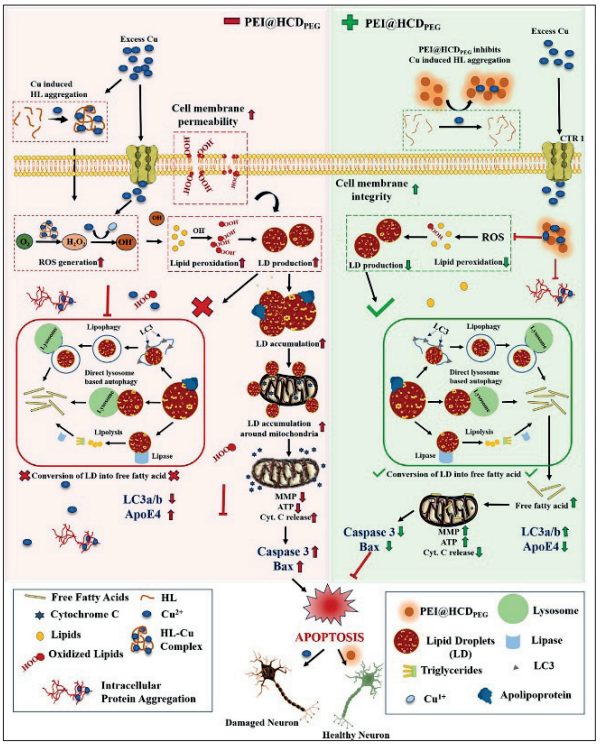


Fig. 1 Schematic representation of proposed mechanism underlying the cytoprotective effect of PEI@HCD$_{PEG}$ against Cu2^{+} induced toxicity. © Willey, 2026.

Nanoengineered Polyphenol–Quantum Dot Conjugates Suppress Biofilm Protein–Aβ42 Heterotypic Fibrillogenesis, Restore Synaptic Function, and Reduce Apoptosis in Alzheimer's Disease

The gut microbiota has been implicated in the progression of neurodegenerative disorders such as Alzheimer's disease (AD), partly through the action of microbial metabolites, including amyloid-like proteins present in bacterial biofilms. One such example is the curli protein produced by *Escherichia coli*. In this study, two primary objectives were addressed: (i) to investigate how cross-kingdom bacterial

biofilm proteins influence the aggregation and neurotoxicity of Aβ42 peptides, and (ii) to evaluate whether a nanochaperone composed of hydrophobic sheets and hydrophilic polyphenolic groups can inhibit such cross-seeded aggregation. To this end, gallic acid-functionalized molybdenum disulfide quantum dots (GA@MoS_2 QDs; ~9.6 ± 4.2 nm) were synthesized and characterized using spectroscopic and microscopic techniques. These nanostructures demonstrated a ~1.84-fold reduction in *E. coli* biofilm thickness, suggesting effective interaction with biofilm constituents. The presence of curli protein within the biofilm was validated through dot blot and MALDI-TOF analyses. Biophysical assays revealed that isolated *E. coli* biofilm proteins significantly enhanced heterotypic Aβ42 aggregation (~6.76-fold increase). In contrast, treatment with GA@MoS_2 QDs markedly inhibited this process, resulting in an approximately 9.49-fold decrease in Aβ42+ECBFP fluorescence relative to untreated aggregates. *In vitro* experiments using SH-SY5Y neuronal cells showed that heterotypic aggregation induced elevated reactive oxygen species (ROS) levels, increased intracellular calcium influx, and triggered apoptosis. Notably, these pathological effects were substantially attenuated in the presence of GA@MoS_2 QDs. Furthermore, the neuroprotective potential of these quantum dots was corroborated *in vivo* using the model organism *Caenorhabditis elegans*. Collectively, these findings highlight the critical role of bacterial amyloid proteins in promoting Aβ42 aggregation and suggest that targeting cross-kingdom co-aggregation mechanisms may represent a promising therapeutic strategy for early-stage AD. (**Fig. 2**).

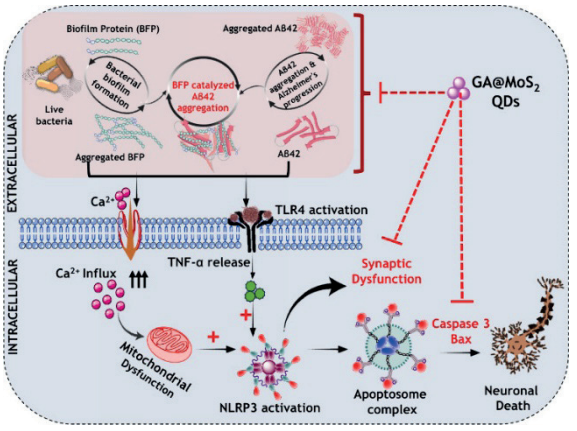


Fig. 2 Polyphenol–Quantum Dot Nanoconjugates Suppress Biofilm Protein–Aβ42 Co-Fibrillogenesis and Rescue Synaptic Transmission in Alzheimer's Disease. © ACS, 2025.

Relevant Publications:

- Small. (2026), 22, e08683.
- ACS Chemical Neuroscience. (2025), 16, 4458–4478.

Research group: Mr. Trilok Chand Saini, Mr. Manik Bathla, Ms. Anjali Nisha, Mr. Rahul Bhardwaj, Ms. Nandini, Ms. Harpreet Kaur, Ms. Anchal Thakur and Mr. Jatin Kumar.

Rohit Joshi, Principal Scientist
rohit.joshi@csir.res.in
Plant Tissue Culture, Stress Physiology

Our group focuses on developing highly efficient *in vitro* protocols for the mass propagation of economically and medicinally important high-altitude plants and studying their molecular regulation during *in vitro* organogenesis and during abiotic stress.

Development of a high-efficiency protoplast isolation and transient expression system in high altitude endangered medicinal plants

An efficient protocol for protoplast isolation was optimized from micropropagated *Picrorhiza kurrooa*, an endangered Himalayan medicinal herb. Different enzymatic concentrations and physical parameters were evaluated to maximize yield and viability. The combination of 2% cellulase, 0.6% macerozyme, 0.6 M mannitol, and 4 h dark incubation produced the highest yield of 2.9 × 10^7 protoplasts g^{-1} fresh weight with 88.04% viability. Transient transformation with 40% PEG4000 achieved 27.33% efficiency (Fig. 1). Nuclear localization of the PkWOX11–GFP fusion protein confirmed the reliability of this system for genome-editing applications.

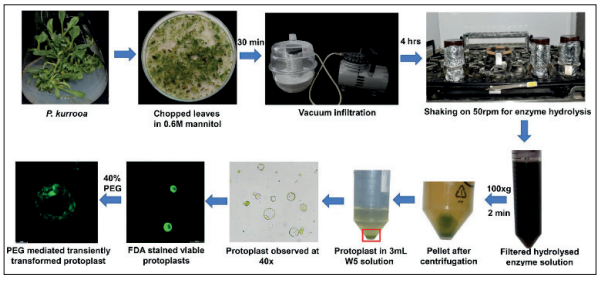


Fig. 1 Schematic representation of the optimized protocol for protoplast isolation and transient transformation system from leaves of *in vitro*-raised *P. kurrooa*.

Further, an efficient *in vitro* regeneration protocol for *N. jatamansi* was developed, achieving the highest callus induction (93.33% ± 4.08%) on MS medium with 1.5 mg/L TDZ and 1 mg/L NAA. A combination of 1.5 mg/L TDZ and 0.1 mg/L NAA produced 68% ± 4.89% regeneration with the highest shoot number (6.4 ± 0.50) at 15°C ± 2°C. GC–MS analysis showed higher metabolite accumulation in regenerated leaves. An *Agrobacterium tumefaciens*-mediated transformation system was optimized, with *GV3101* showing higher efficiency. Virus-induced gene silencing successfully confirmed functional genomics applications in *N. jatamansi*. **(Fig. 2)**.

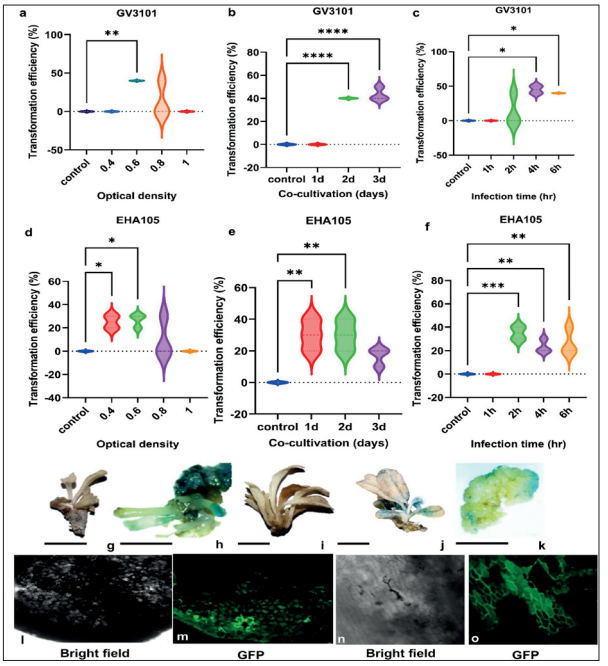


Fig. 2. Transient genetic transformation of *N. jatamansi*.

Advancements in *in vitro* regeneration, metabolite enhancement, and AI-based modelling in the medicinal plant *Ferula assa-foetida*

An efficient micropropagation system was developed through indirect somatic embryogenesis. Callus induction from leaf explants was achieved on MS medium supplemented with 1.0 mg L^{-1} NAA combined with 1.5 mg L^{-1} Kn or 1.0 mg L^{-1} BAP. Somatic embryo development was optimized using 2.0 mg L^{-1} Kn and 0.05–0.1 mg L^{-1} IBA, and embryogenic stages were confirmed through SEM analysis **(Fig. 3)**. Maximum shoot proliferation occurred on MS medium containing 2.0 mg L^{-1} BAP and 0.2 mg L^{-1} NAA, while efficient rooting was obtained with 0.05 mg L^{-1} IBA. Regenerated plantlets were successfully acclimatized and genetic fidelity was validated using RAPD, ISSR, and SCoT markers together with flow cytometry. Differential expression of developmental and metabolic genes, i.e., *SERK2, WUS4, CUC3, HMGR1, PAL*1, and *TPS12*, highlighted their regulatory roles in organogenesis and secondary metabolism. Metabolite profiling of roots using UHPLC-DAD-QTOF-MS identified 57 metabolites, including coumaric acid, ferulic acid, and umbelliferone.

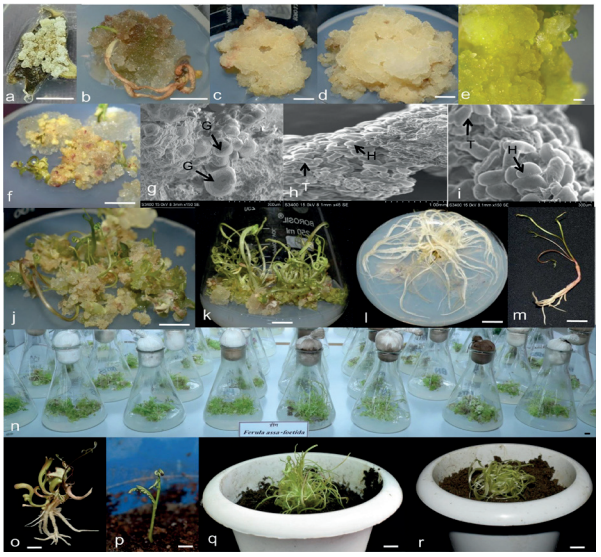


Fig. 3 Indirect somatic embryogenesis, shoot proliferation, root proliferation, and acclimatization in *Ferula assa-foetida*.

Furthermore, UV-C-mediated elicitation significantly enhanced phenolic and flavonoid accumulation, with maximum phenolic content (147.53 ± 1.10 µg mg^{-1}) at 25 °C under dark conditions **(Fig. 4a)**. To further optimize *in vitro* culture conditions, machine learning and deep learning approaches were evaluated, with convolutional neural networks achieving the highest predictive accuracy (87%) in identifying optimal combinations of plant growth regulators for somatic embryogenesis and shoot regeneration **(Fig. 4b)**. This integrated approach combining micropropagation, metabolomics, elicitation, and artificial intelligence provides a robust platform for large-scale propagation, conservation, and enhanced production of bioactive metabolites in *F. assa-foetida*, while also advancing future applications in functional genomics and plant biotechnology.

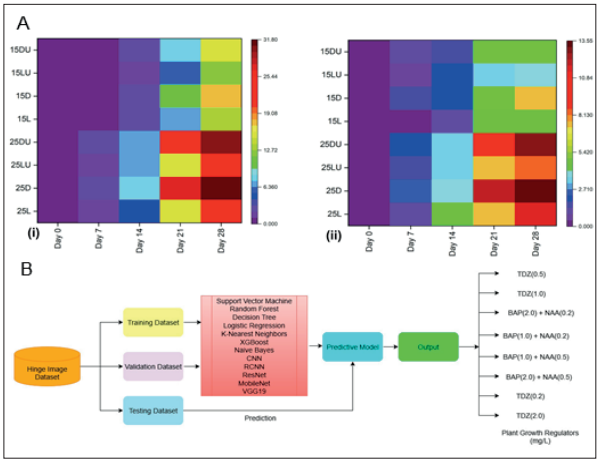


Fig. 4 (A) Growth Index of proliferative calli of *Ferula assa-foetida* cultured under variable UV light and temperature conditions. (B) The graphic illustration of the AI and ML-based optimization of somatic embryogenesis.

Delineating mechanisms of drought tolerance in *Crocus sativus*: Insights from ABA, Calcium, and Nitric Oxide treatments

Field experiments conducted in the Palampur region demonstrated the effects of irrigation, water deficit, and exogenous ABA application on *C. sativus* corms. Drought stress significantly reduced fresh and dry biomass, sprouting percentage, flower number, relative water content, photosynthetic efficiency, and chlorophyll fluorescence (Fv/Fm). Histological observations revealed reduced starch accumulation and enlarged root metaxylem cells under water deficit conditions. Increased transcript abundance of drought-responsive genes *DREB1, DREB2*, and *SnRK2* was observed. However, foliar application of ABA mitigated drought-induced damage by reducing lipid peroxidation and enhancing proline accumulation, chlorophyll content, and antioxidant activity **(Fig. 5a)**.

Additionally, the roles of the signaling molecules calcium (Ca^{2+}) and nitric oxide (NO) were examined using calcium chloride ($CaCl_2$) and sodium nitroprusside (SNP). Treatment with 50 mM $CaCl_2$ and 25 µM SNP significantly improved plant growth, restored chlorophyll and carotenoid levels, enhanced antioxidant enzyme activities (SOD and POD), and reduced electrolyte leakage under drought stress. Furthermore, elicitor treatments upregulated key drought-responsive genes, i.e., *DREB1/2, AREB1, NAC1, MYB37, bZIP23, DHN1*, and *SnRK2* **(Fig. 5b)**. Overall, this study provides comprehensive insights into the drought-tolerance mechanism in saffron and highlights the potential of hormone- and signaling-molecule-based strategies to improve stress resilience.

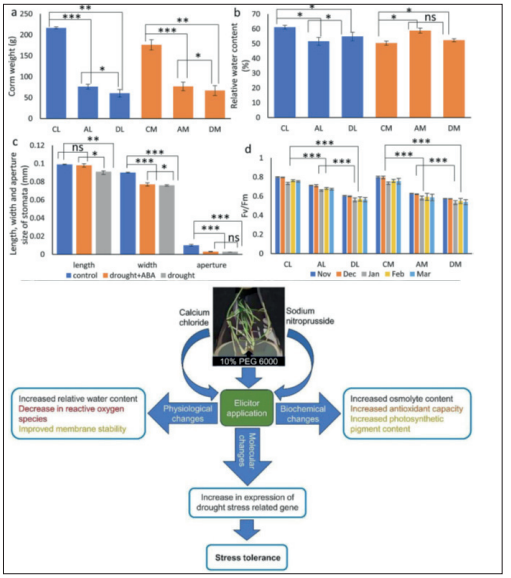


Fig. 5 (A) Impact of drought and drought + ABA on morphological and yield parameters, (B) Effects of $CaCl_2$ and SNP on PEG-induced drought stress.

Establishment of micropropagation and genome-wide identification of glyoxalase genes in *Phyllostachys pubescens*

An efficient tissue culture protocol was established for *Phyllostachys pubescens* using axillary buds as explants for shoot initiation, proliferation, rooting, and acclimatization. MS medium supplemented with 9.0 µM BAP and 1.0 µM mT produced the highest shoot proliferation (81.67 ± 7.38 shoots per explant), along with increased shoot length and leaf number. Root induction was most effective on MS medium supplemented with 2.5 µM IBA, achieving a rooting frequency of 66.63% and producing well-developed roots **(Fig. 6a)**. Regenerated plantlets were successfully acclimatized in a sand:soil:vermiculite (1:1:1) mixture, and genetic fidelity was confirmed using RAPD, ISSR, SCoT markers, and flow cytometry .

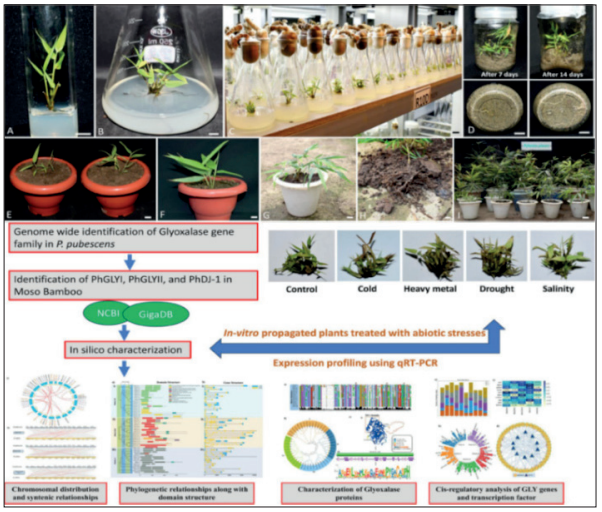


Fig. 6 (A) Complete protocol for mass scale micropropagation of *Phyllostachys pubescens*, (B) Schematic representation of genome-wide identification, characterization, and expression pattern analysis of the glyoxalase gene family.

Genome-wide analysis identified 52 glyoxalase genes, including 19 *GLYI*, 18 *GLYII*, and 15 *GLYIII* members, containing conserved glyoxalase, metallo-β-lactamase, and DJ-1/PfpI domains. Promoter analysis revealed numerous stress-responsive cis-elements, while expression profiling demonstrated significant upregulation of several genes under cold, drought, salinity, and heavy-metal stresses (Fig. 6b). Taken together, this study provides an efficient propagation system and insights into stress resilience in bamboo.

Relevant Publications:

- Drug Discover Today. (2026), 31: 104555.
- Plant Cell & Environment. (2026), 49: 840–857.
- BMC Plant Biology. (2025), 25:1364.

Research group: Dr Rohit Joshi, Dr. Kiran Devi, Mr. Ajay Kumar, Dr. Anita Kumari, Ms. Jhilmil Nath, Mr. Shubham Joshi, Ms. Suman Gusain, Ms. Khusbu Kumari, Ms. Suparna Mandal, Ms. Tanvi Gupta.

Shiv Shanker Pandey, Principal Scientist
shivpandey@ihbt.res.in
Plant-Microbe Interaction, Plant Adaptation and Plant Physiology

Our research group investigates the complex interactions between Himalayan medicinal plants and their associated microbial communities, with a particular emphasis on endophytes. We aim to harness these endophytic microbes as plant probiotics to promote growth, enhance the biosynthesis of valuable secondary metabolites, and improve plant resilience under stress conditions. In parallel, we explore the mechanisms underlying plant adaptation to challenging environmental stresses. We are also engaged in developing an efficient genome-editing platform for *Camellia sinensis* to facilitate targeted crop improvement.

Exploration of high-altitude plants' adaptation strategies for improved Carbon and Nitrogen utilization in food crops

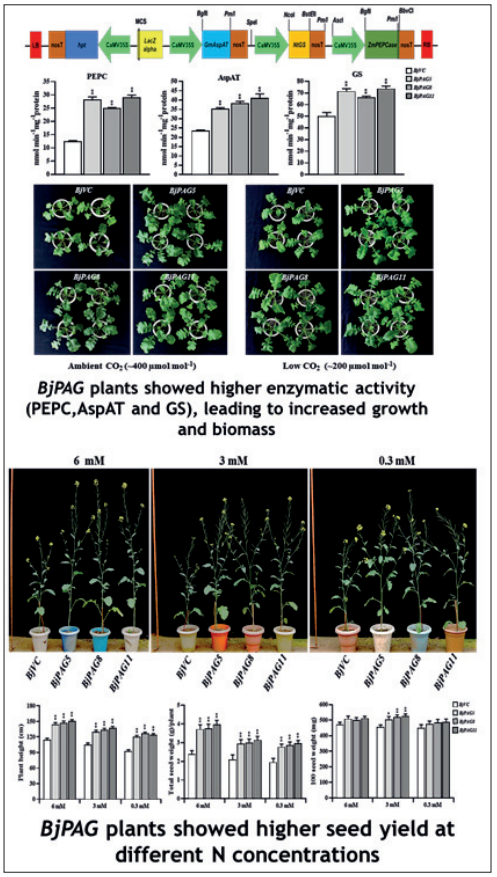


Fig. 1 Generation of *BjPAG* transgenic plants coexpressing *ZmPEPC* + *GmAspAT* + *NtGS*, selected enzyme activity analysis, growth under different CO_2 conditions, effect of different Nitrogen levels on plant growth and morphological & yield traits [Source: Mamta et al., Plant Biotechnology Journal (2026) 24(3):1110-1132].

We established that the coexpression of target genes (having increased expression at high altitude growing plants) such as phosphoenolpyruvate carboxylase (*ZmPEPC*), aspartate aminotransferase (*GmAspAT*), and glutamine synthetase (*NtGS*) in *Brassica juncea* could enhance Carbon (C) and Nitrogen (N) reutilization, and reduced photorespiratory loss, increasing plant performance in low CO_2 and different Nitrogen environments. The transgenic plants (*BjPAG*) exhibited improved growth, biomass, chlorophyll and carotenoid content, along with reduced anthocyanin and hydrogen peroxide levels under both ambient (~400 ppm) and low (~200 ppm) CO_2 conditions. Enhanced photosynthetic efficiency, CO_2 assimilation, and carbohydrate accumulation were also observed. Additionally, *BjPAG* plants showed better nitrogen utilization, with reduced ammonium accumulation and improved performance under varying nitrogen levels. Metabolic analysis confirmed increased flux towards key biomolecules. Overall, coexpression of these genes significantly improved C and N utilization, leading to higher photosynthesis, biomass, and seed yield (Fig. 1).

Mechanistic insight for a psychrophilic endophytic yeast mediated cold stress acclimation in plants

This study investigated the role of the psychrophilic yeast endophyte *Naganishia liquefaciens* ARY7, isolated from high-altitude cold desert plant *Arnebia euchroma*, in enhancing low-temperature (10°C) tolerance in *Arabidopsis thaliana*. ARY7 inoculation improved plant biomass, photosynthetic efficiency, starch accumulation, and reduced stress responses. It enhanced root development through auxin signaling and increased root colonization via exopolysaccharide (EPS) production. Elevated salicylic acid (SA) levels and upregulation of *SID2* and *PBS3* confirmed SA-mediated effects, further supported by improved growth in SA-deficient (*sid2*) mutants.

Downregulation of cold-responsive genes (*CBF*, *COR*, *RD29A*, *P5CS1*) indicated reduced stress sensitivity. Overall, we established that the yeast endophyte ARY7 confers cold tolerance through EPS-mediated colonization and modulation of auxin and SA pathways (Fig. 2).

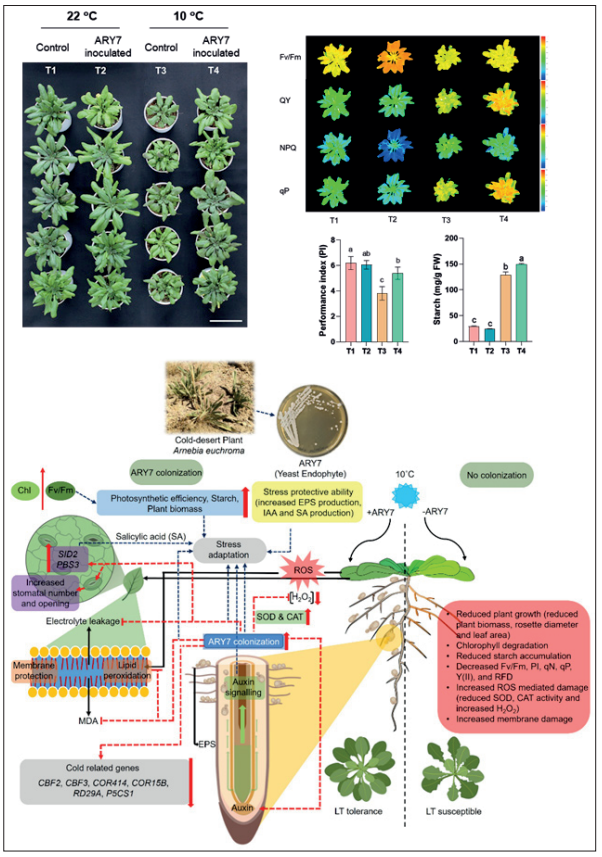


Fig. 2 Effect of low temperature on growth and photosynthetic parameters of ARY7 inoculated *Arabidopsis* plants and overview of ARY7-mediated improved cold acclimation. [Source: Bhardwaj *et al.*, Physiologia Plantarum (2025), 177: e70267].

Microbial formulation for enhanced yield of commercially important crops

An endophytes consortium-based microbial formulation was developed that has potential to enhance growth, biomass, and secondary metabolite yield in *Valeriana jatamansi*. The formulation also improves growth and biomass in food crops, offering dual applications in medicinal and agricultural sectors. Efficacy of formulation was also tested in multiple food crops such as spinach, coriander, radish, brassica, and MAP like marigold, showed beneficial effects on the tested crops. Expression of Interest (EOI) was floated on Institute's website and relevant stakeholders are showing interest in this formulation (Fig. 3).

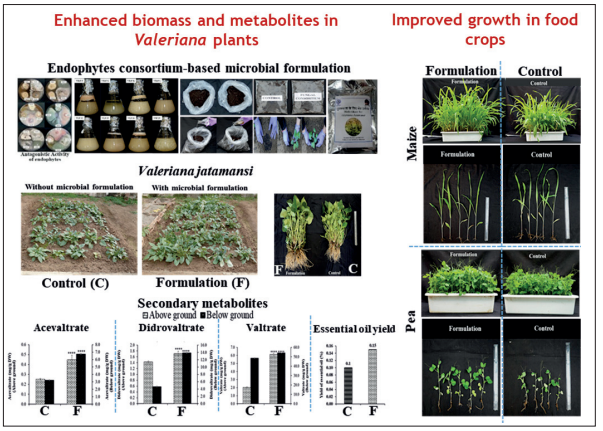


Fig. 3 Development of microbial formulation and its beneficial effect on *Valeriana jatamansi* and food crops (maize and pea).

Under genome editing of *Camellia sinensis*, RNP mediated protoplast editing was established. In the case of protoplast regeneration, we could establish the micro and mass calli formation from RNP transfected protoplast. In addition, to develop Cas9 free genome edited plants (with minimal regulatory constraints), we are developing a process of nanomaterial mediated RNP transfection, which is currently in progress.

Relevant Publications:

- Plant Biotechnology Journal. (2026), 24(3): 1110-1132
- Physiologia Plantarum. (2025), 177: e70267.

Research group: Sumeet Kaundal, Mamta, Manju Kumari, Ankita Thakur, Priyanka Bhardwaj, Jyoti Sharma, Nikhil Rawat, Vanshika Thakur, Aditi Sharma.

Ashish Rambhau Warghat, Principal Scientist
ashish.warghat@csir.res.in
Plant cell and tissue engineering; Aeroponic and Hydroponic farming

Plant cell and tissue engineering; Aeroponic and Hydroponic farming

Our cell and tissue engineering laboratory is working on development of alternative approaches using cambial cell culture, single cell culture, tissue culture systems and aeroponic and Hydroponic farming for specialized metabolites production of high-altitude Himalayan medicinal plants.

(A) Hydroponic cultivation improves plant growth and picrosides production in *Picrorhiza kurroa*

P. kurroa is an important medicinal plant known for its bioactive compounds, Picroside-I and Picroside-II, which exhibit hepatoprotective and anti-inflammatory properties. However, conventional cultivation methods, including tissue culture and open field farming, are limited by high costs, environmental constraints, low survival rates, and long cultivation cycles. Moreover, its endangered status restricts large-scale production, highlighting the need for efficient and sustainable alternative cultivation strategies such as hydroponics. To address these challenges, *in vitro* raised plants along with 3 and 6 month hydroponic cultivated plants were evaluated for morphological traits, biomass yield and secondary metabolite accumulation **(Fig. 1)**. The result indicated that 6 month hydroponic grown plants exhibited improved morphological performance, with maximum shoot length (17.4 cm), leaf number (18.2) and root length (14.4 cm). while 3 month plants exhibit highest leaf biomass (1.13 g FW; 0.11 g DW), 6 month plants exhibit highest root biomass (0.42 g FW; 0.03 g DW). UPLC-based quantification revealed that 3-month hydroponic leaf tissue accumulates maximum picroside-I (1.08%), whereas 6 month root tissue exhibited maximum picroside-II (2.16%) accumulation. Overall, hydroponic cultivation significantly improved plant growth, biomass yield and secondary metabolite production, highlighting its potential as an efficient system for large-scale production and commercial herbal formulations.

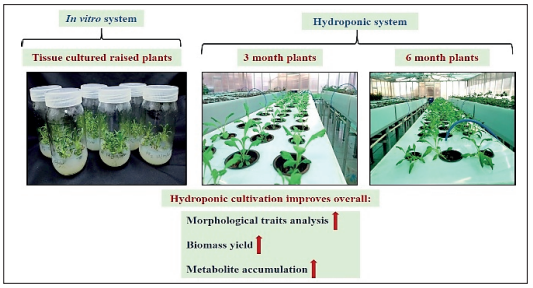


Fig. 1 Comparative overview of *in vitro* and hydroponic cultivation systems of *P. kurroa*.

(B) Establishment of stable cambial meristematic cells and dedifferentiated cell lines for secondary metabolite production in *Picrorhiza kurroa*

Due to limitations in natural propagation and increasing industrial demand of *P. kurroa*, *in vitro* culture systems such as cambium meristematic cells (CMCs) and dedifferentiated cells (DDCs) have been developed as sustainable alternatives for biomass and metabolite production. In the present study, healthy rhizome explants were selected and subjected to a comprehensive surface sterilization protocol, including sequential washing, detergent treatment, ethanol exposure, and sodium hypochlorite sterilization. The explants were further treated with a cutting solution, browning inhibition medium and osmotic regulators. Finally, the explants were thoroughly rinsed with sterile distilled water prior to culture initiation. The sterilized explants were inoculated onto Murashige and Skoog (MS) medium supplemented with picloram (5 mg/L) and thidiazuron (TDZ, 0.5 mg/L) for the initiation of both CMCs and DDCs (**Fig. 2**). Under these conditions, CMCs were successfully induced, characterized by small, uniform, and actively dividing meristematic cells with dense cytoplasm. In contrast, DDCs exhibited heterogeneous morphology and greater phenotypic variability. Comparative analysis indicated that CMCs displayed a more organized growth pattern, structural uniformity, and enhanced cellular stability relative to DDCs. Microscopic observations further revealed that CMCs possess relatively thinner and more regular cell walls compared to the irregular and variable cell wall structure observed in DDCs. Overall, both culture systems were successfully established; however, CMCs demonstrated

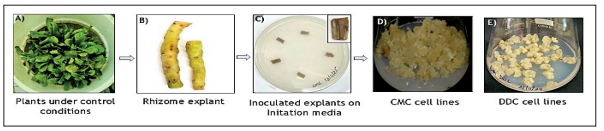


Fig. 2 Establishment of CMC and DDC cell lines from rhizome explant of Picrorhiza kurroa.

superior suitability for consistent and long-term secondary metabolite production with reduced variability, whereas DDCs were found to be more advantageous for rapid biomass proliferation.

(C) Elicitor-induced enhancement of growth and essential oil composition in *Valeriana jatamansi* cultivated in vertical aeroponics

Valeriana jatamansi is a perennial rhizomatous medicinal herb, commonly known as Indian valerian or Tagar. Its roots and rhizomes are rich in essential oil, a highly valued aromatic product widely used in the pharmaceutical industry. In the present study, the effects of a biotic elicitor (seaweed extract, SWE) (4.0 gm/L) and an abiotic elicitor (salicylic acid, SA) (100 µM) were evaluated on morphological traits, biomass yield, and essential oil accumulation of *V. jatamansi* under vertical aeroponic conditions (**Fig. 3**). Among both treatment and the control, SA exhibited the highest growth performance, with maximum shoot height (25.26 cm), leaf length (11.17 cm), leaf width (8.75 cm), leaf number (21.40), and root length (13.29 cm). Biomass accumulation was also enhanced under SA treatment. Leaf fresh weight showed a 1.22- and 1.08-fold. increase compared to the control and SWE treatments, respectively, while root fresh weight increased by 1.21- and 1.03-fold relative to the control and SWE. GC-MS analysis of the essential oil revealed a total of 25 volatile compounds. The highest concentrations of Patchouli alcohol (41.67%), Maaliol (5.93%), and δ-Guaiene (8.62%) were observed in SWE, SA, and control treatments, respectively. Overall, the results demonstrate that elicitation treatments significantly enhance plant growth and the volatile composition of essential oil in *V. jatamansi* under vertical aeroponic conditions.

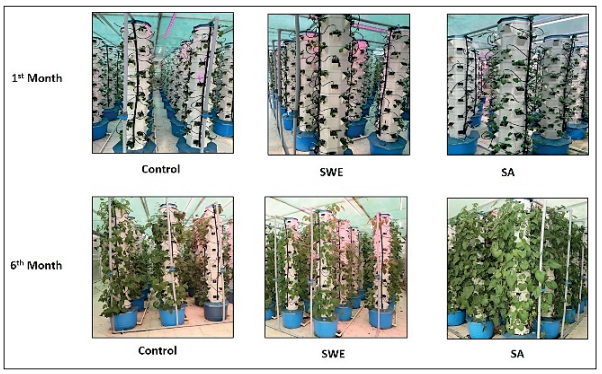


Fig. 3 Valeriana jatamansi cultivated under vertical aeroponics.

(D) Identification of *Dactylorhiza hatagirea* D. Don, Soo using DNA barcodes and development of embryo culture technique

Dactylorhiza hatagirea is an endangered and medicinal orchid. DNA barcoding using the ITS region successfully discriminated *Dactylorhiza* species, demonstrating its effectiveness for species identification. Also in study, mature seeds were cultured on three nutrient media: BM, LD and ½ strength MS medium. The best results were observed on BM-1 medium augmented with 1.5 mg L−1 IBA (indole-3-butyric acid) and 0.05% AC (**Fig. 4**). Activated charcoal proved beneficial in inducing seed germination in the BM-1 and LD media; it showed a decrease in germination frequency on ½MS medium, revealing species-specific requirements of nutrients. These results provide crucial insights into the in vitro propagation and conservation of *D. hatagirea*.

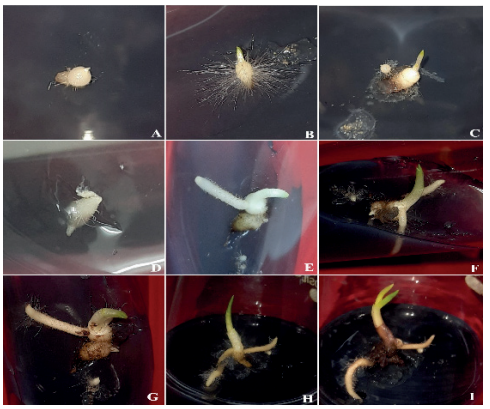


Fig. 4 *In vitro* propagation of *Dactylorhiza hatagirea* D. Don.

Relevant Publication:

- Plant Biotechnology Reports. (2025) 741–761.
- In Vitro Cellular & Developmental Biology–Plant. (2025), 61: 1202–1214.
- In Vitro Cellular & Developmental Biology–Plant. (2026), https://doi.org/10.1007/s11627-026-10647-4.

Research group: Kanika, Amit Kumar, Shashi Rani, Seema Devi, Jasmine Sharma, Jyotsna Pathania, Pawan Kumar, Praveen Kumar, Manish Kumar

Arun Kumar, Principal Scientist
Arun.kumar02@csir.res.in
Molecular Biology and Biochemistry

The research interests and long-term goals of our lab are to identify enzymes with novel functions and exploit them in the healthcare and agriculture industry. In line with these goals, we are currently focusing on the following projects.

Chitin and cellulose active Lytic polysaccharide monooxygenases (LPMO) from *Bacillus spp.* PCH94

The global shift from relying on natural resources to utilizing products derived from biological waste has accelerated in response to the urgent demand for sustainable energy solutions. LPMOs have emerged as promising enzymes for enhancing the biomass deconstruction process. These enzymes utilize monocopper ions at their active sites to oxidatively cleave the C1 and C4 positions of glycosidic bonds in polysaccharide chains. This oxidative cleavage disrupts the crystalline structure, thereby increasing the accessibility of glycosyl hydrolases to the substrate. Therefore, synergistic interaction significantly improves the conversion of complex polysaccharides into simple fermentable sugars. An LPMO encoding gene (referred as LPMO^{Bl}) was identified from the genome of *Bacillus spp.* PCH94 through genome mining. LPMO^{Bl} was successfully cloned and expressed in *E. coli* BL21 cells. The purified LPMO^{Bl} exhibited monooxygenase and peroxygenase activities, with optimal activity at pH 7.0 and 30°C (Fig. 1). The kinetic parameters K_m and V_{max} were 2.31 ± 0.25 mM and 20.36 ± 0.5 Units/mg respectively. LPMO^{Bl} displayed high thermal stability with a melting temperature (T_m) of 74.4± 0.85. Furthermore, enzyme resulted in oxidative cleavage of chitin and PASC. Additionally, a pilot-scale production process for LPMO^{Bl} was developed using 15L fermentor.

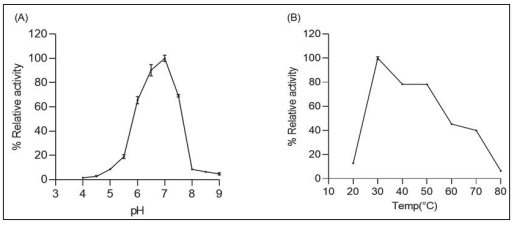


Fig. 1 (A) Effect of pH on the monooxygenase activity of LPMO^{Bl}, determined using the Amplex Red hydrogen peroxide/peroxidase assay at room temperature. (B) Effect of temperature on enzyme activity, measured at the optimal pH. LPMO^{Bl} exhibited maximum activity at pH 7.0 and 30 °C. Data represent relative enzyme activity normalized to the maximum observed activity.

Bioprospecting highly thermostable mitochondrial superoxide dismutase

Manganese superoxide dismutase (MnSOD), plays a vital role in scavenging superoxide anions ($O_2^{\bullet-}$) produced during the electron transport chain. Owing to its high dismutation potential, MnSOD finds applications in several industries. Here, we identified a thermostable MnSOD from *Lantana camara* (*Lc*MnSOD). Full-length cDNA encoding *Lc*MnSOD was cloned and heterologously expressed in *E. coli*. *In silico* prediction of 3D structure revealed alpha-helix dominant structure (Fig. 2A) with active site residues (His49, His97, Asp185, and His189) (Fig. 2B). The purified protein exhibited a low Michaelis-Menten constant (K_m) of 0.026 ± 0.001 µM and a maximum velocity (V_{max}) of 266.29 ± 10.42 Units/mg, and was functional at a broad pH (5.0-9.0) and temperature range (4-80 °C) (Fig. 3B), with a pH and temperature optima of 7.8 and 10 °C, respectively. Recombinant *Lc*MnSOD was resistant to thermal inactivation at 80 °C (k_d = 0.0063 ± 0.0004 min^{-1}, $t_{1/2}$ = 116.48 ± 13.96 min) (Fig. 3B). Molecular dynamics (MD) simulations revealed that *Lc*MnSOD maintains its activity at high temperatures by maintaining a dense hydrogen-bonding network, robust hydrophobic core, and structural integrity of its catalytic site, ensuring accessibility of substrate-binding residues. *Lc*MnSOD is astonishingly stable to varying concentrations of denaturants, inhibitors and reducing agents, confirming its structural robustness. Such thermostable and chemically resistant properties render *Lc*MnSOD a strong candidate for various industrial and biotechnological applications.

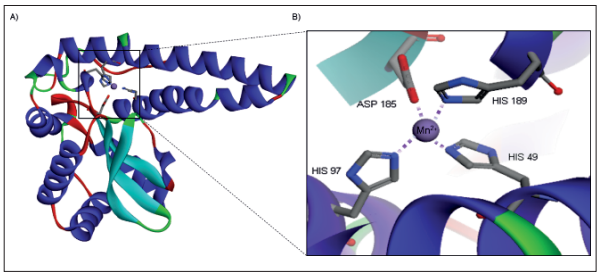


Fig. 2 A) Structure prediction of *Lc*MnSOD A) 3D structure predicted using AlphaFold Protein Structure Database B) active site of *Lc*MnSOD showing metal co-factor Mn (Manganese) with active site residues (His49, His97, Asp185, and His189)

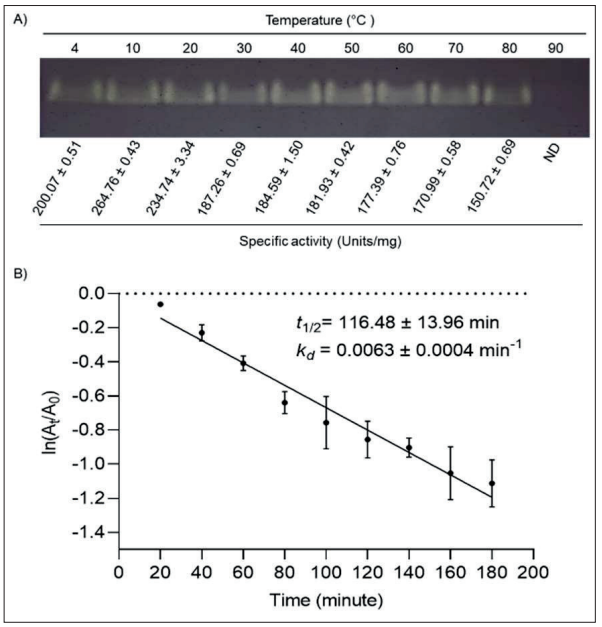


Fig. 3 A) Zymogram and specific activity analysis of *Lc*MnSOD after heating at varying temperatures. B) Thermal inactivation kinetics of recombinant *Lc*MnSOD at 80 °C.

Characterization of Recombinant Mannanase Enzyme(s) from the Himalayan Microbial Resources for Biomass Valorisation

Lignocellulose degrading enzymes holds significant position in circular bioeconomy due to their ability to valorise plant biomass to value added products. Mannanase is one such enzyme that is involved in hydrolysis of mannan, a hemicellulose majorly found in softwood. Among these endo mannanase is gaining prominence owing to their ability to form Manno oligosaccharides (MOS). In this study, the putative mannanase-producing bacterial isolate FV4, identified as *Paenibacillus* sp., maintained in our laboratory, was subjected to whole-genome sequencing. The assembled genome comprised 7.2 Mb. Subsequent bioinformatic analyses led to the identification of three putative mannanase-encoding genes, designated as PbMan1, PbMan2, and PbMan3, within the genome sequence of *Paenibacillus* sp. These genes were cloned and expressed in pET28a and pET47b vector transformed in *E. coli* BL21(DE3). Among these, PbMan1 was purified using a two-step chromatographic approach involving anion-exchange chromatography (Q Sepharose) followed by hydrophobic interaction chromatography (Phenyl Sepharose), yielding a ~55.2 kDa protein with a specific activity of 59.1 U/mg. The enzyme was biochemically characterised and it displayed optimal activity at pH 6 and 40°C. The kinetic parameters, K_m & V_{max} determined by Lineweaver-Burk method were 0.093mM and 60.9U/ml respectively. The potential of PbMan1 for MOS synthesis was further evaluated by thin-layer chromatography using Locust bean gum (LBG) as substrate. (Fig 4)

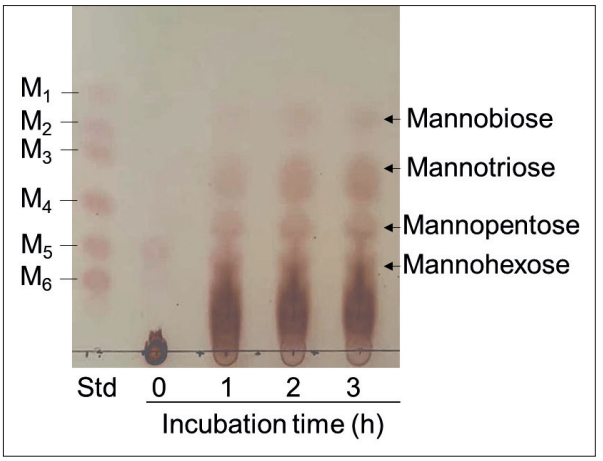


Fig. 4 TLC analysis of hydrolysis of LBG by PbMan1 at different time points. Std, standard oligomers including mannose (M1), mannobiose (M2), mannotriose (M3), mannotetraose (M4), mannopentaose (M5) and mannohexose.

Research group (Left to Right): Akshita Goel, Dr. Kavita Rana, Asheesh Kumar, Dr. Arun Kumar, Dr. Neha Kumari, Sunanda Jassal, Mahima Chauhan, Himanshu, Naveen Kumar

Sarita Devi, Senior Scientist
sarita.devi@csir.res.in
Microbiology and Fermentation Technology

The research group in our laboratory is engaged in the systematic exploration of diverse microbial resources isolated from ethnic fermented foods and environmental niches of the cold desert regions of the Western Indian Himalaya. The primary objective is to identify and characterize novel microorganisms with potential applications in the development of probiotic-based functional foods and the production of thermophilic microbial enzymes. These investigations hold significant promise for both industrial and societal advancement. The isolated microbial strains can be harnessed for the production of value-added biomolecules, including pharmaceuticals, and for improving food processing technologies. In particular, thermostable enzymes derived from these microorganisms have attracted considerable attention due to their enhanced stability, superior catalytic efficiency, and greater ease of production and optimization compared to plant- and animal-derived enzymes. Such properties make them highly suitable for diverse industrial applications. Furthermore, the development of probiotic-based nutraceuticals from indigenous microbial resources offers a sustainable approach to improving human health. These functional foods have the potential to enhance gut health, strengthen immunity, and address malnutrition, particularly among communities residing in high-altitude regions. Overall, this research contributes to the advancement of biotechnology-driven solutions for food security, healthcare, and industrial innovation.

Microbial production of Bile salt hydrolase enzyme

The samples of various ethic fermented products were collected from different high-altitude regions of Western Himalaya (Lahaul and Spiti of Himachal Pradesh and Ladakh). Potential probiotic from these foods were screened using standard protocols and probiotic attributes as described in the guidelines given by World Health Organisation (WHO), 2002. For preserving isolated colonies, Nutrient Agar and selective media MRS Agar stabs were prepared and stored at 4°C and glycerol stocks of all isolated samples made and kept at -80°C for future use and sub culturing is done periodically. Till now, we have screened some potential probiotics for cholesterol lowering properties qualitatively as well as quantitatively under standard aerobic fermentation conditions. For the detection of Bile salt hydrolase, the BSH activity test was adapted from González et al. (2014). The bile salt hydrolase activity of overnight-grown isolates was examined by streaking them on an MRS agar plate supplemented with 0.37 g/l of CaCl2 and 0.5% (w/v) sodium salt of Tauro deoxycholic acid (TDCA; Sigma, USA). For 72 hours, plates were incubated at 37°C. The bacterial bile salt hydrolase activity was shown by the precipitation zone around colonies (Fig. 1).

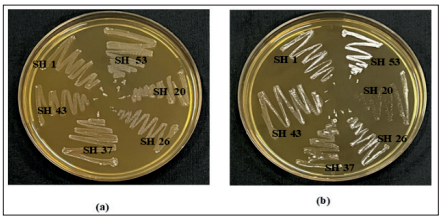


Fig. 1 Plate assay for bile salt hydrolase (BSH) activity of isolates determination in MRS agar Control (a), MRS agar with taurodeoxycholic acid of sodium salt (0.5%) and CaCl2 (0.37 g/l) Test (b).

Thermostable pectinase enzyme from Himalayan Geothermal Belt, Ladakh, India

As part of ongoing investigations, several microbial isolates have been screened and characterized for enzyme production, particularly pectinase. Molecular identification of selected high-performing isolates was carried out using 16S rRNA gene sequencing, which revealed the dominance of thermophilic genera such as *Geobacillus*, *Parageobacillus*, and *Anoxybacillus*, along with mesophilic *Bacillus* species. These findings highlight the presence of robust microbial candidates capable of thriving under extreme environmental conditions and producing industrially important enzymes. Further, a high-yielding isolate *Geobacillus* (PuW4) was selected for detailed biochemical and genomic investigations. Partial purification of pectinase from the selected isolate was achieved using ammonium sulfate precipitation and solvent-based methods (ethanol and acetone). Among these, acetone precipitation (1:1 ratio) resulted in the highest specific enzyme activity, indicating its effectiveness in enzyme recovery. Subsequent purification using gel filtration chromatography significantly enhanced enzyme

purity and activity. The molecular weight of the purified enzyme was confirmed through SDS-PAGE analysis (Fig. 2).

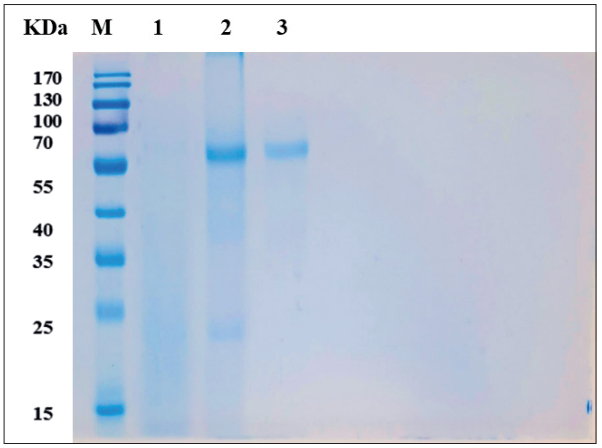


Fig. 2 SDS-PAGE showing protein profile: Lane M Marker, Lane 1 – Crude extract, Lanes 2 Acetone precipitated protein sample, Lanes 3 Purified protein.

These results demonstrate the potential of thermophilic microbes as efficient sources of stable and active enzymes. To gain deeper insights into the genetic basis of enzyme production, whole-genome sequencing of the isolate PuW4 was performed using a combination of Illumina and Nanopore sequencing platforms. The assembled genome exhibited high completeness and coverage, enabling comprehensive annotation and functional analysis (Fig. 3). Genome annotation revealed the presence of genes associated with carbohydrate metabolism, amino acid metabolism, energy production, and biosynthesis of secondary metabolites, indicating its metabolic versatility and industrial relevance.

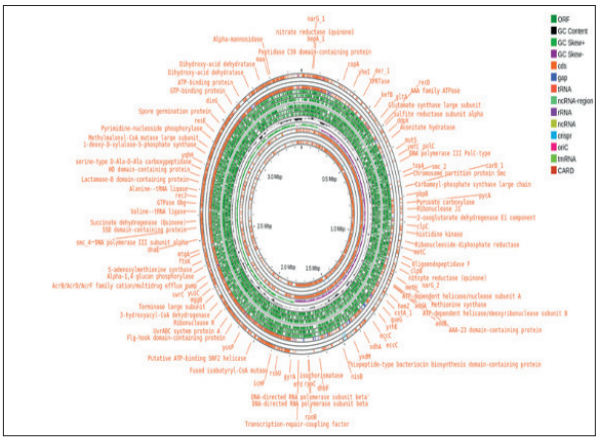


Fig. 3 CGView genome map of PuW4.

The outcomes of this research have far-reaching implications for both industry and society. Thermostable enzymes derived from such microorganisms are highly valued in industrial processes due to their stability, efficiency, and ease of production compared to plant- and animal-derived enzymes. Additionally, the development of probiotic-based nutraceuticals from indigenous microbial resources can significantly contribute to improving human health by enhancing gut microbiota, boosting immunity, and addressing malnutrition, particularly in high-altitude communities. Overall, this research not only advances our understanding of microbial diversity in extreme environments but also supports the development of sustainable biotechnological solutions for food, health, and industrial applications.

Relevant Publications:

- Food Safety and Risk. (2026), https://doi.org/10.1186/s40550-026-00136-2.

Research group: Kumari Shanu, Ms. Shalini Kumari, Ms. Geetanji, Ms. Pragya Bardewa, Mr. Puneet, and Mr. Abhishek Kumar

Vishal Sharma, Scientist
vishal.sharma@csir.res.in
Plant Tissue Culture

The focus of our lab is to develop an efficient *in vitro* mass-propagation system for high-value cash crops and industrially important medicinal plants.

Effect of different surface sterilization treatments on aseptic culture establishment in blueberry

Blueberry is a high-value exotic crop with increasing demand due to its nutritional and economic importance. India imported approximately 20,000 tonnes of blueberry fruit in 2025. Very recently, farmers started blueberry cultivation in India using imported planting material. Traditionally, blueberry plants propagate through stem cuttings; however, the method is not feasible to meet the demand for planting material. The lack of quality, disease-free, and uniform planting material limits large-scale cultivation in India. Therefore, development of reliable and scalable tissue culture-based propagation systems is essential to support commercial cultivation, reduce imports, and enhance farmer income.

In the current study surface sterilization protocol was optimized for 4 different varieties of blueberry. Maximum uncontaminated explants (>90%) were observed in all the varieties when treated with bavistin (0.1%) and streptomycin (0.1%) for 15 minutes followed by $HgCl_2$ (0.1%) for 8 minutes. However, survival at this treatment was low in all varieties due to toxicity caused by sterilants. Different survival rate was observed in all the varieties. Maximum survival was achieved in Emerald, Biloxi and Misty, when their explants were treated with bavistin (0.1%) and streptomycin (0.1%) for 12 minutes followed by $HgCl_2$ (0.1%) for 8 minutes. This treatment leads to 80.12 % survival rate of 'Emerald' variety. Similar observations were recorded in 'Biloxi' and 'Misty' with highest survival rate of 73.88% and 77.12%, respectively. 'Legacy' variety had a different observation from the other three varieties. Explants could not survive the elevated sterilant treatment. Therefore, maximum survival rate of 28.28% was recorded in treatment combination of Bavistin + Streptomycin (10 min) followed by $HgCl_2$ (5 min) **(Fig. 1)**. It has been observed that long-term exposure to mercuric chloride results in the browning of explants.

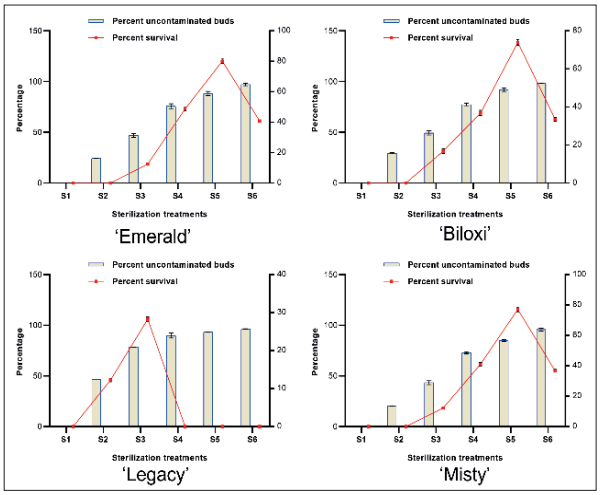


Fig. 1 Effect of different concentrations and durations of surface sterilants on percent uncontaminated explants and survival in different varieties of blueberry.

Effect of different media on aseptic culture establishment in different varieties of blueberry

In our results, WPM supplemented with zeatin showed the maximum percent bud establishment, indicating the potential of zeatin to form adventitious shoots in blueberry genotypes in *in vitro* conditions. The type and concentration of cytokinin significantly affect the establishment of cultures. Also, the response of each variety differs with the type and composition of growth regulators. WPM supplemented with 2 mg/l of zeatin was found to be the most effective medium for the establishment of *in vitro* cultures in all four varieties of blueberry with highest culture establishment of 72.28% in 'Emerald' followed by 71.25% in 'Biloxi'. Blueberry varieties 'Legacy' and 'Misty' had significantly lower establishment rates of 48.33% and 42.55%, respectively on the same composition of media (WPM+ 2mg/l zeatin). MS medium was not found suitable in all the varieties of blueberry with highest culture establishment of 18.06% in case of 'Emerald'. Overall growth rate of 'Legacy' and 'Misty' was found to be low as compared to 'Emerald' and 'Biloxi'. It was found that when the concentration of zeatin in the medium was increased to 4 mg/l, callusing was observed on the base, which hindered the shoot growth. Half-strength WPM was also used, which significantly

reduced the *in vitro* culture establishment rate in all four genotypes of blueberry **(Fig. 2)**.

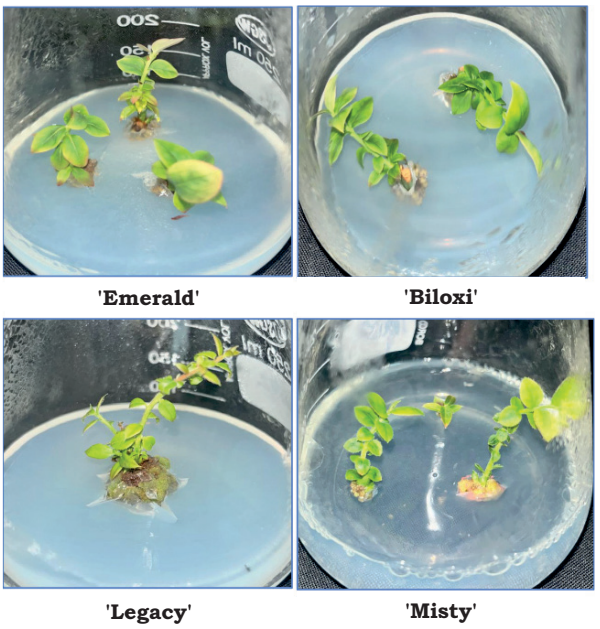


Fig. 2 *In vitro* establishment of aseptic cultures using nodal explants in different varieties of blueberry.

The current research provides the valuable insights on the role of different surface sterilants and media combinations of the establishment of *in vitro* cultures in blueberry. Further, optimization of different concentrations and combinations of phytohormones will be evaluated for *in vitro* shoot multiplication. The completion of this study will provide a suitable and optimum protocol for mass production of quality planting material in blueberry for commercial cultivation in India.

Research group (Left to Right): Dr. Kapil Deswal, Mr. Dixant Chaudhary, Dr. Vishal Sharma, Ms. Prerna, Ms. Sanjna Kumari.

CENTRE FOR HIGH ALTITUDE BIOLOGY (CeHAB)

CENTRE FOR HIGH ALTITUDE BIOLOGY (CeHAB) (ESTBL. 2011)

Location: Ribling, V.P.O. Tandi, Lahaul & Spiti (32°34'13.9"N, 76°58'32.0"E, 3450 masl (11,200ft)
Area: 20 ha (50 acres)

Mission: Connect to Innovate for Ecology, Economy and Societies of Higher Himalayas through Fundamental and Industrial Research.

Progress of Work: The progress made under the specified objectives is given as follows: -

(I) Mapping and bioprospecting of genetic resources of high altitudes

(i) The dominant plant species (113 nos.) occurring in high elevation eco-region of western Himalaya were studied to understand how elevation & aspect shape key plant traits related to resource use and competition and investigated. Such a trait covariation dataset revealed that in high-elevation Himalayan region, aspect outweighs elevation in shaping plant functional traits.

(II) Study and predict the effects of climate change and understanding adaptation strategies of high altitude plants.

(i) At our alpine Long Term Ecological Research (LTER) site at Rohtang, we continued our studies of manipulating snow cover to induce 'Early Snow-melt (ES)' during the start of a growing season. This year we analysed the effect of changes in snow-melt timing on species and functional diversity of alpine plant communities and found that experimental early snow-melting caused increase in both species & functional diversities with more pronounced effects at upper elevations.

(ii) In the experiment setup to study the adaptation of *Juniperus polycarpos*, a coniferous tree occurring in southern slopes of Lahaul Himalaya, to high UV radiation and low temperature, it was found that advanced freezing tolerance due to full exposure to intense UV-A/B stressors under ambient conditions. Our preliminary observations suggest that UV-B exposure might act as a cue for early cold acclimation in *J. polycarpos*.

(iii) A total of 52 species representative of alpine region of trans-Himalaya were assessed for their thermo-tolerance ability where was found to range from 44.9°C to 65.9°C, highest in graminoids followed by forbs and rosettes. Further, thermal safety margins (TSMs) ranged from 20.3°C (*Malva neglecta*) to 40.5°C (*Calamagrostis emodensis*) for most of the species, and were found to be much higher than the daily maximum leaf temperature recorded through thermal imaging during the study period.

(III) *Ex situ* conservation of native, endemic & threatened plants including establishment of conservatories

(i) Conservation of *Sinopodophyllum hexandrum* and *Nardostachys jatamansi* through Tissue Culture

P. hexandrum a perennial, rhizomatous medicinal plant is highly valued for its rhizomes, which are widely used in anticancer formulations and other therapeutic applications. It is classified as Endangered under IUCN criteria (A2bd+3cd+4cd, version 3.1). its slow growth cycle, requiring five to seven years to reach maturity, coupled with irregular flowering and fruiting, results in poor natural regeneration. The species is under severe threat due to excessive harvesting driven by sustained market demand. Additional pressures such as habitat degradation, deforestation, and climate change have further accelerated its decline. Population assessments indicate a reduction of over 50% in the past 21 years (approximately three generations), and this declining trend is expected to continue if current exploitation levels persist. There is an urgent need for development of sustainable harvesting practices and cultivation strategies to ensure its long-term conservation and availability. With these in view, an effort is underway to standardize in vitro protocols for its propagation (c).

(ii) Tissue culture approaches were employed to conserve *N. jatamansi* under controlled conditions, supporting its conservation and mass multiplication.

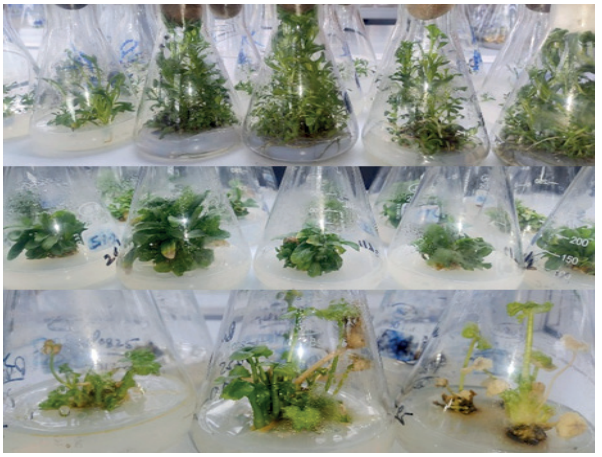


Fig. 1 En masse in vitro propagation of *P. kurroa* (a), *N. jatamansi* (b) and *S. hexandrum* (c).

(iii) Establishment & Enrichment of Field Gene Bank (FGB) at Ribling

The FGB established at CeHAB now includes more than 40 threatened plant species with multiple accessions. The FGB was enriched with more accessions for various species such as Eremurus himalaicus, Arnebia euchroma, Colchicum luteum etc. Conservation and acclimatization activities during this year focused on medicinal important species such as *Arnebia euchroma, Eremurus himalaicus, Carum carvi, Angelica glauca, Polygonatum cirrhifolium, Allium carolinianum, A. negianum, Heracleum candicans, Sinopodophyllum hexandrum, etc.* Furthermore, conserved plants were characterized for their morpho-biochemical traits which is a source of quality planting materials for our experiments and re-introduction program in their natural habitats.

Conservation of raised nursery seedlings of *A. euchroma*

Germplasm conservation of Eremurus himalaicus Baker, Allium caroliniamum Redoute, Carum carvi L. and Polygonatum cirrihifolium (Wall.) Royle.

Further, multiple accessions of woody plant species (*Rosa webbianum*, *Salix denticulata*, Crataegus oxyacantha, *Fraxinus xanthoxyloides*) were also added to the FGB. Their cuttings were planted in the poly-sleeves for their propagation and establishment of nurseries.

Seed Bank Repository: This year the repository was enhanced with addition of accessions of 10 species viz., *Carum carvi, Angelica glauca, Sinopodophyllum hexandrum, Aconitum heterophyllum, Saussurea costus, Inula racemosa, Eremurus himalaicus, Allium carolinianum, Allium negianum, Heracleum candicans*. A total of 3.920kg of seeds of *Angelica glauca, Aconitum heterophyllum, Sinopodophyllum hexandrum, Carum carvi, Saussurea costus, Inula racemosa* produced at our plant conservatory were distributed to forest department at Keylong division for rewilding purpose.

(IV) To develop strategies for conserving and promoting high altitude bio-resource.

(A) Enhancing seed yield of *Bunium persicum* through optimization of tuber size and nutrient management

Bunium persicum (Boiss.) faces cultivation constraints due to deep seed dormancy and low productivity. Therefore, an experiment was conducted at CeHAB to evaluate the effects of tuber size and vermicompost-based nutrient treatments enriched with bacterial consortium on growth, seed yield, essential oil (EO) yield and EO composition. The results revealed that large-sized tubers with 100% N supplied through vermicompost recorded superior performance in terms of growth and reproductive parameters, and seed yield. However, the integrated application of 75% N through vermicompost with bacterial consortium also gave statistically equivalent results, indicating that microbial inoculation can maintain productivity while improving nutrient-use efficiency (Fig. 2).

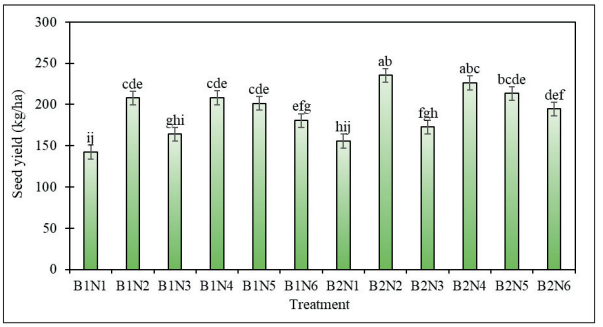


Fig. 2. Effect of tuber size and nutrient management seed yield of B. persicum.

Analysis of EO composition revealed γ-terpinene, γ-terpinen-7-al, cuminaldehyde, p-cymene, and 2-caren-10-al as the predominant constituents, together contributing over 90% of the total identified compounds across all treatments.

(V) Societal upliftment through extension of technologies and skill development programmes

➢ **Training/Awareness Programmes**

The following Training-cum-Awareness programmes were conducted:

Title of programme	Date	Venue	Participants
Phytopharmaceutical Mission III	24.05.2025	Rappe	8
Phytopharmaceutical Mission III	27.11.2025	Jobrang & Rashil	31

Rashil

Rappe

PLANNING PROJECT MONITORING & EVALUATION (PPME)

&

BUSINESS DEVELOPMENT AND MARKETING UNIT (BDMU)

CSIR-IHBT PPME (Planning, Performance Monitoring and Evaluation) Division helps align research with CSIR priorities, monitors performance, and ensures effective planning, reporting, and review of scientific activities. It also supports the Director, ISTAG, and IT divison for data-driven decision-making, facilitates fund allocation and channelization, and serves as an interface between scientific, administrative, accounts, and stores & purchase functions.

Research Planning and Monitoring

The division's activities began with fund allocation from CSIR Headquarters and the creation of seven infrastructure projects representing various R&D areas of the institute. The allocated funds were subsequently distributed among these infrastructure projects. During the year, PPME recorded the initiation of 21 new projects funded by agencies such as DBT, DST, ANRF, NMPB, NMHS, ICMR, and MSME. In addition, 47 proposals (FTT/FTC/NCP/FBR/CSIR-FIRST/RDSF) were submitted under various themes to the Theme Directorate. The Division also submitted the ULIP proposal for the XVI Finance Commission cycle (2026–31), with RC approval, to the Nodal Coordinator of the CSIR NLS Scheme. The division also prepared CSIR reform and CSIR-IHBT Key Performance Indicator (KPI) benchmarking documents and contributed in the Technology Transfer Commitments (TTC) 2030 of the institute.

During 2025–26, the Division uploaded 22 proforma, along with daily, monthly, and quarterly reports highlighting significant achievements, on the C-DIS portal. It also contributed to the preparation of the CSIR-IHBT annual report and AcSIR NIRF 2026 reports by compiling inputs on publications, events, awards, and other key accomplishments. Besides this, 87 Parliamentary questions were also addressed on a priority basis. Facilitated the Internal Audit (6–17th October 2025) and CAG Audit (2–20th February 2026) processes by providing information for risk assessment, general database details, and replies to audit memos concerning projects, budgets, publications, patents, etc. Additionally, furnished responses for the removal of pending audit paras and the settlement of OB/BR observations.

The division actively supported the Directorate by preparing performance monitoring parameters for scientists and facilitating review meetings convened by the Director. These meetings assessed scientist performance against targets and achievements in areas such as publications, ECF, patents, technology transfer, and societal impact. Also convened review meetings for newly inducted scientists to assess their work progress. The Division compiled institutional data for the DST Survey on S&T Activities, supported Theme Director meetings, and provided lab-identified publications to SCDD for social media outreach. It also contributed to enhancing the visibility of CSIR research through the development of infographics.

The Division conducted 69th and 70th Meeting of Research Council of CSIR-IHBT on 05-06th June, 2025 and 18-19th December, 2025 respectively.

Resource planning and monitoring

The division's activities began with fund allocation from CSIR Headquarters and the creation of seven infrastructure projects representing various R&D areas of the institute. The allocated funds were subsequently distributed among these infrastructure projects. During the Monthly Expenditure Utilization Monitoring Meetings (MUMM) with CPD, the pace of expenditure was reviewed and managed. Coordinated meetings for planning new infrastructure and equipment. To address manpower requirements, necessary approvals were facilitated for induction of new project staff. The Division is also actively monitoring progress under the R&D Seed Fund (RDSF) and Prioritized Equipment Fund (PEF) schemes of CSPS-2024. Based on the project requirements and the institute's equipment priority list, the indenting process was initiated. Accordingly, a total of 3687 indents (Non-recurring: 475 and Recurring: 3212) were raised and processed through the PPME system for further necessary action. The XRD, UHPLC/UPLC System with PDA & ELSD Detector, Cold Plasma Reactor, Multisolvent recovery unit, Lab Scale Homogenizer, Soil Respiration System, Chlorophyll Fluoresence system, 3D Food Printer etc. are some of the major instruments procured during the year. In continuation the equipment procurement plan for the year 2026-27 was also prepared. Maintenance of the lab reserve fund is another key responsibility, with the balance reaching ₹ 526 lakhs at the end of the financial year, starting from an initial amount of ₹ 414 lakhs at the beginning of the year. The ₹ 801 lakhs were raised as External Cash Flow (ECF) through the grants received from various government added projects.

Events organized

PPME organized following major events of national importance:

- National Technology Day (15th May, 2025): The Union Minister of State (Independent Charge) for Science and Technology, Dr. Jitendra Singh, virtually presided over the celebrations.
- Visit of Shri Giriraj Singh Jee, Hon'ble Minister of Textiles, Govt of India to CSIR-IHBT Palampur (24th-26th May, 2025)
- World Environment Day (5th June, 2025)
- CSIR-IHBT Foundation Day (2nd July, 2025)
- Himalaya Diwas (4th September, 2025)
- CSIR Foundation Day (8th October, 2025)
- National Science Day (6th March, 2026)

International Science & Technology Affairs Activity

As part of International Science & Technology Affairs Group (ISTAG) activities, the PPME facilitated visit of Dr Vipin Hallan, Chief Scientist to France during 22-30 November, 2025.

IT based activities

The information related to Institute's activities were promptly posted in social media (Facebook, Tweeter, YouTube etc.) and sent to CSIR headquarters as and when asked for its inclusion in CSIR activities. Information were regularly updated and flashed in intranet as well as Institute website.

An interface was developed to monitor indent expenditure under INFRA, CSIR, and ECF projects, with information accessible through the ACCESS portal. The portal provides details on indents, purchase orders, and usage, thereby supporting effective decision-making.

Expenditure File Viewer

Access Sheet Upload File | Expenditure(CSIR Projects) | Expenditure (Infra) | Expenditure (ECF) | Indent-PO Difference | Sct Total Indents (CSIR Projects) | Sct Total Indents (Infra)

Print this page

Project No	Title	PI	Allocation (A&E)	Indent (A&E)	(A&E) Util. (%)	Allocation (Chem/Cons)	Chem/Cons Indent	Chem/Cons Util. (%)	Allocation (Cont.)	Cont. Indent	Cont. Util. (%)	ORE Allocation	ORE Indent	ORE Util. (%)	Maint. Allocation	Maint. Indent	Maint. Util. (%)
FIR020304	How does heat signaling machinery coax DNA methylation and gene expression patterns in plants - connecting the heat waves and gene waves	Dr. Gaurav Zinta	0	0	0	3090700	3030560	98.05	100000	119220	119.22	100000	0	0.00	0	0	0
FTT020503	CRM 2-Candidate Indian Certified Reference Materials (CRMs)/Bhartiya Nirdeshak Dravya (BND) of Phyto & Aroma Chemicals for Quality and Safety Assessment of Derived Products	Dr. Upendra Sharma	0	0	0	1500000	1268295	84.55	200000	346278	173.14	300000	0	0.00	0	23974	0
FTT020507	Phycobiliproteins-based nutraceutical from edible microalgae for the management of fatty liver disease	Dr. Vikram Patial	0	0	0	1650000	1696155	102.80	250000	210879	84.35	150000	0	0.00	0	23974	0
HCP000024	Identification of potential location across India for seaweed cultivation (IPL-ISeaC)	Dr. Sanatsujat Singh	0	0	0	300000	280280	93.43	50000	0	0.00	0	0	0	0	0	0
HCP00007	CSIR Aroma Mission Phase ❖ III	Dr. Sanatsujat Singh	3000000	3012500	100.42	15900000	15784916	99.28	800000	34414	4.30	7800000	0	0.00	1000000	968553	96.86
HCP00037	CSIR Floriculture Mission Phase-II	Dr. Bhavya Bhargava	0	0	0	29500000	42500329	144.07	140000	4300	3.07	13200000	99818	0.76	350000	311040	88.87
HCP00047	Phenome India-CSIR Health Cohort Knowledgebase	Dr. Yogendra S. Padwad	0	0	0	200000	197896	98.95	100000	16850	16.85	0	0	0	0	0	0
HCP00054	Waste to Wealth: Comprehensive solutions towards circular economy and sustainability	Dr. Sarita Devi	0	0	0	1800000	2106380	117.02	200000	0	0.00	200000	0	0.00	0	0	0
HCP00057	Region specific smart agrotechnologies for enhancing soil and plant health (RSSA)	Dr. Rakesh Kumar	0	0	0	1200000	1105575	92.13	216000	0	0.00	500000	218455	43.69	0	0	0
HCP00101	Jigyasa 2.0: Virtual Laboratory Integration	Dr Gireesh Nadda	100000	102900	102.90	250000	276025	110.41	300000	27500	9.17	400000	121500	30.38	0	0	0
HCP002502	CSIR Integrated Skill Initiative - Phase III	Dr Gireesh Nadda	1000000	1014700	101.47	2000000	2031020	101.55	300000	166980	55.66	600000	0	0.00	0	0	0
IHP002401	Mass-scale propagation of monk fruit (Siraitia grosvenorii): A new initiative towards health and livelihood improvement	Dr. Rohit Joshi	0	0	0	700000	669162	95.59	50000	13000	26.00	500000	4400	0.88	0	0	0

हिंदी के प्रगामी प्रयोग से संबंधित संशोधित तिमाही प्रगति रिपोर्ट जमा करने व प्रिन्ट हेतु online प्रारूप तैयार किया।

हिंदी के प्रगामी प्रयोग से संबंधित तिमाही प्रगति रिपोर्ट

1.राजभाषा अधिनियम,1963 की धारा 3(3) में उल्लिखित कागजात (Documents specified in Section 3(3) of Official Languages Act) (सभी द्विभाषी होना अनिवार्य है।)

		द्विभाषी रूप में	केवल अंग्रेजी में	केवल हिंदी में	कुल संख्या
1.	सामान्य आदेश (General Orders)				
2.	अधिसूचनाएं (Notifications)				
3.	प्रेस विज्ञप्तियां/टिप्पणियां (Press Communiques/ Releases)				
4.	संविदाएं (Contracts)				
5.	करार (Agreements)				
6.	टेंडर के फॉर्म और नोटिस (Notice and forms of tenders)				
7.	संकल्प (Resolutions)				
8.	नियम (Rules)				
9.	प्रशासनिक या अन्य रिपोर्ट (Administrative or other Reports)				

2.हिंदी में प्राप्त पत्रों (हिंदी में हस्ताक्षरित पत्रों सहित) की स्थिति (अर्थात निदेशक सचिवालय से मार्क किए गए पत्र + प्रशासन नियंत्रक/प्रशासनिक अधिकारी अथवा अन्य प्रभागों व अनुभागों से मार्क पत्र + ठाक से सीधे प्राप्त हिन्दी के पत्रों + इमेल के माध्यम से प्राप्त हिन्दी के पत्रों) के उत्तर की भाषा

(i)	हिंदी में प्राप्त पत्रों की कुल संख्या	
(ii)	जिनके उत्तर हिंदी में दिए गए	
(iii)	जिनके उत्तर अंग्रेजी में दिए गए	
(iv)	जिनके उत्तर दिए जाने अपेक्षित नहीं थे	
(v)	हिंदी पत्रों का उत्तर हिंदी में न दिए जाने के कारण	कारण

BDMU is making its all efforts to convert high-end R&D technologies into the business. This unit is involved in techno- economic analysis, organizing/ facilitating scientific & industrial meets, promoting technologies at different platforms, responding to the queries of farmers and entrepreneurs regarding different technologies, facilitating technology transfers through Agreements, Material Transfer Agreements (MTAs), R&D need based project agreements (collaborative and sponsored), MoU with farmer societies, Research and academic activities, disseminating technologies and products to the society.

During 2025-26, BDMU facilitated for signing 201 agreements/MoUs including, Twenty Technology Transfers, One Hundred Forty-six Material Transfer Agreements (MTAs), Two Need based Agreements, Thirty miscellaneous MoUs signed with different farmer societies, academic and R&D collaborations with government institutes/ universities including one international MoU, Two for incubation and facility use of CSIR-IHBT, and one consultancy Agreement. BDMU was also intensively involved in showcasing institute's technologies and products in various business meetings, trade fairs and exhibitions at regional as well as national levels. Delivered lectures/ talks in different Institutes on CSIR-IHBT technologies based business opportunities. Provided information to CSIR Hqr and other agencies pertaining to business development in different formats on regular basis.

BDMU also undertake other activities including evaluation of techno-economic feasibilities of technologies developed at CSIR-IHBT, drafting agreements for transfer of technology, material transfer agreements, agreements with incubatees and MoU's with government institutes, responding queries of clients, raising expression of interest (EOI) for different technologies, assessing technology readiness level (TRL), and providing inputs for drafting technology specific documents.

Transfer of Technologies

During 2025-26 CSIR-IHBT has signed twenty agreements for transfer of technology i.e.(i) Agreement for New Gerbera cultivars "Him Kumud, Him Prabha and Him Aruna" and standardized its micro propagation protocol for mass multiplication with M/s Sashanka Agrotech Pvt. Ltd., Jharkhand (ii) Agreement for Commercial manufacturing of phycobiliproteins and derived formulations for combating fatty liver and other related disorders with M/s Vyoum Biotech Pvt. Ltd., Indore (iii) Agreement for making herbal incense cones and sticks from temple waste flowers with Dharma Kisan Vikas Committee Chamba (H.P.) (iv) Technology for Artifact making using dry flowers with M/s Kangra (Komal) Innovation and wellness initiative (KIWI), Nagrota Baghwan, Distt Kangra (H.P) (v) Technology for Manufacturing/processing of i) Bee Pollen Based Ready to use products like Bars, Beverages ii) Flavoured Honey (Aroma Infused Honey), iii) Honey Based Jam Products with M/s Himalaya Apiaries, Una (H.P.) (vi) Agreement Production of Naphthoquinone pigment (Shikonin Derivatives) as natural colorants on sustainable basis with M/s Phytopulse Unit of AB Scientific Solutions, Palampur (H.P.) (vii) Aeroponic production of Brahmi, Jatamansi, Thyme and Basil with M/s Suraj Shree Chemicals Ltd., New Delhi (viii) Agreement for Manufacturing/ processing of (i) Ragi banana porridge mix powder, (ii)Ragi carrot beetroot porridge mix powder, (iii)Rice apple and banana porridge mix powder, (iv) Agreement for Ragi green gram porridge mix powder, and (v) Multi grain porridge mix powder with M/s Tashvika India Food Pvt. Ltd., New Delhi (ix) Technology for Protein bar chocolate with M/s Tashvika India Food Pvt. Ltd., New Delhi (x) Agreement for Making (i) Aromatic/ non aromatic floral wax and (ii) aromatic floral wax candle with M/s Mountleaf Pvt Ltd, Ghurkari, Distt Kangra 176001, Himachal Pradesh (xi) Technology for Making herbal soaps (bars) with M/s Softbio Pharma Pvt. Ltd., Delhi (xii) Agreement for Agro-technology of Monk Fruit for multiplication and cultivation with M/s The Squirrels, Ludhiana (Pb.) (xiii) Agreement for Agro-technology of Monk Fruit for multiplication and cultivation with M/s Rami Hortitech Pvt. Ltd., Muzaffarnagar, Uttar Pradesh (xiv) Technology for Manufacturing/processing of Multigrain Porridge Mix with M/s Godhan Masala Foods Limited, Haryana (xv) Technology for Making herbal incense cones and sticks from temple waste flowers to M/s Trimurti Udyog Palampur (H.P.) (xvi) Agreement for Agro-technology of Gerbera and new gerbera selections (1 flask of each variety (total 3 flask) for multiplication and cultivation) with M/s Madan Lal Tissue Culture Lab, Jaisinghpur (H.P.) (xvii) Technology for Making flower based resin encapsulated products with M/s Harsh Enterprises, Punjab (xviii) Agreement for Tulip Agro- technology, including grading, sorting, packaging and cold storage of bulbs with M/s Red Mirchi Associates, Jind, Haryana (xix) Agreement for Ready to eat Seera in the convenience package with M/s Behatar Himachal, Bilaspur (H.P.) (xx) Agreement for Development of L-Asparaginase for Pharma and Food Processing Application with M/s Biolaxi Enzymes Pvt. Ltd., Maharashtra through NRDC.

Business Development Group: Dr. Sukhjinder Singh, Mr. Vikrant Awasthi, Mrs. Ishani Gautam, Mr. Didar Singh, Mr. Akhil Rana and Ms. Nitika Parmar

Sukhjinder Singh, Principal Scientist
sukhjinder@ihbt.res.in
Coordinator Business Development & Marketing Unit

Research Focus: Transfer of Technology, Business Development, Techno-economics, Promotion of technologies, Establishing Institute's linkages with Industries/ Startups/ Farmers and R&D Institutes/ Academia. Acting as Nodal Scientist for Vertical, "Establishing effective domestic and international market linkage" in CSIR Floriculture Mission-II. Registered Technology Transfer Professional (RTTP) by Alliance of Technology Transfer Professionals (ATTP). https://attp.info/current-rttps/.

Business Development and Marketing unit is focusing on Transfer of Technologies, Business Development, Techno-economics, Procurement of R&D and technical services, Raising FVC, Promotion of technologies, and Liaison with Industries/ Startups/ Farmers and Institutes.

Transfer of Technologies: Interaction with the interested industries/ entrepreneurs/ startups/ farmers related to transfer the technologies/ materials. Drafted agreements/ MoUs/ MTAs as per mutually decided terms and conditions.

Total MoU/ Agreements signed: 20 Technology Transfer Agreements; 146 Material transfer agreements; 2 R&D need based, 1 consultancy agreement, 2 facility use agreements, and 30 Misc. MoUs (with farmer's Societies, NGOs, cooperatives, academia and R&D collaborations, including one International MoU with International MoU between National Research Institute of Chinese Medicine (NRICM), Ministry of Health and Welfare, Taiwan and CSIR-IHBT for Academic and R&D Co-operation. Details of agreements/ MoUs signed are provided in Rolled out Technologies.

Business Development: New clients (more than 200 numbers) were added to the organization through ToT/MTA/Consultancy agreements and technical services. Also focused on client retention; upsell and cross sale of technologies to the customers; and industry's feedback/ satisfaction. Facilitating industry partners/ startups to market outreach their CSIR-IHBT technology based products.

Techno- economic feasibility evaluation of technologies: Floating Expression of Interest (EOI) on institute's websites for transfer of technologies available at CSIR-IHBT. Evaluating techno- economic feasibility/ cost of production of technologies as this information is required during deal for transfer of technologies. Also evaluated charges for different consultancy projects, sponsored projects, training programmes, and facility availing.

Promotion of technologies: Participated in national and international exhibitions/ trade fairs to represent CSIR-IHBT for promotion of technologies through virtual platforms. Some of the major events we participated are as:

- Arranged Exhibition for Industry partners, and Agri-preneurs to showcase their CSIR-IHBT technology based products during Herbal Herbal Sector Stakeholder Meet, 2025 held at CSIR-IHBT during 02.07.2025 to 03.07.2025
- Arranged Exhibition for Industry partners, and Agri-preneurs to showcase their CSIR-IHBT technology based products during National Symposium on Sustainable Development and Conservation of Himalayan Bioresources through a Multidisciplinary Approach held at CSIR-IHBT during 02.09.2025 to 03.09.2025
- Participated in 'World Food India' (from 25.09.2025 to 28.09.2025) at Bharat Mandapam, New Delhi. In this mega exhibition, showcased the CSIR-IHBT technologies related to Food and Nutrition.
- Acted as nodal from CSIR-IHBT and arranged/ facilitated five industry partners to showcase and sell the CSIR-IHBT technology based products in 'CSIR Model, Super store' at 'Dilli Haat' New Delhi from 24.09.2025 to 26.09.2025
- Participated in World Food India' (from 25.09.2025 to 28.09.2025) at Bharat Mandapam, New Delhi. In this mega exhibition, showcased the CSIR-IHBT technologies related to Food and Nutrition.
- Participated in 'IISF 2025" (from 06.12.2025 to 09.12.2025) at Panchkula, Haryana. In this mega exhibition, showcased the CSIR-IHBT technologies (Agro technology, Biotechnology, Chemical Technology, and Food and Nutraceuticals Technology etc.).
- Participated in 'Empowering India Exhibition" (from 06.02.2026 to 08.02.2026) at Indore (M.P.). In this mega exhibition, showcased the CSIR-IHBT technologies relevant for M.P.

Revelant Publications:

- Agricultural Reviews. (2026), 47 (1): 25-35.

RAMANUJAN FELLOW, CSIR-POOL SCIENTIST, WOMEN SCIENTIST AND YOUNG SCIENTIST

Dipankar Bera, ANRF-NPDF
dipberageo@gmail.com
Forestry, Machine learning and deep learning

Disturbance-Driven Forest Cover Loss and Carbon Emission Dynamics in the Indian Himalayan Region

The project aims to understand the patterns and magnitude of forest cover loss and associated carbon emissions in relation to climatic and anthropogenic drivers in the Indian Himalayan Region (IHR) from 2001 to 2024. Given the diverse physiographical, economic, political, and social contexts within the Indian Himalayan Region (IHR), variations in forest loss and its disturbance drivers are expected across states and union territories. The key outcomes of the project to date are summarized below.

Forest cover loss and carbon emissions have been increasing trends in the IHR

A total of about 19 lakh ha (about 9% of IHR forest) of forest has been lost across the IHR from 2001 to 2024, with the Northeast IHR (NE IHR) accounting for most of the loss (about 11% of its forest), and the Northwest IHR (NW IHR) shows minimal loss (about 1% of its forest) (**Fig. 1)**. The average annual forest loss is also increasing, with the highest values in the NE IHR.

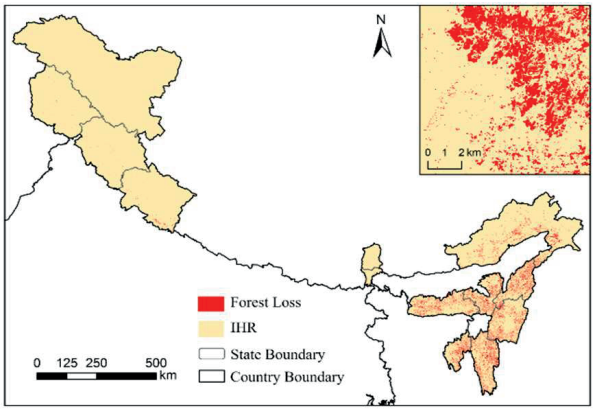


Fig. 1 Forest cover loss from 2001 to 2024.

Total biomass carbon loss in the IHR during 2001–2024 is about 2600 lakh Mg, with the NE IHR accounting for more than 95% of the total carbon loss. Annual loss also shows an increasing trend over 2001-2024 (**Fig. 2**). Higher carbon losses are observed particularly in the later years, reflecting intensified forest disturbances and associated biomass removal.

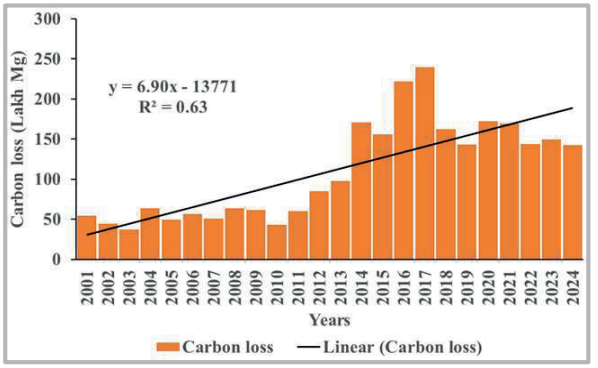


Fig. 2 Biomass carbon loss from forest ecosystems in the IHR during 2001 to 2024

Total carbon loss (2001-2024) corresponds to about 1 Gt CO_2 emissions, which is equivalent to about 20% of current global annual CO_2 emissions from land-use change. The annual loss is an average of 0.04 Gt CO_2 yr^{-1}, contributing about 1% of global annual CO_2 emissions from permanent deforestation. This trend underscores the increasing influence of both anthropogenic and climatic drivers on forest ecosystems and highlights their significant contribution to atmospheric carbon levels and global warming.

Kapil Deswal, ANRF-NPDF
kapildeswal3@gmail.com
Fermentation and Phytofarming

Enhancing Bioactive Compound Production in *Withania somnifera* Through Tissue Culture and Hairy Root Technologies: Overcoming Propagation and Yield Barriers

Ashwagandha (*Withania somnifera*) is a drought-tolerant medicinal shrub with ovate leaves, red berries, and a taproot rich in secondary metabolites that contains various bioactive compounds (like withanolides and withaferin-A) which can be used for different healthcare benefits like anti-inflammatory, neuro-protective, adapt-ogenic, antidiabetic, cardio-protective, antioxidant, and male fertility-enhancing properties.

Existing tissue culture methods often fail to consistently produce bioactive metabolites at high yields. Moreover, optimized protocols for cell suspension and hairy root cultures are lacking for efficient secondary metabolite production. Enhancing these methods, particularly through hairy root induction, could significantly improve the yield of withanolides and other valuable phytochemicals.

To achieve the objectives of project, seven *Withania somnifera* seed varieties—CIM-Pushti, CIM-Pratap, CIM-Chetak, Poshita, NMITLI-101, and NMITLI-118 (from CSIR-CIMAP, with MTA approval), and ABG-02 (from CSIR-IIIM) were procured, along with *Agrobacterium rhizogenes* strains (MTCC 532 and MTCC 2364) from CSIR-IMTECH.

Subsequently, successful seed germination was achieved using a soil:cocopeat (1:1) mixture under optimized conditions. Furthermore, *in vitro* cultures were successfully established using seeds for the two selected varieties, NMITLI-118 and Poshita, in MS medium (**Fig. 1**).

Fig. 1 *In vitro* seed germination in *Withania somnifera*.

Mamta, Women Scientist-A Fellow
mamtakau90@gmail.com
Fermentation and Phytofarming Technology

"Women Scientist-A Fellowship SR/WOS-A/LS-164/2019- Enhancing C and N assimilation in *Brassica juncea* by genetic engineering for yield enhancement.

Hypothesis to be tested

Based on previous observations that high-altitude plants exhibit enhanced activities of key enzymes involved in carbon and nitrogen metabolism, it is hypothesized that coordinated overexpression of PEPC, AspAT and GS will improve the efficiency of CO_2 capture and NH_2 assimilation in plants **(Fig. 1)**. PEPC is expected to enhance fixation of atmospheric and photorespired CO_2, generating carbon skeletons (OAA), while AspAT and GS will facilitate the incorporation of nitrogen into organic forms through amino acid biosynthesis. Therefore, co-expression of *ZmPEPC*, *GmAspAT* and *NtGS* in *Brassica juncea* is anticipated to enhance carbon and nitrogen use efficiency, leading to improved photosynthesis, growth and yield. This strategy is further expected to confer better performance under varying environmental conditions, including different CO_2 levels (~400 ppm and ~200 ppm) and nitrogen availability (6 mM, 3 mM and 0.3 mM), as supported by earlier findings demonstrating improved reassimilation of photorespired CO_2 and NH_2 in transgenic systems.

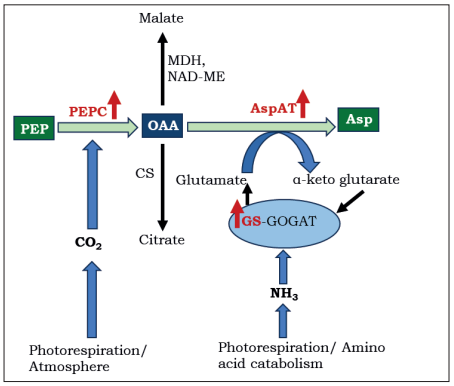


Fig. 1 A schematic diagram showing changes in photosynthetic metabolism in plants growing at high altitude (HA).

Development and Functional Characterization of PEPC, AspAT, and GS Co-expressing Transgenic *Brassica juncea* under Variable CO_2 and Nitrogen Conditions

In our previous study, transgenic *Brassica juncea* plants co-expressing PEPC, AspAT and GS were successfully developed through *Agrobacterium*-mediated transformation using hypocotyl explants. PCR analysis confirmed the presence of the target genes. Quantitative PCR further identified *BjPAG5*, *BjPAG8* and *BjPAG11* as single-copy homozygous lines, which were selected for detailed analysis, while enzymatic assays validated significantly higher expression levels compared to the vector control (*BjVC*). Under both ambient (~400 ppm) and low (~200 ppm) CO_2 conditions, *BjPAG* transgenic plants exhibited enhanced growth performance, including increased leaf area, shoot fresh weight and dry weight, along with improved biochemical traits such as higher photosynthetic pigments, carbohydrate accumulation and reduced ammonium and reactive oxygen species levels. Additionally, stomatal density was significantly higher on both leaf surfaces in transgenic lines. When evaluated under varying nitrogen concentrations (6 mM, 3 mM and 0.3 mM). *BjPAG* plants consistently showed superior growth, biomass accumulation and improved physiological performance compared to controls. Enhanced biochemical parameters, including increased chlorophyll, sugars and starch content, along with reduced ROS levels, were also observed under different nitrogen regimes. Furthermore, *BjPAG* plants demonstrated improved agronomic traits such as increased leaf number, plant height, siliques and seed yield. Overall, these findings indicate that co-expression of PEPC, AspAT and GS enhances carbon and nitrogen assimilation, leading to improved photosynthesis, growth, yield and oil content in *Brassica juncea* under varying environmental conditions.

NMR-based metabolite analysis in *BjPAG* plants

1H NMR spectroscopy of 45-day-old *BjVC* and *BjPAG* leaves identified 40 metabolites across amino acid, carbohydrate and phenolic regions using TSP as an internal standard **(Fig. 2)**. *BjPAG* plants showed higher carbohydrate levels (notably α-glucose, maltose, and fructose with α-glucose being most abundant. Several amino acids were elevated and phenylalanine, tryptophan and cysteine were detected only in *BjPAG* lines, along with increased glycine and serine. Organic acids such as quinic acid

(*BjPAG5* and *BjPAG8*) and formic acid (only in *BjPAG*) were also observed. Additionally, secondary metabolites including phenolics, flavonoids, glucosinolates, vitamins and sterols were generally higher in *BjPAG* plants, indicating enhanced primary and secondary metabolism due to *PAG* co-expression.

BjPAG plants exhibited increased oil content and favourable fatty acids

BjPAG transgenic lines exhibited a significant increase in seed oil content, with enhancements of 14% (*BjPAG5*), 26% (*BjPAG8*) and 21% (*BjPAG11*) compared to *BjVC* plants **(Fig. 3 A-B)**. GC–MS chromatograms revealed that *Brassica juncea* seed oil contains a complex mixture of compounds **(Fig. 3 C-F)**, with identified components accounting for 86.4%–98.5% of the total oil content.

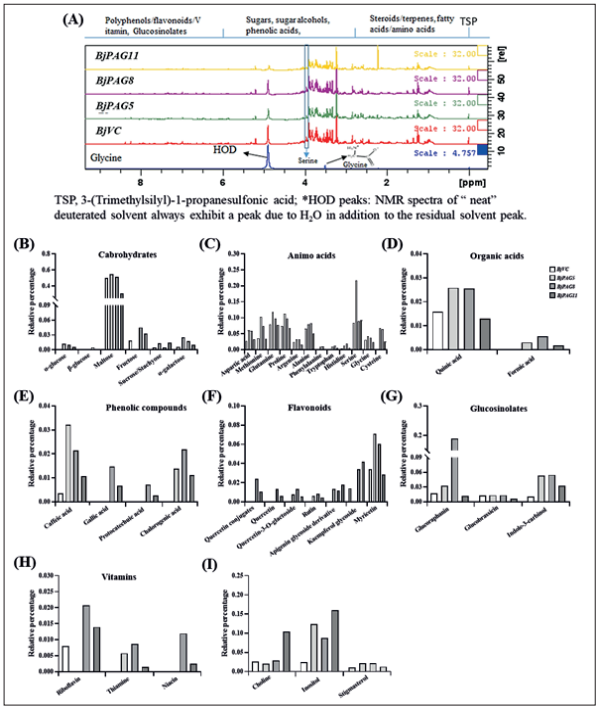


Fig. 2 (A) ^{1}H NMR spectra of standards and extracts of *Brassica* leaf samples in D_2O. Metabolite content analysis in *Brassica juncea* transgenic plants (*BjVC, BjPAG5, BjPAG8* and *BjPAG11*). The following metabolites were quantified in both *BjVC* and *BjPAG* plants: (B) Carbohydrates, (C) Amino acids, (D) Organic acids, (E) Phenolic compounds, (F) Flavonoids, (G) Glucosinolates, (H) Vitamins and (I) Other compounds.

Major fatty acids included palmitic acid, linoleic acid, oleic acid, methyl hexadecadienoate, stearic acid and erucic acid, consistent with previous reports (Sharafi *et al.,* 2015). Notably, *BjPAG* lines showed a relatively lower proportion of certain fatty acids such as oleic and stearic acid compared to *BjVC*, along with distinct variations in fatty acid composition across transgenic lines, indicating that *PAG* co-expression alters both oil quantity and fatty acid profile in *B. juncea*.

Discussion

Co-expression of *ZmPEPC*, *GmAspAT* and *NtGS* in transgenic *Brassica juncea* (*BjPAG*) plants resulted in coordinated enhancement of carbon and nitrogen metabolism, leading to improved growth, photosynthesis and yield under varying CO_2 and nitrogen conditions. While PEPC alone may not consistently enhance photosynthesis, its combined expression with AspAT and GS ensured efficient utilization of oxaloacetate for amino acid synthesis and improved nitrogen assimilation. *BjPAG* plants exhibited increased biomass, higher photosynthetic efficiency (Fv/Fm, Y(II), ETR), enhanced carbohydrate and pigment accumulation and reduced ROS and ammonium levels even under low CO_2 and nitrogen-deficient conditions. Improved stomatal density and gas exchange further contributed to higher CO_2 assimilation and photosynthetic performance. Metabolomic analysis confirmed increased accumulation of sugars, amino acids and secondary metabolites, indicating enhanced metabolic activity. Additionally, *BjPAG* plants showed higher seed yield and oil content with favorable fatty acid composition. These findings demonstrate that simultaneous manipulation of key enzymes in carbon and nitrogen pathways improves photosynthesis, nitrogen use efficiency (NUE) and overall plant productivity, highlighting a promising strategy for developing climate-resilient crops under changing environmental conditions.

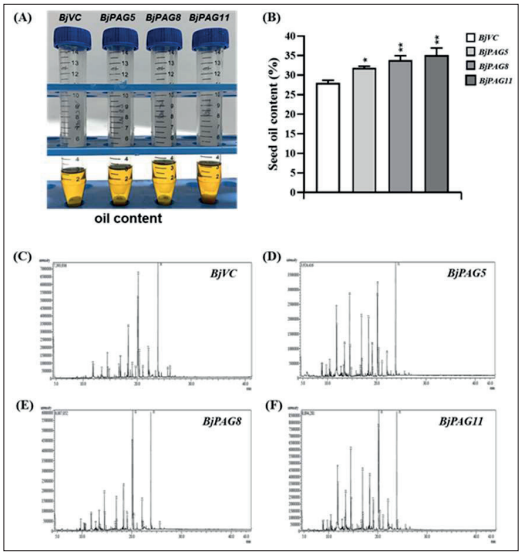


Fig. 3 (A–B) Oil percentage and seed oil content of *BjVC* and *BjPAG* lines (*BjPAG5, BjPAG8* and *BjPAG11*). (C–F) GC–MS chromatograms of seed extracts showing major fatty acids and compounds, including palmitic acid, linoleic acid, methyl esters and erucic acid, with variation among *BjVC* and *BjPAG* lines.

Future Prospective

Future work will focus on isolating endophytes from different *Brassica juncea* cultivars and identifying key genes associated with enhanced biomass and nitrogen use efficiency through expression analysis. Integrating these endophyte-based insights with transgenic approaches may offer a synergistic strategy to further improve plant productivity and resource-use efficiency.

Revelant Publications:

➢ Plant Biotechnology Journal. (2025), doi: 10.1111/pbi.70120.

Neha Kumari, WOS-A
neha188thakur@gmail.com
Fermentation and Phytofarming Technology, CSIR IHBT

Therapeutic Efficacy of Mitochondrial Superoxide Dismutase (mSOD) -Loaded Nanoparticle Formulation in an Animal Model of Cerebral Ischemia-Reperfusion Injury

Stroke remains a major global health burden and the second leading cause of mortality, with ischemic stroke accounting for ~87% of all cases. It arises from obstruction of cerebral blood flow, leading to oxygen deprivation, metabolic failure, and damage to neural cells. Although tissue plasminogen activator is the only FDA-approved therapy, its clinical utility is severely limited by a narrow therapeutic window (3-4 h) and the risk of exacerbating injury through ischemia-reperfusion (I/R) -induced oxidative stress. Mitochondrial dysfunction and excessive reactive oxygen species (ROS) generation are central to I/R-mediated neuronal injury, underscoring the need for safer, effective, antioxidant-based therapies.

Superoxide dismutase (SOD), a potent ROS-scavenging enzyme, holds strong therapeutic promise; however, its clinical translation is restricted by poor stability, short half-life, and limited blood-brain barrier (BBB) permeability. To address these limitations, the present study focuses on the development of a purified, tag-free mitochondrial SOD (mSOD) nanoformulation for effective stability and targeted delivery. The therapeutic efficacy of this system will be evaluated in zebrafish and rat models of IR injury, aiming to establish mSOD as a viable neuroprotective candidate for stroke management.

Project summary

The present study aimed to develop an mSOD nanoformulation for therapeutic delivery in IR injury. The His-tag-free mitochondrial superoxide dismutase (mSOD) from *Camellia sinensis* was successfully amplified, cloned into pGEM-T Easy vector, and subcloned into pET-28a(+) for heterologous expression in *E. coli* BL21(DE3). Expression conditions were optimized, with maximum soluble protein obtained at 28 °C using 0.5 mM IPTG and 25 µM Mn^{2+} supplementation. The recombinant protein was efficiently purified using heat treatment followed by SP-Sepharose cation exchange chromatography. SDS-PAGE analysis confirmed high purity with a distinct band corresponding to ~24 kDa, indicating successful production of tag-free mSOD. For clinical application, purified protein will be employed for nanoformulation, and in vivo studies will be carried out in zebrafish and rat models.

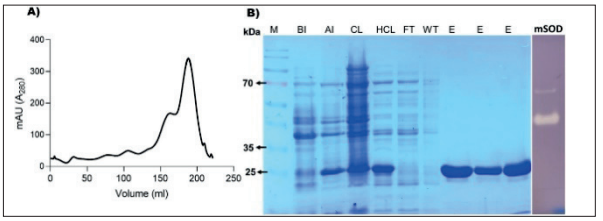
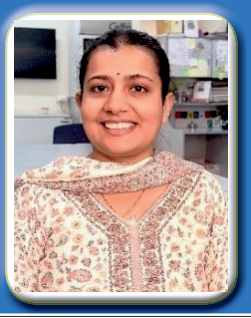


Fig. 1 Purification of His-tag-free mSOD analyzed by SDS-PAGE: Expression and purification profile of recombinant tag-free mSOD from *Camellia sinensis*. Lane M: protein marker; BI: before induction; AI: after induction; CL: cell lysate; HCL: heat-treated cell lysate; FT: flow-through; WT: wash-through; E: eluted fractions. A prominent band at ~24 kDa in elution fractions indicate successful purification of mSOD.

Revelant Publications:

- Archives of Microbiology. (2025), https://doi.org/10.1007/s00203-025-04446-5.

Monika Rana, DBT-BioCARe Woman Scientist
monikakrana@gmail.com
Molecular Biology and Biochemistry Lab



My research interests focus on the recombinant production of industrial enzymes, optimization of fermentation processes, and the development of functional prebiotic oligosaccharides from sustainable biomass.

Current project involves heterologous expression, purification, and characterization of the β-mannanase enzyme, followed by its application in the controlled hydrolysis of mannan-rich substrates to generate prebiotic Mannooligosaccharides (MOS). Furthermore, the work aims to evaluate the potential of these oligosaccharides in the management of obesity and associated metabolic disorders through modulation of gut microbiota and metabolic pathways.

Production of a recombinant β-mannanase from *Bacillus* sp.- Cloning, heterologous expression, purification and characterization

Mannanases (β-mannanase; EC 3.2.1.78) are hydrolytic enzymes that catalyze the breakdown of β-1,4-mannosidic linkages in mannans, glucomannans, and galactomannans. These enzymes have significant industrial applications in food, feed, paper and pulp, oil drilling, and biofuel industries. Recombinant production of mannanase ensures high yield, purity, and consistency compared to native extraction. Therefore, in the current study the cloning, expression, and purification of the recombinant β-mannanase using a bacterial expression system will be explored for its application in the production of prebiotic β-MOS.

A β-mannanase encoding gene (referred as BMan) was identified from the genome of *Bacillus sp.* through genome mining. BMan gene was successfully cloned in pET-28a(+) expression vectors and transformed into *E. coli* BL21(DE3) cells (Fig. 1A). Further gene was successfully expressed in *E. coli* BL21 (DE3) cells (Fig. 1B). BMan was purified using Ni-NTA chromatography (Fig. 1C).

Purified enzyme will be biochemically characterised for various parameters and will be used for the production of β-MOS from guar gum.

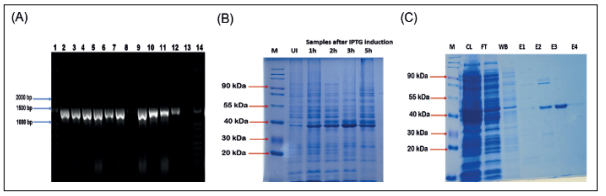
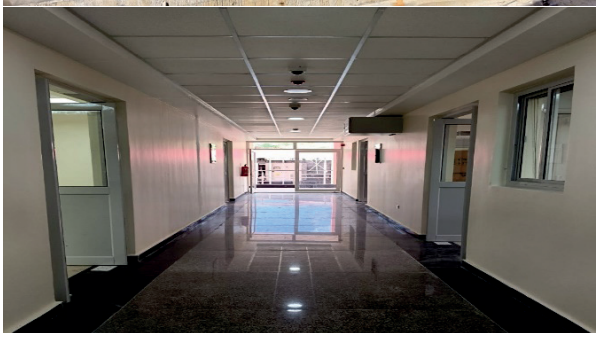


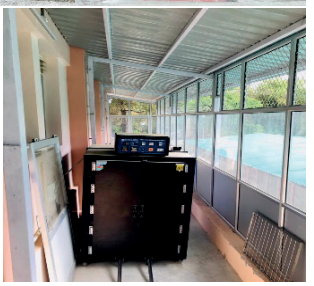
Fig. 1 Cloning and heterologous expression of BMan. (A) Colony PCR analysis confirming the presence of BMan gene in *E. coli* BL21(DE3) clones. (B) SDS-PAGE analysis showing optimization of incubation time after IPTG induction at 37 °C for recombinant BMan expression. (C) SDS-PAGE analysis of recombinant BMan purification showing different fractions obtained during Ni-NTA affinity chromatography.

SCIENCE & TECHNOLOGY SUPPORT SERVICES

1. C/o New Lab Block: Final approval of this building was received on 29.09.2023. The RCC framed three storey building having covered area 2551 sqm is near completion. The building is centrally Air conditioned, having 8 Labs, 16 sitting space, 8 student zones, heavy equipment area, sophisticated instruments zone, meeting room, walk in Growth chambers etc. The tentative completion cost is Rs. 20.20 crores.



2. Phytofarming Facility: Foundation Stone of this Facility was laid by Dr. Jitender Singh, Honorable Minister of State for S&T and Earth Science, Vice President CSIR, on 26th Feb, 2025. The facility is having 120.00 sqm area and approved and completion cost is Rs. 56.78 Lacs was completed on 14.09.2025.



3. C/o Toilet Blocks: Toilet blocks at different location viz near Administration (double story) near enzyme bioprocessing (single story) and near Ramdas block (single story) has been completed on 30.09.2025 with completion cost of Rs. 41.93 lacs.

4. C/o Boundary Wall from Gate No. 1 to Gate No. 2 : The project has approved by DG. CSIR for estimated cost of Rs. 96.12 lacs. The length of boundary wall is 420 mtrs. The work is near completion with tentative completion cost approx. Rs. 60.00 lacs.

5. Green House: Green House project under GAP-0352 of area 80 sqm was constructed with completion cost of Rs. 13.31 Lacs. The Structure has been completed on 09/03/2026.

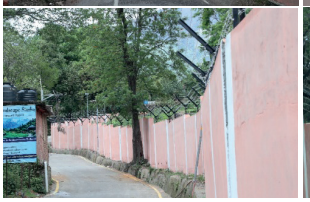
6. Herbal Garden: Herbal garden spread over 1000 sqm area was inaugurated by Dr. S.K. Sopory on 06/03/2026. The completion cost of this work was Rs. 12.84 lacs.

7. C/o Selfie Point: Selfie Point was completed on 25.01.2026 with completion cost Rs. 14.57 Lacs. The main feature of this Selfie point is Makrana Marble IHBT letter mounted on chisel dressed Kullu Stones.

8. Upgradation of Staff Quarters Type IV-12 Nos (D5-D16) & Type III (C1-C4)- 4 Nos. Under the CSIR-Special Scheme (CSPS) the work of Upgradation of Staff Quarters Type IV-12 Nos (D5-D16) & Type III (C1-C4)- 4 Nos has been approved by DG CSIR. The Work has been completed satisfactorily on 15/10/25 with completion cost of Rs. 141.37 lacs.

9. C/o Boundary Wall at Bharmat Colony: The Project has been approved by DG CSIR for estimated cost of Rs. 144.80 Lacs. The Length of Boundary wall is 750 meter. The work is in progress.

10. C/o Boundary Wall at Banuri Farm: The Project has been approved by DG CSIR for estimated cost of Rs. 413.25 Lacs. Foundation stone of C/o Boundary wall at Banuri farm was laid by H.E. Anisha K. MBEGA, High Commissioner, United Republic of Tanzania, India, New Delhi on 2nd July 2024. The Length of Boundary wall is 2360 meter. The work is in progress and around 2000-meter boundary wall has been constructed.



ADMINISTRATION

The Administration carries roles and responsibilities to handle all administrative matters of the Institute and to assist the Director/ HoDs of the Institute in managing all affairs, including R&D activities, to fulfil the mandate of CSIR-IHBT, Palampur, in accordance with CSIR bye-laws, rules, and guidelines.

The Administration plays a critical role at every phase of career advancement for all employees, right from their recruitment, orientation training, performance appraisal, and various service matters to their superannuation. It also facilitates all employees, including research scholars, in their sphere of duty so that they can perform their tasks efficiently.

Other major activities performed by the Administration are enumerated as follows:

- Assist the Director/Heads of Departments/ Principal Investigators on various issues and in taking decisions of an administrative nature, viz. recruitment, assessment & promotion, DPC, establishment, vigilance, legal matters, RTI, finance, stores, purchase, and grievances of staff and others, as the case may be. Maintain liaison with CSIR Headquarters, New Delhi, on administrative matters.
- Implement policies in pursuance of the guidelines issued by CSIR Headquarters, New Delhi.
- Provide administrative support to various functional bodies (committees/ functional groups) within the organization.
- Provide a conducive working environment in the laboratory through the interpretation and implementation of governing rules and regulations.

The Administration is headed by the Controller of Administration/ Administrative Officer. He is supported by Section Officers, a group of Assistant Section Officers, Senior Secretariat Assistants, Junior Secretariat Assistants, and supporting staff, including Security Services and the Rajbhasha Cell.

Security Section

The Security Section is responsible for the complete safety and security of the valuable resources within the premises of the Institute. The section strives to secure the Institute's premises by patrolling, inspecting buildings on a day-to-day basis, and monitoring various access points attentively through an electronic surveillance system.

The section has successfully restrained trespassers through continuous and attentive vigilance. It maintains records of the movement of visitors as well as materials entering and exiting the Institute's premises. In addition, it provides other essential assistance at the main entrance of the Institute as and when required.

Administration group: Sh. S.D. Rishi, Sh. Sanjay Kumar, Sh. Didar Singh Patial, Sh. Prajwal Rai, Ms. Saroj, Sh. Boni Kumar, Mrs. Santosh Kumari, Sh. Baldev, Sh. Kiran Kumar, Mrs. Pooja Awasthi, Sh. Ankit Rohilla, Ms. Jyoti, Sh. Praveen Kumar, Sh. Shubham Barsola, Sh. Nikhil Awasthi, Ms. Deepika, Sh. Ashwani Kumar Chauhan, Sh. Abhishek Thakur, Ms. Pramila Kumari, Sh. Rakesh Kumar, Sh. Rakesh Khatkar, Sh. Amit Chahal, Sh. Jasbinder Sangwan, Sh. Thaman Bahadur.

FINANCE AND ACCOUNTS DIVISION

The Finance and Accounts Division has provided outstanding support to all the Divisions of CSIR-IHBT, Palampur for various R&D/administrative activities. For effective monitoring of expenditure against allocation and smooth functioning, this Division maintains various types of records & data such as Project-wise, Head-wise Audit Registers, Ledgers & Broadsheets. All the financial transactions (Receipts & Payments) are captured in AMS Accounting System. Subsequently, the financial transactions are reconciled on monthly, quarterly & yearly basis with subsidiary records. After reconciliation, various types of Financial Reports (Monthly, Quarterly & Yearly) are prepared/generated throughout the financial year and sent to CSIR HQ for their scrutiny/records. During the year 2025-26, the Institute received Government Grant of Rs.9628.65 lakh (including Rs.1174.31 lakh under Pension and Other Retirement benefits) from CSIR. The entire grant was utilized for the purpose it was sanctioned. Moreover, CSIR also provided financial support from HQRF and sanctioned 9 projects, 4 items of Works & Services and 1 major equipment in the financial year 2025-26. Accordingly, an expenditure of Rs.654.99 lakh from HQRF/LRF has also been incurred in this regard. This expenditure includes laboratory activities and other unavoidable commitments. With regard to generation of resources, the Laboratory has generated an amount of Rs.127.66 lakh as Lab Reserve Fund and Rs.822.62 lakh as ECF during the financial year 2025-26.

In compliance to the CSIR's instruction, the Annual Accounts of CSIR- IHBT for the year 2025-26 have also been generated on 1st April, 2026 successfully.

STORES AND PURCHASE

The Stores and Purchase division ensures provision of adequate and timely supply of various materials required for execution of

various R&D projects & other non-R&D items required for Lab and Staff quarter maintenance as per rules in force. The items are procured primarily through GeM (Government eMarketplace). For the items, which are not available in GeM, the procurement is done through CPP Portal by inviting e-tenders, and other modes of procurement as laid down in CSIR Manual on Procurement of Goods 2019.

The division also maintains stocks of stationery, cleaning etc. which are regularly required in the Institute.

The division had purchased following major equipments during the financial year 2025-26:

- Binary UHPLC System with PDA and ELSD
- Cold Plasma Reactor
- Lab-scale High Pressure Homogenizer
- Multi-purpose Mobile Essential Oil Distillation Unit mounted on a truck
- Soil Respiration System
- 3D Food Printer
- Multi-solvent Recovery Unit
- Chlorophyll Fluorescence System
- UV Pam Flourometer
- SAP Flow System
- Quadcopter with Multispectral payload
- Integrated Modular Modeling and Computational Chemistry Software Suite

Stores and Purchase group: Sh. Sanjay Rawat, Sh. Ravinder Singh, Sh. Sohan Singh, Sh. Rajeev Sood, Ms. Deepika, Sh.Pransh Katoch, Sh. Mital Rana, Sh.Ranjeet Singh and Smt. Anupama Saini.

COMPUTER SECTION

This section takes care of Managing Existing IT resources in the institute which has a fleet of servers used for hosting website, Centralized Antivirus solution, Intranet website etc.

Institute is one of the nodal points of NKN (National Knowledge Network) Connectivity as a part of CSIR Programme under the premise of Govt. of India's National Programme, in which a dedicated 1GBps WAN link is provided to the institute on optical fiber backbone through which Wired (LAN) & wireless Internet facility has been provided in the campus including hostel and faculty residences with the use of managed layer2 and layer3 switches, indoor and outdoor wireless access points. All Internet users are managed centrally with the help of an authenticator.

Network Security hardware used for LAN & WAN comprises of high speed Managed switches, a Unified threat management System (UTM/Firewall), a Web application firewall, Wireless Authenticator, Wireless Controller on high availability, and its policies have been deployed to protect IHBT resources centrally.

Also facilitated Video-Conferencing and Biometric based Attendance system (AEBAS) facilities for the Institute.

As a routine job, this cell constantly extended services related to network, computers, and peripherals over Local Area Network in the campus and coordinated AMC for Computer & Peripherals.

KNOWLEDGE RESOURCE CENTRE (KRC): LIBRARY

IHBT Library continuously contributing to achieve the scientific goals of the Institute through making available the quality knowledge resources and database to the scientists, scholars and technical staff of the institute. The knowledge resources include e-journals, databases and other materials such as books, reports, online databases in the field of science and technology. In addition, the library extends reference and consultation, circulation, document delivery, reprographic, resource sharing, information alert, user awareness using latest tools of the ICTs to users. In this way, library contributed in generating new knowledge by the scientists and other researchers working in the institute.

All the scientists, research scholars, and other staff have access to more than 13500+ scientific e-journals of 32 major publishers through ONOS.

We provided information on journal impact factors, publishers' guidelines, and journal publishing policies to help researchers select quality journals and submit their articles online. This year, we added 22 research books, 46 Hindi books on scientific and societal topics, and 48 thesis to our collection. All books, journals, and other documents were updated in KOHA, our open-source library management software, which is accessible online at http://library.ihbt.res.in.

Similarity and Grammar Check: The library used the iThenticate database to check documents for similarity and plagiarism. We provided similarity and AI reports to the relevant scientists and scholars. Grammarly software was installed on all scientists' and scholars' computers for grammar checks.

Library staff also reviewed document drafts using Grammarly and shared reports to help scientists, scholars, and staff improve their work.

OPAC - Online Public Access Catalogue: The library catalogue was updated and is now available on both the intranet and internet. Users can access and search the OPAC online at http://14.139.59.218/. They can view checkout status, reserve books, and recommend new books or journals. Users also receive check-in, checkout, and overdue notices by email. Records can be searched by keyword, author, title, publisher, accession number, subject, or ISBN.

E-Mail Alert: The IHBT Library provides Email alert service for circulation activities, including issue, return, and overdue notice, as well as other library updates for users.

Printing and Photocopying Service: The library coordinate the printing and photocopying activities of the institute. The library staff have assisted S & T staff for layout settings of different types of the documents such as scientific & technical brochures, annual report, manuals, banners, products stickers, advertising materials, flyers of technology developed, official documents, project proposals & reports. The binding of documents was also facilitated through the library.

Press and Media Activities: The IHBT Library coordinated the institute's press and media activities, preparing press notes on new technologies and scientific programs. These efforts help share new knowledge with society through print and electronic media.

The library subscribed to an employment newspaper and twelve Hindi and English newspapers. Daily media coverage about the institute was scanned and shared with the directorate and relevant scientists. The scanned news items were also uploaded to our blog at http://ihbtinnews.blogspot.in/.

Library group: Sh. Saurabh Sharma, Mrs. Jasveer Kaur and Sh. Sarwan Kumar.

PHOTOGRAPHY UNIT

The institute's professional Photography Unit provides a comprehensive range of services, primarily focused on high-quality photographic and videographic documentation of scientific research and institutional events.

During 2025–2026, the unit actively contributed to showcasing the institute's R&D activities through the production of knowledge-based short films for social media platforms. A major highlight of the year was the production of a corporate film for the institute, while work on three additional short films is currently in progress.

Fig. 1 Lilium cultivation activities are being carried out in Drass.

The unit meticulously documented a wide range of the institute's R&D activities through both still photography and videography. This included coverage of various crops and research activities such as:

- **Medicinal and Aromatic Plants:** Wild marigold, valerian, damask rose, *Picrorhiza*, *Crataegus*, ginkgo, stevia, rosemary, geranium, lemongrass, lavender, saffron, and heeng cultivation.
- **Other Specialized Crops:** Bamboo and monk fruit cultivation.
- **Floriculture Crops:** Tulips, lilies, gerberas, carnations, chrysanthemums, roses, alstroemerias, and gladiolus.

In addition, the unit documented intricate tissue culture processes and provided photographic support for all institutional projects, including the Food and Nutraceutical Mission and the Floriculture and Aroma Mission.

The year 2025–2026 was particularly productive for the unit in visually representing the institute's activities and achievements. Significant contributions were made toward cover page and layout design, as well as photographic inputs, for several important publications and events, including:

- Annual Report 2024–25
- CSIR-IHBT Handbook of Herbal Crops
- Economic Impact of CSIR-IHBT Technologies
- Herbal Sector Stakeholder Meet
- हिमसंपदा वैज्ञानिकी पत्रिका

The unit's photographic contributions added a strong visual dimension to these publications, playing a vital role in effectively communicating the institute's achievements, impact, and objectives to a wider audience. Furthermore, the 2026 wall and table calendars were designed

as informative and visually appealing outreach materials, helping to keep the institute's work prominently visible among stakeholders throughout the year.

Fig. 2 Hing flowering plant at Salgran, Lahaul valley.

Fig. 3 Tulip Garden at Madgran, Lahaul valley.

Fig. 4 CSIR-IHBT has developed a portable, two-man handheld tea leaf plucking machine, which is currently being used in fieldwork at the institute.

Fig. 5 Curcuma field at CSIR-IHBT.

Fig. 6 Peony flowers at CSIR-IHBT.

Fig. 7 Crataegus fruit field at CSIR-IHBT.

Fig. 8 Damask rose field at CSIR-IHBT.

Fig. 9 Vertical farming at CSIR-IHBT showcase a blend of high-tech indoor cultivation.

Fig. 10 Extraction of essential oils from Damask roses(Rosa damascena) at a processing facility, likely the pilot plant at CSIR-IHBT.

राजभाषा

संस्थान में 9 से 23 सितम्बर, 2025 तक हिंदी पखवाड़ा का आयोजन

संस्थान में 9 से 23 सितम्बर, 2025 तक हिंदी पखवाड़ा का आयोजन किया गया। 23 सितम्बर 2025 को हिंदी दिवस के मुख्य समारोह का आयोजन किया गया। इस अवसर पर जवाहरलाल नेहरू विश्वविद्यालय, नई दिल्ली के प्रोफेसर डा. कृष्ण मोहन पाण्डेय ने वेदों में विज्ञान विषय पर एक संभाषण दिया। अपने संबोधन में उन्होंने वेदों में वर्णित अनेकों औषधियों के उपयोग के बारे में बहुत ही रोचक तथ्य प्रस्तुत किए।

संस्थान के निदेशक डॉ. सुदेश कुमार यादव ने अपने संबोधन में कहा कि आज का विषय बहुत ही प्रासंगिक है। आवश्यकता है कि विज्ञान के क्षेत्र में हो रहे अनुसंधान, उपलब्धियां जन–जन तक पहुँचें, क्योंकि यदि ये उपलब्धियां आम लोगों तक नहीं पहुँचेंगी, तो ऐसे अनुसंधान की क्या सार्थकता? राष्ट्रीय स्तर पर राजभाषा हिन्दी ही एक ऐसी भाषा है जिसके माध्यम से वैज्ञानिक उपलब्धियों को जन–जन तक पहुँचाने का कार्य सफलतापूर्वक किया जा सकता है। उन्होंने वैज्ञानिकों से आह्वान किया कि वे अपने शोध को जन साधारण तक पहुंचाने की दिशा में प्रयास करें। हिंदी माध्यम से तैयार करके संस्थान के एक वार्षिक प्रकाशन हिमसंपदा वैज्ञानिकी के माध्यम से भी अपने शोध को आगे बढ़ाए। उन्होंने हिंदी पखवाड़ा के अंतर्गत आयोजित की जाने वाली प्रतियोगिताओं के विजेताओं को अपनी शुभकामनाएं दीं तथा सभी कर्मियों से आह्वान किया कि इनसे प्रेरणा लेते हुए आने वाले समय में इन आयोजनों में अपनी सक्रिय प्रतिभागिता सुनिश्चित करें।

इस अवसर पर संस्थान की पत्रिका हिमसंपदा वैज्ञानिकी का विमोचन भी किया गया। विभिन्न प्रतियोगिताओं के विजेताओं को पुरस्कृत भी किया गया।

उल्लेखनीय हे कि हिंदी पखवाड़े के अन्तर्गत दिनांक 09.09.2025 भाषान्तर एवं टिप्पण लेखन, 10.09.2025 को लोकप्रिय विज्ञान लेखन, 16.09.2025 को हिंदी भाषण प्रतियोगिता (रिसर्च स्कॉलर के लिए) तथा 19.09.2025 को हिंदी कार्यशाला का आयोजन किया गया।

भाषा एवं संस्कृति विभाग द्वारा सी. एस.आई.आर.–हिमालय जैव संपदा प्रौद्योगिकी संस्थान,पालमपुर, कांगड़ा के सहयोग से राज्य स्तरीय पंडित चंद्रधर शर्मा गुलेरी जयंती का आयोजन 7 जुलाई, 2025 को सी.एस.आई.आर.,पालमपुर में किया गया। प्रथम सत्र में लेखक गोष्ठी का आयोजन किया गया। कार्यक्रम में मुख्य अतिथि के रूप में डॉ. सुदेश कुमार यादव निदेशक, सी.एस.आई.आर.–आईएचबीटी, पालमपुर उपस्थित रहे। कार्यक्रम में विशिष्ठ अतिथि के रूप में वरिष्ठ साहित्यकार डॉ. गौतम शर्मा व्यथित तथा पंडित चंद्र शर्मा गुलेरी जी के वंशज डॉ. अदिति गुलेरी और डॉ. आशुतोष गुलेरी उपस्थित रहे। कार्यक्रम की अध्यक्षता वरिष्ठ कथाकार, साहित्यकार एवं आलोचक डॉ. सुशील कुमार फुल्ल ने की। सर्वप्रथम विभाग की निदेशक डॉ. रीमा कश्यप ने मुख्य अतिथि व अन्य गणमान्य को सम्मानित किया। डॉ. प्रशांत रवि रमन द्वारा 'पंडित चंद्रधर शर्मा गुलेरी और उनका कथा संसार' विषय पर शोध पत्र पढ़ा जिस पर श्रीमती सरोज परमार, प्रभात शर्मा, युगल किशोर डोगरा, डॉ. आशु फुल्ल, डॉ. आशुतोष गुलेरी, डॉ. अदिति गुलेरी द्वारा चर्चा की गई। कार्यक्रम के मुख्य अतिथि डॉक्टर सुदेश कुमार यादव ने कहा कि साहित्य समाज का दर्पण होता है। उन्होंने कहा कि संस्थान भविष्य में भी विभाग के सहयोग से इसी प्रकार के कार्यक्रमों का व्यापक स्तर पर आयोजन करवाता रहेगा। कार्यक्रम के दूसरे सत्र में कवि सम्मेलन का आयोजन किया गया। कवि सम्मेलन की अध्यक्षता श्री द्विजेंदर द्विज ने की। वरिष्ठ पत्रकार नवनीत शर्मा विशिष्ठ अतिथि के रूप में उपस्थित रहे। कवि सम्मेलन में दुर्गेश नंदन, डॉ. प्रेम लाल गौतम, जाहिद अबरोल, शिव पंचकरण, डॉ. शिल्पी, कुंदन लाल, भूपेन्द्र जम्वाल, दिनेश शिक्षार्थी, प्रतिभा शर्मा, शक्ति चंद राणा, बबीता ओबेरॉय, कमल आर्य, रमेश चंद मस्ताना, डॉ. प्रशांत रवि रमण, पवनेंद्र पवन, प्रतिभा, राजेन्द्र पालमपुरी, अरविंद कुमार, कमलेश सूद इत्यादि ने अपनी कविताएं सुनाई। विभाग की निदेशक रीमा कश्यप ने मुख्य अतिथि व अन्य गणमान्यों कार्यक्रम में पधारने पर धन्यवाद किया तथा संस्थान के निदेशक का इस कार्यक्रम को संस्थान में करवाने की अनुमति प्रदान करने के लिए धन्यवाद किया। उन्होंने कहा कि पंडित चंद्रधर शर्मा गुलेरी बहुमुखी प्रतिभा के धनी थे। पंडित चंद्रधर शर्मा गुलेरी जी का संस्मरणात्मक निबंध 'सुमिरनी के मनके' के हिमाचल प्रदेश शिक्षा बोर्ड के

पाठ्यक्रम में शामिल है। उन्होंने बताया कि दिनांक 7 और 8 जुलाई को सी.इस.आई.आर. में हिमाचल कला संस्कृति एवं भाषा अकादमी द्वारा पुस्तक प्रदर्शनी, कांगड़ा कला संग्रहालय द्वारा आर्ट एंड क्राफ्ट प्रदर्शनी व राज्य अभिलेखागार द्वारा ऐतिहासिक एवं दुर्लभ अभिलेखों की दो दिवसीय प्रदर्शनी लगाई गई है। उन्होंने निकटवर्ती विद्यालय/महाविद्यालय तथा अन्य जनमानस को प्रदर्शनी का भ्रमण कर इसका लाभ उठाने का आह्वान किया। मंच संचालन विभाग की उपनिदेशक श्रीमती कुसुम शंघाई ने किया। कार्यक्रम में सहायक निदेशक सुरेश राणा, सुनीला ठाकुर, जिला भाषा अधिकारी अमित गुलेरी, सी.एस.आई.आर–आईएचबीटी के हिंदी अधिकारी संजय कुमार उपस्थित रहे।

सीएसआईआर–आईएचबीटी में हिंदी कार्यशाला का आयोजन

संस्थान में दिनांक 27 फरवरी 2026 एक दिवसीय हिंदी कार्यशाला का आयोजन किया गया। कार्यशाला में डा. लोकेश शर्मा, हिंदी अधिकारी, सीएसआईआर–केन्द्रीय वैज्ञानिक उपकरण संगठन, चण्डीगढ़ ने 'राजभाषा नीति एवं हमारा दायित्व विषय पर व्याख्यान दिया। उनहोंने भाषा के संबन्ध में संवेधानिक प्रावधानों, राजभाषा अधियम एवं राजभाषा नियमावली पर व्यापक जानकारी प्रदान की। इसके साथ ही डा. लोकेश ने राजभाषा विभाग, भारत सरकार द्वारा जारी अनुवाद टूल 'भारती –बहुभाषी अनुवाद सारथी' की जानकारी एवं विस्तृत व्यवहारिक प्रशिक्षण प्रदान किया। इस कार्यशाला में संस्थान वैज्ञानिक एवं तकनीकी स्टाफ के साथ–साथ प्रशासनिक कर्मियों ने प्रतिभागिता कर प्रशिक्षण प्राप्त किया।

प्रतिभागिता

- राजभाषा विभाग स्वर्ण जयंती सम्मेलन, 26 जून 2025 भारत मंडपम, राजभाषा विभाग, भारत सरकार
- राजभाषा विभाग स्वर्ण जयंती सम्मेलन,11 जुलाई 2025, हैदराबाद राजभाषा विभाग, भारत सरकार
- पंचम अखिल भारतीय राजभाषा सम्मेलन 14–15 सितम्बर 2025 गांधीनगर, राजभाषा विभाग, भारत सरकार

राजभाषा विभाग, भारत सरकार एवं परिषद् मुख्यालय द्वारा समय–समय पर जारी निर्देशों के अनुरूप हिंदी में कार्य करने के लिए उचित वातावरण बनाने और राजभाषा हिंदी में मूल रूप से कार्य करने को प्रोत्साहित करने के लिए हिंदी में प्रकाशित सहायक सामग्रियों जैसे पुस्तकें, कोश, पत्रिकाएं और अन्य संदर्भ साहित्य संस्थान में उपलब्ध करवाय इसके अतिरिक्त विभिन्न प्रयोगशालाओं/संस्थानों द्वारा प्रकाशित पत्रिकाओं को भी संस्थान में उपलब्ध करवाया गया।

इस वर्ष 16 हजार रुपये की 34 पुस्तकें खरीदी गई। इसके अतिरिक्त योजना, कुरुक्षेत्र, आजकल तथा बाल भारती की ग्राहकता का नवीनीकरण किया गया।

प्रत्येक तिमाही में निदेशक महोदय की अध्यक्षता में संस्थान की राजभाषा कार्यान्वयन समिति का बैठक आयोजित करना, बैठकों की कार्यसूची व कार्यवृत्त तैयार करना एवं निर्णयों का अनुपालन सुनिश्चित करने के लिए आवश्यक अनुवर्ती कार्रवाई करना। तिमाही प्रगति रिपोर्ट के लिए विभिन्न अनुभागों/प्रभागों से आंकड़े प्राप्त कर रिपोर्ट राजभाषा विभाग,भारत सरकार एवं सीएसआईआर मुख्यालय भेजी गई। राजभाषा कार्यान्वयन की दिशा में वार्षिक कार्यक्रम एवं सीएसआईआर मुख्यालय से प्राप्त निर्देशों के अनुपालन हेतु आवश्यक आदेश जारी किए गए।

संस्थान के कार्मिकों का राजभाषा हिंदी ज्ञान संबंधी रोस्टर तैयार एवं अपडेट करना। कर्मचारियों को राजभाषा नीति एवं संस्थान में राजभाषा अनुभाग के कार्यों के बारे में व्यक्तिगत रूप से अवगत करवाया गया तथा प्रशासनिक शब्दावली उपलब्ध कराई गई। इसके अतिरिक्त प्रशासन में सदर्भ सामग्री भी हिंदी में उपलब्ध कराई गई।

संस्थान द्वारा आयोजित किए जाने वाले विभिन्न समारोहों जैसे स्वच्छता पखवाड़ा, सतर्कता जागरुकता सप्ताह, कौमी एकता सप्ताह, सद्भावना दिवस, सीएसआईआर स्थापना दिवस, आईएचबीटी स्थापना दिवस, किसानों एवं उद्यमियों के लिए आयोजित प्रशिक्षण कार्यक्रमों, विभिन्न कार्यशालाओं / समरोहों के आयोजनों में सहयोग

- 1 भारत सरकार की राजभाषा नीति का अनुपालन सुनिश्चित करना
- धारा 3(3) का अनुपालन सुनिश्चित करना
- संस्थान की राजभाषा कार्यान्वयन समिति की तिमाही बैठकों का आयोजन
- राजभाषा संबन्धी तिमाही रिपोर्ट संकलन एवं राजभाषा विभाग एवं परिषद मुख्यालय को प्रेषित करना

CSIR SKILL DEVELOPMENT PROGRAMS - JIGYASA - INCUBATION CENTRE - AcSIR - IMPORTANT EVENTS

CSIR-Institute of Himalayan Bioresource Technology organized various activities under the "CSIR-JIGYASA 2.0 Virtual Laboratory Integration Programme" to motivate students towards science during 2025-26. A total of **10539** students and teachers from different schools (JNVs, KVs, State Govt. and Public schools) participated in different activities conducted throughout the year. This year Institute witnessed the participation from 229 Govt. and Public schools of Himachal Pradesh, Punjab and J&K. The participants were exposed to various R&D activities (state-of-art facilities in the area of biotechnology, bioinformatics, agro-technologies of commercially important crops, floriculture, natural product chemistry, synthetic chemistry, internationally recognized herbarium, remote sensing and mapping facilities, regulatory research facility, pilot plant for nutraceuticals, essential oil and herbals and other facilities) of the Institute through demonstrations, exhibitions, lectures, hands-on trainings, visits and outreach activities.

One day visits benefitted 4,475 students and 433 teachers (121 visits, 113 schools) from 2 states (Himachal Pradesh and Punjab) and one UT (J&K) covering 9 districts of H.P., 5 of Punjab and one of J&K). Students were also mentored for making projects for children science congress. During the year, special days/ events were celebrated in the Institute in which 560 students and 52 teachers participated. These events included 13th AcSIR Foundation Day, World Environment Day, CSIR-IHBT 43rd Foundation Day, 84th CSIR Foundation Day, National Science Day, valedictory function of Janjatiya Gaurav Varsh, Curtain Raiser of India International Science Festival (IISF) 2025, programme on "Empowering Chamba (Aspirational District): Driving sustainable growth with CSIR-IHBT's cutting-edge technologies".

A five day programme "One Day As A Scientist (ODAS) was organized from 21-25 July, 2025 wherein 454 students from 26 schools across four districts of Himachal Pradesh participated. The programme offered young learners an immersive introduction to scientific research, giving them hands-on experience in the Institute, exposure to advanced instruments, and offered insight into modern scientific innovations.

One Day As A Scientist- 2025

Details of activities conducted during 2025-26 are presented in the Table 1.

Table 1. Details of all the students and teachers participated in Jigyasa Programme during 2025-26.

Sr. No.	Activities	No. of Activities	No. of Students	No. of Teachers	Total Beneficiaries
1	One Day Visits	121	4475	433	4908
2	Outreach	5	466	24	490
3	One Day As A Scientist (ODAS) Week (21-25 July 2025)	1	454	0	454
4	Vocational Training (5 days)	1	14	2	16
5	Special Days and Events	9	560	52	612
6	Tulip Garden Visits	102	3511	548	4059
Total		**239**	**9480**	**1059**	**10539**

Glimpse of Activities conducted under Jigyasa Programme (2025-26)

Educational Visits of Colleges/Universities/Institutes at CSIR-IHBT

This year, **1860** students and faculty members from various universities, institutes and colleges of 9 states (Himachal Pradesh, Punjab, Uttar Pradesh, Madhya Pradesh, Rajasthan, Haryana, Gujrat, Karnataka, and Uttarakhand) and 2 UTs (Chandigarh, and Delhi) visited various R&D facilities of the Institute (Table 2).

Table 2. Details of visits of different Colleges, Universities, and Institutes during 2025-26.

Sr. No.	Date	Name of the Institute	Total Students	No. of Faculty
1	01.04.2025	Panjab University, Chandigarh	24	1
2	07.04.2025	Khalsa College, Distt Patiala (P.B.)	27	6
3	07.04.2025	Rayat Bahra University, Chandigarh	26	8
4	08.04.2025	Sanmati Govt. College of Science Education and Research, Jagraon, Distt Ludhiana (P.B.)	14	3
5	11.04.2025	Career Point University, Distt Hamirpur (H.P.)	38	2
6	15.04.2025	BBAU, Distt Lucknow (U.P.)	56	3
7	17.04.2025	B.I.S. College of Pharmacy, Distt Moga (P.B.)	31	4
8	21.04.2025	Pt. Khushilal Sharma Government (Autonomous) Ayurveda College & Institute, Distt Bhopal (M.P.)	57	2

Sr. No.	Date	Name of the Institute	Total Students	No. of Faculty
9	05.05.2025	Indo Swiss Training Centre, CSIR-CSIO, Chandigarh	48	4
10	17.06.2025	Abhilashi University, Chail chowk, Distt Mandi (H.P.)	33	2
11	07.07.2025	Eternal University, Baru Sahib, Distt Sirmour (H.P.)	43	3
12	06.08.2025	College of Horticulture and Forestry, Rani Lakshmi Bai Central Agricultural University, Distt Jhansi (U.P.)	37	0
13	12.09.2025	GDC, Shahpur, Distt Kangra (H.P.)	24	3
14	24.09.2025	Sarvodaya Institute of Electrohomeopathy and Research Centre, Dharamshala Distt Kangra (H.P.)	24	3
15	26.09.2025	GDC , Baijnath, Distt Kangra (H.P.)	35	2
16	16.10.2025	Government College Bassa, Gohar, Distt Mandi (H.P.)	20	2
17	28.10.2025	Jamia Hamdard, (Deemed University) New Delhi	46	4
18	31.10.2025	Deshbandhu College (University of Delhi), New Delhi	45	6
19	03.11.2025	Axis Institute of Pharmacy, Distt Kanpur (U.P.)	26	2
20	03.11.2025	JECRC University, Distt Jaipur (R.J.)	48	3
21	07.11.2025	GDC Dhaliara, Distt Kangra (H.P.)	26	2
22	10.11.2025	GDC, Dharamshala, Distt Kangra (H.P.)	47	3
23	12.11.2025	GDC, Distt Chamba (H.P.)	25	4
24	14.11.2025	GGDSD College Rajpur, Palampur, Distt Kangra (H.P.)	31	4
25	14.11.2025	KLB DAV College for Girls, Palampur, Distt Kangra (H.P.)	37	1
26	18.11.2025	Central University Haryana, Distt Mahendragarh (H.R.)	42	3
27	26.11.2025	Raja Virbhadra Singh Govt. College, Seema Distt Shimla (H.P.)	24	2
28	04.12.2025	Teerthanker Mahaveer University, Distt Moradabad (U.P.)	59	3
29	10.12.2025	SCVB Govt. College, Palampur, Distt Kangra (H.P.)	28	2
30	06.01.2026	Integral University, Distt Lucknow (U.P.)	66	7
31	20.01.2026	Marwadi University, Distt Rajkot (G.J.)	35	4
32	30.01.2026	University of Horticultural Sciences, Distt Bagalkot (K.A.)	64	3
33	02.02.2026	CSKHPKV, Palampur, Distt Kangra (H.P.)	28	1
34	13.02.2026	Doon Business School, Distt Dehradun (U.K.)	26	2
35	16.02.2026	Government ITI Palampur, Distt Kangra (H.P.)	19	1
36	16.02.2026	GDC, Nagrota Bagwan, Distt Kangra (H.P.)	30	1
37	20.02.2026	GDC, Dharamshala, Distt Kangra (H.P.)	48	2
38	02.03.2026	Central University of HP, Distt Kangra (H.P.)	38	3
39	26.03.2026	Eternal University, Baru Sahib, Distt Sirmour (H.P.)	30	3
		Total	**1405**	**114**

Apart from One Day Visits, in the month of February and March 2026, 307 students and 34 faculty members of various colleges, universities, and institutes visited the Tulip Garden (Table 3)

Table 3. Details of colleges, universities, and institutes visited the Tulip Garden.

Sr. No.	Date	Name of the Institute	Total Students	No. of Faculty
1	10.02.2026	DGCN COVAS, Palampur Distt Kangra (H.P.)	7	0
2	13.02.2026	DGCN COVAS, Palampur Distt Kangra (H.P.)	6	0
3	14.02.2026	Naura Pharmacy College, Distt Kangra (H.P.)	5	5
4	17.02.2026	GDC Majheen, Distt Kangra (H.P.)	40	2
5	18.02.2026	Sai University, Palampur Distt Kangra (H.P.)	12	0
6	21.02.2026	GPCS(B)HMR Distt Hamirpur (H.P.)	32	7
7	23.02.2026	KLB DAV College Palampur, Distt Kangra (H.P.)	22	2
8	24.02.2026	DIET Distt Solan (H.P.)	74	9
9	27.02.2026	GDC Rirkmar, Distt Kangra (H.P.)	65	7
10	01.03.2026	IED Skill Centre Rait, Distt Kangra (H.P.)	15	2
11	03.03.2026	GDC Dharamshala, Distt Kangra (H.P.)	29	0
		Total	**307**	**34**

Under CSIR-Integrated Skill Initiative Phase-III Programme, trained 708 persons under different programmes and activities organized at CSIR-IHBT (Table).

Table 1.The details of different skill development programmes.

S. No.	Date(s)	Title of SDP	No. of Trainees															
			Total	Gender		Area				Category								
				M	F	Urban		Rural		SC/ST		OBC		EWS		General	
						M	F	M	F	M	F	M	F	M	F	M	F
1	01.04.2025-31.05.2025	Plant Tissue Culture Technician	02	01	01	01	-	-	01	-	01	-	-	-	-	01	-
2	02.06.2025-30.06.2025	Gujarat State Biotechnology Mission (GSBTM) Under summer research internship program	15	08	07	06	06	02	01	-	-	03	-	-	02	05	05
3	18.08.2025-18.10.2025	Plant Tissue Culture Technician	04	01	03	01	01	-	02	-	01	-	-	-	-	01	02
4	25.08.2025-30.08.2025	Short-term hands-on training and internship program in Food, Chemical and Bioprocess Technologies	12	-	12	-	04	-	08	-		-	08	-		-	04
5	01.09.2025-09.10.2025	Bamboo Grower	01	-	01	-	-	-	01	-	01	-	-	-	-	-	-
6	22.09.2025-22.10.2025	Honey Bee Farmer(Small Unit)	01	-	01	-	-	-	01	-	-	-	-	-	-	-	01
7	22.11.2025-15.01.2025	Essential Oil Extractor	01	-	01	-	-	-	01	-	-	-	-	-	01	-	-
8	27.11.2025-05.02.2026	Floriculturist	01	01	-	-	-	01	-	-	-	-	-	-	-	01	-
9	27.11.2025-05.02.2026	Master Gardener	02	02	-	01	-	01	-	01	-	-	-	-	-	01	-
10	28.11.2025-12.01.2025	Plant Tissue Culture Technician	02	02	-	-	-	02	-	-	-	01	-	-	-	01	-
11	28.11.2025-23.01.2026	Basics Of HPLC Analysis	01	01	-	01	-	-	-	-	-	01	-	-	-	-	-
12	22.12.2025-23.01.2026	Herb Grower	03	03	-	-	-	03	-	01	-	-	-	-	-	02	-
13	23.12.2025-22.01.2026	Hands-on training in laboratory animal handling, histopathology and molecular techniques	01	-	01	-	01	-	-	-	01	-	-	-	-	-	-
14	02.01.2026-12.01.2026	Hands-on training cum exposure visit to agro and process technologies of floriculture, aromatic, medicinal, spices and plantation crops	01	-	01	-	-	-	01	-	-	-	-	-	-	-	01
15	05.01.2026-18.03.2026	Plant Tissue Culture Technician	02	02	-	01	-	01	-	01	-	01	-	-	-	-	-
16	05.01.2026-09.01.2026	Hands-on training cum exposure visit to agro and process technologies of floriculture, aromatic, medicinal, spices and plantation crops	26	13	13	10	11	03	02	05	01	03	07	03	-	02	05

S. No.	Date(s)	Title of SDP	No. of Trainees															
			Total	Gender		Area				Category								
				M	F	Urban		Rural		SC/ST		OBC		EWS		General		
						M	F	M	F	M	F	M	F	M	F	M	F	
17	12.01.2026-16.01.2026	Exposure visit cum hands-on training to different Agro technologies of Floriculture, Aromatic, Medicinal, Spices and Plantation crops	14	04	10	-	-	04	10	04	05	-	02	-	-	-	03
18	12.01.2026-26.02.2026	Pesticide & Fertilizer Applicator	01	-	01	-	01	-	-	-	-	-	-	-	-	-	01
19	27.01.2026-03.04.2026	Medicinal and Aromatic Plants Grower	01	01	-	-	-	01	-	-	-	-	-	-	-	01	-
20	05.02.2026-10.02.2026	Hands-on Training in Recombinant DNA Technology	19	01	18	-	-	01	18	-	03	01	02	-	-	-	13
21	12.02.2026-13.02.2026	Hydroponics for Sustainable Food Production: A Green Technology for the Future"	75	16	59	05	20	11	39	04	11	02	23	01	07	09	18
22	17.02.2026	Herbarium Preparation	08	01	07	01	02	-	05	-	-	01	03	-	02	-	02
23	17.02.2026-27.03.2026	Vermicompost Producer (Small Unit)	04	03	01	02	01	01	-	-	-	01	-	-	-	02	01
24	17.02.2026-10.02.2026	Basics Of HPLC Analysis	04	03	01	01	-	02	01	-	-	01	-	-	-	02	01
25	27.02.2026	Gardening Awareness Programme in schools	196	79	117	-	-	79	117	42	78	11	15	8	10	18	14
26	13.03.2026	Exposure visit cum hands-on-training programme on "Promotion of Commercial Floriculture"	29	29	-	-	-	29	-	05	-	-	-	-	-	24	-
27	23.03.2026-27.03.2026	Hands on Training on hydroponic and Aeroponic cultivation	09	04	05	01	04	03	01	-	01	02	02	-	-	02	02
28	April 2025-March 2026	Research internship/ training/ Project work	273	95	178	46	101	49	77	15	25	28	36	04	04	48	113
Total			708	270	438	77	152	193	286	78	128	56	98	16	26	120	186

Details of research interns/ trainees at CSIR-IHBT, Palampur

Institute is providing trainings to Graduate/ Post Graduate/ Ph.D. students from different Institutes, Universities and affiliated colleges. This year, 273 Under Graduate/ Graduate/ Post Graduate/ Ph.D. students from different Institutes, Universities and affiliated colleges completed their research internship/ training at CSIR-IHBT, Palampur for various durations **(Table 1)**.

Table 1. Details of research internship/ training imparted at CSIR-IHBT (April, 2025 to March, 2026)

Sr. No.	Student Name	Course	Affiliation	Duration (Months)	Supervisor	Title
1	Mr. Rahul Choudhary	M.Sc. Zoology	Panjab University, Chandigarh (Pass out)	5	Dr. Gaurav Zinta	Biochemical and molecular techniques to dissect plant stress response.
2	Ms. Kumari Vandana	BSc. Biotechnology	Dr. Bhim Rao Ambedkar University, Agra, Utter Pradesh	3	Dr. Vipin Hallan	Screening of beta satellite based VIGS vector in *Solanum lycopersicum.*
3	Ms. Kashish Jasrotia	M.Sc. Zoology	Arni University, Kathgarh, Indora, Himachal Pradesh	2	Dr. Gireesh Nadda	Insecticidal activity of plant extract against Diamondback Moth, *Plutella xylostella* (L.)
4	Ms. Adya Goenka	B. Tech Food Technology	Amity University, Noida, Utter Pradesh	4	Dr. Ashok Kumar Pathera	Development of soy protein added snack product
5	Ms. Shweta Sharma	B. Tech Food Technology	Amity University, Noida, Utter Pradesh	4	Dr. Ashok Kumar Pathera	Development of pea protein added snack product
6	Ms. Kajal Devi	M.Sc. Zoology	Arni University, Kathgarh, Indora, Himachal Pradesh	3	Dr. Gireesh Nadda	Insecticidal activity of plant extract against Cowpea Aphid, *Aphis craccivora* Koch
7	Ms. Aparna Sreeprakash	M.Sc. Biotechnology	Pondicherry University, Kalapet, Pondicherry	9	Dr. Gaurav Zinta	Gene functional analysis to elucidate the role of an R2R3-MYB transcription factor in high temperature signalling in *Arabidopsis thaliana*
8	Ms. Mohini Thakur	M.Sc. Biotechnology	Shoolini University, Solan, Himachal Pradesh	4	Dr. Ashish Warghat	Basic techniques in Plant Cell and Tissue Culture
9	Mr. Akash Jayan AK	B.Tech. Biotechnology	Tamil Nadu Agriculture University, Coimbatore, Tamil Nadu	2	Dr. Ravi Shankar	Identification of Anti-VEGFR2 molecule from Himalayan Resources for Cancer Therapy
10	Mr. Dharun Kumar c	B.Tech. Biotechnology	Tamil Nadu Agriculture University, Coimbatore, Tamil Nadu	2	Dr. Rohit Joshi	Exploring *in vitro* organogenesis, micropropagation, DNA isolation and genetic fidelity testing in *Picrorhiza kurrooa* Royle ex. Benth
11	Mr. Thilagavarman V	B. Tech Biotechnology	Tamil Nadu Agriculture University, Coimbatore, Tamil Nadu	2	Dr. Ravi Shankar	In Silico Screening of Astragaloside for Resistant Candida albicans DHFR Inhibition
12	Mr. Somvardhan Singh Jaitawat	M.Pharma	Bhupal Noble's University, Udaipur, Rajasthan	7	Dr. Yogendra Padwad	Exploring anti-cancer effects of a small molecule UBNHC using cell culture and molecular biology techniques in human cancer cells
13	Ms. Ravina Patidar	M.Pharma	Bhupal Noble's University, Udaipur, Rajasthan	7	Dr. Yogendra Padwad	Study on anti-diabetic potential of IHBT-2024A1 in ameliorating the insulin resistance in differentiated L6 myotubes
14	Ms. Ruchi Dashora	M.Pharma	Bhupal Noble's University, Udaipur, Rajasthan	7	Dr. Damanpreet Singh	*In vivo* Efficacy Testing of IHBT/BZ-01 in a Hypoxia/ Reoxygenation Zebrafish Larva Model

Sr. No.	Student Name	Course	Affiliation	Duration (Months)	Supervisor	Title
15	Ms. Tanuja	M.Sc. Biotechnology	Shoolini University, Solan, Himachal Pradesh	4.5	Dr. Ashish Warghat	Hands-on training on Micropropagation and callus culture initiation in *Valeriana jatamansi*
16	Ms. G. Shravani	B.Sc. Biotechnology	Gitam University, Visakhapatnam, Andhra Pradesh	4	Dr. Vishal Sharma	Optimization of an efficient explant-surface sterilization protocol for blueberry
17	Ms. Sakshi	M.Sc. Microbiology (Completed)	Himachal Pradesh University, Shimla, Himachal Pradesh (Passout)	6	Dr. Aparna Maitra Pati	Isolation, screening and molecular identification of hydrolytic and plant growth promoting strains from Himalayan regions
18	Ms. R Harippriya	M.Tech. Biotechnology (Integrated)	SASTRA, Deemed University, Thanjavur, Tamil Nadu	4	Dr. Vandana Jaiswal	Functional Characterization of *FtGAPDH11* under cold stress tolerance in buckwheat through transient expression
19	Ms. Aishwarya Sharma	M.Sc. Biotechnology	Gautam Budha University, Noida, Utter Pradesh	4	Dr. Jeremy Dkhar	Studies on the plant growth-promoting potential of culturable microbes from the pitcher fluid of *Nepenthes Khasiana*
20	Mr. Ajay Kumar	M.Sc. Biotechnology	Kurukshtra University, Haryana	5	Dr. Rajiv Kumar	Molecular cloning of CBL11 from *Picrorhiza kurroa*
21	Mr. Khilender Sharma	M.Sc. Biotechnology	Kurukshtra University, Haryana	5	Dr. Dharam singh	Basic Biochemistry and Protein Purification in Bioprocess Development
22	Ms. Teenu	M.Sc. Biotechnology	St. Thomas College, Chhattisgarh	4	Dr. Shashi Bhushan	Effect of meta-Topolin and different light condition in *Picrorhiza* species shoot growth
23	Ms. Aayushi	M.Sc. Biotechnology	St. Thomas College, Chhattisgarh	4	Dr. Shashi Bhushan	Optimization of *in vitro* Incubation condition for induction of organ culture from *Valeriana* species
24	Mr. Ammardeep Naik	B.Tech. Biotechnology	DY Patil University, Navi Mumbai, Maharashtra	6	Dr. Gaurav Zinta	Dissecting the cross-talk between genetic and epigenetic responses against heat stress in *Arabiodopsis thaliana*
25	Ms. Kanchan	M.Sc. Microbiology (Completed)	HPU, Shimla, Himachal Pradesh (Passout)	6	Dr. Arun Kumar	Cloning, heterologous expression and purification of superoxide dismutase
26	Mr. Gaurav Kumar Naik	B.Sc. Biotechnology (Botany)	Christ University, Bengaluru, Karnataka	1	Dr. Bhavya Bhargava	Basic techniques in plant tissue culture and molecular biology
27	Ms. Renu	M.Sc. Nutrition Biology	Central University of Haryana, Mahendergarh, Haryana	5	Dr. Vidyashankar Srivatsan	Development and characterization of nutritionally enriched pasta products utilizing wild edibles of Western Himalayas
28	Ms. Pooja	M.Sc. Nutrition Biology	Central University of Haryana, Mahendergarh, Haryana	5	Dr. Mahesh Gupta	Study the nutritional, functional and storage stability of probiotic enriched sorghum premix
29	Mr. Kartik	Vety Pharmacist	Abhilashi University, Mandi, Himachal Pradesh	15 Days	Dr. Vikram Patial	Hands-on training in laboratory animal care, handling, and breeding

Sr. No.	Student Name	Course	Affiliation	Duration (Months)	Supervisor	Title
30	Mr. Karan Saini	M.Sc. Biotechnology	Shoolini University, Solan, Himachal Pradesh	5	Dr. Vidyashankar Srivatsan	Evaluation of edible oils as biocompatible solvents for the extraction of carotenoids from green microalga *Chlorella pyrenoidosa*
31	Ms. Saumya Rai	B.Tech. Biotechnology	Jaipur National University Jagatpura, Rajasthan	5	Dr. Ashish Warghat	Tissue and Cell Culture Studies of *Bacopa monnieri* - an Economically Important Medicinal Plant
32	Ms. Swati Kushwaha	B.Tech. Biotechnology	Jaipur National University, Jagatpura, Rajasthan	5	Dr. Rohit Joshi	*In vitro* propagation, biochemical analysis, and protein profiling of an aromatic plant *Lavandula hybrid* Balb. Ex. Ging.
33	Mr. Sashikant Pradhan	M.Sc. Botany	Dr. Harisingh Gour University, Sagar, Madhya Pradesh	5	Dr. Vivek Dogra	Generation, screening and characterization of transgenic lines of RCA in *Arabiodopsis thaliana*
34	Mr. Avishek Mandal	M.Sc. Biotechnology	Shoolini University, Solan, Himachal Pradesh	5	Dr. Rajesh Kumar Singh	Establishment of Suspension culture for Metabolic engineering for *in-vitro* production of Apocarotenoids in *Crocus sativus* (Saffron)
35	Mr. Krishna Kumar Rai	M.Sc. Biotechnology	Shoolini University, Solan, Himachal Pradesh	5	Dr. Rohit Joshi	Unveiling the Role of Exogenous Calcium and *In silico* Validation of the Regulatory Mechanism of the *RBOH* Gene Family in *Nardostachys jatamansi* D. Don
36	Mr. Pratyush Vyas	M.Tech. (Environmental Science)	Thapar Institute of Engineering & Technology, Patiala, Punjab	6	Dr. Amit Kumar (Environmental Technology)	Spatio-Temporal Assessment of Atmospheric Pollution (Aerosols, Black Carbon) and Snow Cover Dynamics in Himachal Pradesh Using Sentinel-5P Data (2020, 2022, 2024)
37	Mr. Jaswanth Meka	B.Sc. Life Sciences	Central University of Karnataka	1	Dr. Rituraj Purohit	Biomolecular Visualisation & Automation of Molecular Docking
38	Mr. Aakash Jiten	M.Sc. Chemistry	NIT, Hamirpur, Himachal Pradesh	1	Dr. Amitabha Acharya	Hands on training on spectroscopy and microscopy techniques
39	Ms. Shiny Rajpoot	M.Sc. Biotechnology	Shoolini University, Solan, Himachal Pradesh	4.5	Dr. Rajesh Kumar Singh	Cloning of *Csat SWEET14* & *Csat SUT4* of *Saffron (Crocus Sativus* 1.)
40	Ms. Preetika Tanwar	M.Sc. Biotechnology	Shoolini University, Solan, Himachal Pradesh	5	Dr. Vandana Jaiswal	Functional characterization of FtGAPDH10 under cold stress tolerance in buckwheat through transient expression
41	Ms. Kanakpriya Sharma	B.Sc. Bioscience	Banasthali Vidyapith, Rajasthan	1	Dr. Kunal Singh	Basic techniques on handling the Himalayan rhizobacteria
42	Ms Neetu Rao	MCA	MLSU, Udaipur, Rajasthan	1	Dr. Bhavya Bhargava	Edible Flowers and Mushroom Cultivation Techniques in Modern Food Systems
43	Mr. Akshat Rao	B.Tech. Biotechnology	Jaipur National University, Jagatpura, Rajasthan	1	Dr. Bhavya Bhargava	Basic Molecular and Plant Tissue Culture Techniques

Sr. No.	Student Name	Course	Affiliation	Duration (Months)	Supervisor	Title
44	Ms. Sanjana Chauhan	M.Sc. Biotechnology	Banasthali Vidyapith, Rajasthan	5	Dr. Amitabha Acharya	Plant-Based Synthesis of Silver Nanoparticles and its Antibacterial Efficacy Evaluation
45	Ms. Swapnika Sharma	B.Sc. Hons. Biotechnology	Banasthali Vidyapith, Rajasthan	1	Dr. Vipin Hallan	Techniques in Plant Molecular Biology
46	Ms. Shivangi Mishra	B.Sc. Hons. Biotechnology	Banasthali Vidyapith, Rajasthan	1	Dr. Vivek Dogra	Techniques involved in the characterization of transgenic lines in *Arabidopsis*
47	Ms. Pallavi	M.Sc. Chemistry	NIT, Hamirpur, Himachal Pradesh	1	Dr. Pralay Das	Hands-on experience in general laboratory techniques with catalytic and non- catalytic synthesis of bioactive and synthetic compounds, along with their isolation and characterization
48	Mr. Ubaid Ahmed	M.Sc. Chemistry	NIT, Hamirpur, Himachal Pradesh	1	Dr. Pralay Das	Hands-on training on general lab practices: Catalytic and non-catalytic synthesis, isolation and characterization of the synthesized organic compound
49	Ms. Garima Sharma	M. Pharma in Forensic Science	National Forensic Science University, Gandhinagar, Gujarat	1	Dr. Vikram Patial	Hands-on training in laboratory animal handling and histopathological techniques
50	Mr. Parag Lodhi	M.Sc. Microbiology	Rani Durgavati University, Jabalpur, Madhya Pradesh	5	Dr. Vipin Hallan and Dr. Mohit Kumar Swarnkar	Isolation and Purification of Nucleic Acids for High-throughput Genomics Applications
51	Ms. Pratima Singh	M.Sc. Microbiology	Rani Durgavati University, Jabalpur, Madhya Pradesh	5	Dr. Shiv Shanker Pandey	Evaluation of role of endophytes in plant stress tolerance
52	Ms. Awantika Pandey	B.Sc. Biotechnology Honours with Research	Banasthali Vidyapith, Rajasthan	5.5	Dr. R.K. Sharma	Expression studies of key genes regulating anthocyanin accumulation under heat stress
53	Ms. Apoorva Gurung	M.Sc. Biosciences	Sri Sathya Sai Institute of Higher Learning, Puttaparthi, Andhra Pradesh (Deemed to be University), AP	1.5	Dr. Vivek Dogra	Techniques involved in screening of EMS mutagenized population of *Arabidopsis*
54	Ms. T. Monika	M.Sc. Biosciences	Sri Sathya Sai Institute of Higher Learning Puttaparthi, Andhra Pradesh (Deemed to be University), AP	1.5	Dr. Sarita Devi	Screening and Characterization of various microorganisms from soil samples of Western Himalayan regions for their hydrolytic potential
55	Ms. Anjali	B.Sc. Biosciences (Honours)	Sri Sathya Sai Institute of Higher Learning Puttaparthi, Andhra Pradesh (Deemed to be University), AP	1.5	Dr. Vidyashankar Srivatsan	A study on biochemical methods with applications in Algal and Mushroom cultivation
56	Ms. Kritika Attri	M.Sc. Botany (Completed)	Gautam College, Hamirpur, Himachal Pradesh	5	Dr. Vishal Sharma	Evaluation of different media and plant growth regulators for *in vitro* callus induction and organogenesis in Blueberry

Sr. No.	Student Name	Course	Affiliation	Duration (Months)	Supervisor	Title
57	Ms. Mannat Sharma	B.Sc Microbiology (Hons. With Research)	Amity University, Noida, Utter Pradesh	1.5	Dr. Rohit Joshi	Studies on physiological and biochemical parameters of elicitors and abiotic stress induced responses in *in-vitro* grown *Phyllostachys pubescens*
58	Ms. Priyanka Uniyal	Ph.D	UPES, Dehradun, Uttarakhand	1	Dr. Yogendra Padwad	Hands-on Training in Animal Cell Culture Techniques, Molecular Methods and Applications
59	Ms. Angel Chaudhary	B.Sc. Microbiology (Hons.)	Amity University, Noida, Utter Pradesh	1.5	Dr. Arun Kumar	Lab-scale production, purification, and characterization of mannanase enzyme from a bacterial isolate
60	Ms. Disha Biswas	B.Sc. Biosciences	Banasthali Vidyapith, Rajasthan	1	Dr. Shashi Bhushan	Studies on antioxidant activity of Himalayan Medicinal Plant
61	Ms. Garima Gather	B.Sc. Biotechnology	Banasthali Vidyapith, Rajasthan	1	Dr. Shashi Bhushan	Plant tissue culture techniques for propagation of Himalayan Medicinal Plants
62	Mr. Harshvardhan Thakur	B.Tech Chemical Engineering	NIT, Hamirpur, Himachal Pradesh	1.5	Er. Mohit Sharma	Exposure cum hands-on training on unit operation involved in herbal industry
63	Ms. Vaishnavi Solanki	M.Sc. Biotechnology	Institute for Excellence in Higher Education (IEHE), Bhopal, Madhya Pradesh	6	Dr. Vivek Dogra	Characterization of light harvesting complex proteins in *Arabidopsis thaliana*
64	Mr. Deval Fuletra	B.Tech. Biotechnology	Institute of Advanced Research, Gandhinagar, Gujrat	6	Dr. Ashish Warghat	The effect of salicylic acid (SA) on plant growth, biomass yield and biochemical analysis in hydroponically grown *Valeriana jatamansi* Jones
65	Ms. Arnima Sharma	M. Pharma	Jiwaji University, Gwalior, Madhya Pradesh	8	Dr. Ankit Saneja	Development and Characterization of Genipin/Sulphobutylether-β-Cyclodextrin inclusion complex incorporated pullulan nanofibers
66	Ms. Minakshi Komare	BS-MS	IISER, Bhopal, Madhya Pradesh	2	Dr. Vivek Dogra	Screening and Characterization of Tea Germplasm under Elevated Temperature
67	Mr. Samarpan Masih	B.Tech. Biotechnology	JIBB, SHUATS, Prayagraj, Utter Pradesh	1	Dr. Bhavya Bhargava	Basic Techniques of Biotechnology
68	Mr. Parth Dohroo	B.Tech. Chemical Engineering	NIT, Hamirpur, Himachal Pradesh	1.5	Er. Mohit Sharma	Exposure cum hands-on training on unit operation involved in herbal industry
69	Mr. Parteek	B.Tech. Chemical Engineering	NIT, Hamirpur, Himachal Pradesh	1.5	Er. Mohit Sharma	Exposure cum hands-on training on unit operation involved in herbal industry
70	Ms. Smriti Aswal	M.Sc. Biotechnology	Graphic Era University, Dehradun, Uttarakhand	6	Dr. Kunal Singh	Assessment of four plant growth-promoting rhizobacteria identified salt- tolerant and maize growth-promoting strains
71	Ms. Gracy Singh	MBA (ABM)	Anand Agriculture University, Anand, Gujarat	1.5	Dr. Sukhjinder Singh	Socio economic impacts of CSIR-IHBT activities on Kangra Tea

Sr. No.	Student Name	Course	Affiliation	Duration (Months)	Supervisor	Title
72	Mr. Dhruv Raj	M.Sc. Honours Biotechnology	Panjab University, Chandigarh	1	Dr. Vishal Sharma	Comparative analysis of different media combinations on axillary bud initiation in Blueberry
73	Ms. Ojal	M.Sc. Honours Microbiology	Panjab University, Chandigarh	1	Dr. Dharam Singh	Hands-on basic techniques in protein biochemistry
74	Ms. Akanksha	M.Sc. Biotechnology	Delhi Technological University	1	Dr. Ashish Warghat	Hands-on training in plant tissue culture and hydroponic cultivation
75	Ms. Vanshika	B.Sc. Biotechnology	Chandigarh University,	1	Dr. Ashish Warghat	Hands-on training in plant tissue culture and hydroponic cultivation
76	Ms. Kajal	B.Sc. Biotechnology	Chandigarh university	1	Dr. Ashish Warghat	Hands-on training in plant tissue culture and hydroponic cultivation
77	Ms. Ekta Choudhary	M. Pharmacy	Maharshi Dayanand University, Rohtak, Haryana	1	Dr. Vikram Patial	Hands-on training in laboratory animal handling, histopathological and molecular techniques
78	Mr. Mukul Acharya	M. Pharmacy	Shoolini University, Solan, Himachal Pradesh	1	Dr. Vikram Patial	Hands-on training in laboratory animal handling, histopathological and molecular techniques
79	Ms. Silpa Priyadarshini	M.Sc. Biotechnology	Ravenshaw University, Cuttack, Odisha	6	Dr. Aparna Maitra Pati	Evaluation of Landfill-Derived Bacterial Isolates for Pine Needle Degradation Compost Quality Enhancement and Plant Growth Promoting Potential
80	Mr. Manvinder Jaswal	M.Sc. Honours Biotechnology	Panjab University, Chandigarh	1	Dr. Shiv Shanker Pandey	Hands-on training in molecular biology and microscopy application
81	Mr. Devansh Arora	B. Pharmacy	Jamia Hamdard University, Delhi	1	Dr. Damanpreet Singh	Training in Pharmacology lab
82	Mr. Vikas Rana	Masters in Geoinformatics	Panjab University, Chandigarh	1	Dr. Amit Kumar (Environmental Technology)	Canopy cover segmentation and height modelling using multispectral drone imagery in selected forest areas of Kangra region
83	Ms. Shiva Thakur	B.Tech. Biotechnology	Shoolini University, Solan, Himachal Pradesh	1	Dr. Sanatsujat Singh	Micropropagation and Hardening of Stevia Plant
84	Mr. Sidharth Dhadwal	Masters in Geoinformatics	Panjab University, Chandigarh	1	Dr. Amit Kumar (Environmental Technology)	Spatiotemporal Earthquake Analysis, Gutenberg-Richter Modeling and Buffer-Based Seismic Vulnerability Zonation in Chamba District (1906-2025)
85	Ms. Tamanna Patial	BBA in Digital Marketing	Shoolini University, Solan, Himachal Pradesh	1	Dr. Sukhjinder Singh	Promotion of CSIR-IHBT Technologies through Digital Marketing
86	Mr. Prakhar Osatwal	B.Tech. Biotechnology	Amity University, Jaipur, Rajasthan	1	Dr. Rohit Joshi	Optimization of biochemical parameters and *in vitro* genetic transformation in *Camellia sinensis*
87	Ms. Nandini Garg	B.Tech. Biotechnology	Amity University, Jaipur, Rajasthan	1	Dr. Rohit Joshi	Studies on biochemical profiling and genetic transformation in *Camellia sinensis*
88	Mr. Sujal Katoch	M.Sc. Bioinformatics	Amity University, Noida, Utter Pradesh	2	Dr. Rituraj Purohit	Structural visualization of USP30 for exploring binding site features and lead identification

Sr. No.	Student Name	Course	Affiliation	Duration (Months)	Supervisor	Title
89	Ms. Thakore Miti Saurin	M.Sc. Biotechnology	The Maharaja Sayajirao University of Baroda, Gujarat	2	Dr. Rohit Joshi	Integrated studies on micropropagation, biochemical profiling, in silico characterization and genetic transformation in *Nardostachys jatamansi*
90	Mr. Kaushik	B.Tech. Chemical Engineering	NIT, Hamirpur, Himachal Pradesh	1.5	Er. Amit Kumari	Hands-on training experience in molecular biology techniques
91	Ms. Pallavi Anand	M.Sc. Biotechnology	Manipal University, Jaipur, Rajasthan	6	Dr. Rajiv Kumar	Identification and Characterization of Bioactive Peptides (BP_s) from *Aconitum heterophyllum* Wall ex Royle
92	Ms. Akansha Sharma	B.Sc. Biotechnology	Uttam Institute of Technology & Management, Agra, Utter Pradesh	6	Dr. Vipin Hallan	Cloning of reverse transcriptase like gene from greenhouse whitefly
93	Ms. Shailja Sharma	B.Tech. +M.Tech. Integrated Biotechnology	Amity University, Uttar Pradesh	2	Dr. Ashok Kumar Pathera	Valorisation of commonly consumed pulses through protein extraction and quantification
94	Mr. Bhiresh Kumar	M.Pharma (Pharmacology)	LR Institute of Pharmacy, Solan, Himachal Pradesh	3	Dr. Vikram Patial	Studies on the antioxidant and antisteatotic effect of IHBT-GKE in Huh7 cell line
95	Ms. Suhani Sharma	M.Sc. (FYIP) Zoology	Guru Nanak Dev University, Amritsar, Punjab	1	Dr. Gireesh Nadda	Pesticidal activity of plant extract against two-spotted spider mite, *Tetranychus urticae* Koch
96	Ms. Samridhi	M.Sc. (FYIP) Zoology	Guru Nanak Dev University, Amritsar, Punjab	1	Dr. Gireesh Nadda	Pesticidal activity of plant extract against two-spotted spider mite, *Tetranychus urticae* Koch
97	Ms. Kesar Mahajan	M.Sc. (FYIP) Zoology	Guru Nanak Dev University, Amritsar, Punjab	1	Dr. Gireesh Nadda	Insecticidal potential of plant extract against cowpea aphid, *Aphis craccivora* Koch
98	Ms. Shrinidhi M	B.Sc. Chemistry Hons. / Research	Amity University, Noida, Utter Pradesh	2	Dr. Pralay Das	Hands-on training on synthesis, isolation and characterization of organic compound
99	Ms. Amodini Rishi	Microbial & Food Technology	MCM DAV College, Chandigarh	1	Dr. Mahesh Gupta	Development and Analysis of Horse Gram Based Protein Rich Noodles
100	Mr. Aniket	B.Tech. Chemical Engineering	NIT, Hamirpur, Himachal Pradesh	1.5	Dr. Amit Kumari	Practical Training and Exposure of Natural Process and Product Development using Himalayan Bioresources
101	Mr. Rajesh Kumar	M.Sc. (Botany)	HPU, Shimla, Himachal Pradesh (Passout)	4	Dr. Amit Chawla	Training on plant ecological and ecophysiological techniques for understanding high altitude plant adaptation
102	Mr. Shivansh Jassal	B.Tech. Computer Science	Chandigarh university	1	Dr. Vishal Acharya	Design and implementation of the Front-End for in-house automated drug discovery pipeline
103	Mr. Sahil Verma	M.Pharmacy (Pharmaceutics)	MRSPTU, Bathinda, Punjab	1	Dr. Amitabha Acharya	Hands-on Training in Bioanalytical Techniques
104	Ms. Arpana Sharma	M.Sc. Biotechnology (Hons.)	Punjabi University, Patiala, Punjab	1	Dr. Ashok Kumar Pathera	Protein extraction and characterization from selected pulses

Sr. No.	Student Name	Course	Affiliation	Duration (Months)	Supervisor	Title
105	Ms. Shimran	M.Sc. Microbial & Food Technology (Hons.)	Punjabi University, Patiala, Punjab	1	Dr. Ashok Kumar Pathera	Development and Analysis of Finger Millet (*Eleusine coracana*) cookies
106	Ms. Esha Palyekar	B.Sc. Microbiology (Hons)	Amity University, Uttar Pradesh	2	Dr. Ravi Shankar	Understanding de-novo transcriptome assembly
107	Ms. Shiwali Rana	M.Sc. Biotechnology	D.Y. Patil Biotechnology and Bioinformatics Institute, Pune, Maharashtra	1	Dr. Rajiv Kumar	Hands-on Training in Proteomics and Molecular Biology Techniques
108	Ms. Aakansha Sanjay Yadav	B.Sc. Biomedical Science	NMIMS, Mumbai	2	Dr. Yogendra Padwad	Hands-on experimental training in *in vitro* cell culture, cellular assays, and cell biology studies on L6 myoblasts
109	Ms. Harshita Garg	B.Tech. Biotechnology	Shoolini University, Solan, Himachal Pradesh	1	Dr. Sarita Devi	Hands-on training of basic microbiology techniques
110	Ms. Mishti Thakur	B.Tech. Biotechnology	Shoolini University, Solan, Himachal Pradesh	1	Dr. Rajesh Kumar Singh	Hands-on training experience in molecular biology techniques
111	Mr. Jagatheshwaran	BS-MS Chemistry (Major)	IISER, Thiruvananthapuram, Kerala	2	Dr. Rituraj Purohit	Computational Modelling of Supramolecular Drug Carriers
112	Ms. Mehak	M.Sc. Biotechnology	CGC, Landran, Mohali, Chandigarh	1	Dr. Ashish Warghat	Practical exposure on plant tissue and cell culture Hydroponics & Aeroponics cultivation
113	Ms. Shivangi	M.Sc. Biotechnology	CGC, Landran, Mohali, Chandigarh	1	Dr. Ashish Warghat	Practical exposure on plant tissue and cell culture Hydroponics & Aeroponics cultivation
114	Ms. Tamanna	M.Sc. Biotechnology	CGC, Landran, Mohali, Chandigarh	1	Dr. Ashish Warghat	Practical exposure on plant tissue and cell culture Hydroponics & Aeroponics cultivation
115	Ms. Kashika Sood	BE-Biotechnology	Chandigarh university	1	Dr. Rituraj Purohit	Identification of Key Functional Residues in MurG of *Mycobacterium tuberculosis* through Computational approaches
116	Ms. Akanksha Verma	M.Tech. Agricultural systems and Management	IIT, Kharagpur, West Bengal	2	Dr. Gaurav Zinta	Phenotyping, Biochemistry and Histochemistry Analysis of *Arabidopsis thaliana* under High Temperature Regime
117	Ms. Anshika Singh	M.Sc. (AMBT)	Banasthali Vidyapith, Rajasthan	6	Dr. Aparna Maitra Pati	Unlocking Rhizobacteria from Heavy Metal Contaminated Soil: Assessment of Their Plant Growth Promoting Traits and Tolerance to Multuiple Abiotic Stress
118	Mr. Amit Kumar Singh	B.Sc. Biotechnology (Hons.)	Axis Institute of Higher Education, Rooma, Kanpur, Odisha	6	Dr. Bhavya Bhargava	*In vitro* Propagation and Genetic Fidelity Assessment of Micropropagated Plants of *Tagetes erecta L.*
119	Ms. Hridyanshi Mishra	B.Sc. Biotechnology (Hons.)	Axis Institute of Higher Education, Rooma, Kanpur, Odisha	6	Dr. Ashish Warghat	Micropropagation, Callus Development and Biochemical Analysis of *Withania somnifera*

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120	Mr. Adhikansh Verma	M.Tech. Food Technology	Shoolini University, Solan, Himachal Pradesh	1.5	Dr. Mahesh Gupta	Nutritional and Phytochemical Analysis of Plum Fruit Extract
121	Mr. Himanshu Sharma	B.Tech. Computer Science	JIMS, Greater Noida, Utter Pradesh	1	Dr. Vishal Acharya	A node.js backend developer for streamlining AI-enabled drug discovery pipeline
122	Ms. Sonal Rana	B.Sc. Biotechnology	Kanya Maha Vidyalaya (Autonomous), Jalandhar, Punjab	1	Dr. Ashish Warghat	Hands-on Training on Plant Tissue Culture
123	Mr. MD Ashiq SJ	M.Tech. Computational Biology	Pondicherry University, Puducherry	2	Dr. Ravi Shankar	Construction of Deep-learning Models to detect RNA Binding Proteins
124	Ms. Nimisha Sharma	B.Tech. Biotechnology (Research)	Shoolini University, Solan, Himachal Pradesh	1.5	Dr. Ashok Kumar Pathera	Valorisation of commonly consumed pulses through protein extraction and quantification
125	Mr. Yatharth Malhotra	B.Tech. Biotechnology	Shoolini University, Solan, Himachal Pradesh	1.5	Dr. Gireesh Nadda	Basic techniques of plant extract preparation and their evaluation against two-spotted spider mite
126	Ms. Versha Sharma	B.Tech. Biotechnology	Shoolini University, Solan, Himachal Pradesh	1.5	Dr. Gireesh Nadda	Hands-on training in basic microbiological techniques
127	Ms. Himanshi Dogra	B.Tech. Biotechnology	Shoolini University, Solan, Himachal Pradesh	1.5	Dr. Poonam Kumari	Exploring microbial communities in floricultural crops using 16S rRNA gene amplification
128	Ms. Nandini Minhas	B.Tech. Biotechnology (Research)	Shoolini University, Solan, Himachal Pradesh	1.5	Dr. Poonam Kumari	Optimizing *in vitro* culture conditions for micro propagation of rose
129	Ms. Shraiya Malhotra	M.Sc. Biotechnology	GGDSD College, Chandigarh	1	Dr. Jeremy Dkhar	Hands-on training in plant tissue culture and molecular biology techniques
130	Mr. Kuldeep Kumhar	B.Tech. Biotechnology (Research)	Shoolini University, Solan, Himachal Pradesh	1.5	Dr. Rohit Joshi	Elucidating biochemical and genetic analysis of *Camellia sinensis* in response to abiotic and biotic elicitation
131	Ms. Ellapu Hema Roshini	B.Sc. Hons. Botany	Maitreyi College, University of Delhi, New Delhi	1	Dr. Vikas Kumar	Plant collection, identification and herbarium preparation
132	Ms. Tamanna Sharma	Masters in Geoinformatics	Panjab University, Chandigarh	1	Dr. Amit Kumar	Integrating Hyperspectral and Sentinel-2 imagery for endmember extraction and spectral similarity analysis
133	Ms. Aditi Sharma	M.Sc. Hons. Biotechnology	Lovely Professional University, Phagwara, Punjab	1.5	Dr. Arun Kumar	Cloning, heterologous expression and biochemical characterization of an industrially important enzyme
134	Ms. Akanksha	B.Tech. Biotechnology	Punjab Agricultural University, Phagwara, Punjab	1	Dr. Poonam Jyoti (Inspired Faculty)	Exploration of bioinformatics and molecular biology techniques to decode microbial potential for various benefits
135	Ms. Palak	B.Tech. Food Technology	CSKHPKV, Palampur, Himachal Pradesh	4	Dr. Ashok Kumar Pathera	Development and analysis of protein enriched chips and *vigna radiata* cookies
136	Mr. Satvik	B.Tech. Food Technology	CSKHPKV, Palampur, Himachal Pradesh	4	Dr. Ashok Kumar Pathera	Development and analysis of protein enriched chips and *vigna radiata* cookies

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137	Ms. Aarushi Sood	B.Tech. Food Technology	CSKHPKV, Palampur, Himachal Pradesh	4	Dr. Vidyashankar Srivatsan	Development of Nutritionally Enriched Functional Pasta from Underutilized Green Leafy Vegetables
138	Mr. Gaurav Awasthi	B.Tech. Food Technology	CSKHPKV, Palampur, Himachal Pradesh	4	Dr. Vidyashankar Srivatsan	Development of Spirulina-based spice beverage mix: Nutritional, Functional, Phytochemical and Sensory Analysis
139	Mr. Manish Kumar	B.Tech. Food Technology	CSKHPKV, Palampur, Himachal Pradesh	4	Dr. Vidyashankar Srivatsan	Development of a ready-to-drink multi-millet beverage and evaluation of its nutritional and sensory properties
140	Ms. Akanksha Parashar	B.Tech. Food Technology	CSKHPKV, Palampur, Himachal Pradesh	4	Dr. Sandopu Sravan Kumar	Characterization of Nutritional and Nutraceutical Potential of Endangered and Underutilized Medicinal Plants
141	Ms. Rohini Sharma	B.Tech. Food Technology	CSKHPKV, Palampur, Himachal Pradesh	4	Dr. Sandopu Sravan Kumar	Optimization of Pansy (*Viola x wittrockiana*) Infusion: Bioactive Profiling and Evaluation of Antioxidant Activities
142	Mr. Kinshuk Sharma	B.Tech. Food Technology	CSKHPKV, Palampur, v	4	Dr. Prashant Kumar	Development, Proximate and Sensory Analysis of Energy bar infused with Rasayan Churna Herbs
143	Ms. Ramanpreet Kaur	B.Sc. Human Genetics & molecular Medicine	Amity University, Punjab	1	Dr. Vivek Dogra	Basic Techniques in Molecular Biology
144	Ms. Vanshika Sharma	B.Sc. Microbial & Food Technology	MCM DAV College for women, Chandigarh	1	Dr. Ashok Kumar Pathera	Development of finger millet cookies
145	Ms. Mansi Nehra	M.Sc. Life Science	NIT, Rourkela, Odisha	2	Dr. Ravi Shankar	Learning the Foundations of Bioinformatics: From Bash Commands to RNA-Seq Analysis
146	Ms. Tanvi Sharma	M.Sc. Chemistry	NIT, Jalandhar, Punjab	1.5	Dr. Dinesh Kumar	Hands-on training for chemical exploration of medicinal plants using traditional and modern approaches
147	Mr. Shubham Awasthi	M.Sc. Chemistry	NIT, Jalandhar, Punjab	1.5	Dr. Dinesh Kumar	Hands-on training for chemical exploration of medicinal plants using traditional and modern approaches
148	Ms. Shreeyashree Sahoo	Integrated M.Sc. Biotechnology	Siksha 'O' Anusandhan University, Bhubaneswar, Odisha	1	Dr. Vishal Sharma	Practical insights into Plant Tissue Culture: Instrumentation, media preparation and sub-culturing strategies
149	Mr. Rohit Jaryal	B.Tech. Biotechnology	Lovely Professional University, Phagwara, Punjab	1	Dr. Vishal Sharma	Practical insights into Plant Tissue Culture: Instrumentation, media preparation and sub-culturing strategies
150	Mr. Chirag Kumar Dua	B.Tech. Biotechnology	Lovely Professional University, Phagwara, Punjab	1	Dr. Vishal Sharma	Practical insights into Plant Tissue Culture: Instrumentation, media preparation and sub-culturing strategies

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151	Ms. Shaiyna Bhardwaj	B.Tech. Bioterchnology	Lovely Professional University, Phagwara, Punjab	1	Dr. Shiv Shanker Pandey	Basic Techniques in Molecular Biology
152	Ms. Stuti Kaushik	B.Tech. Biotechnology	Punjab Agricultural University, Ludhiana, Punjab	1	Dr. Rajesh Kumar Singh	Hands-on training experience in molecular biology techniques
153	Ms. Sanya	BS-MS	IISER, Mohali, Chandigarh	2	Dr. Upendra Sharma	Valorization of *Citrus limetta* waste: Extraction and characterization of essential oil and hydrolate for antioxidant potential and phenolic content
154	Ms. Vibhuti	B.Sc. (hons.) Biotechnology Research	Shoolini University, Solan, Himachal Pradesh	2	Dr. Rajesh Kumar Singh	Laboratory-Based Learning in Molecular Biology: Tools and Techniques
155	Mr. Bhanu Parsad	M Pharmacy	Maharaja Ranjit Singh Punjab Technical University, Bathinda, Punjab	6	Dr. Damanpreet Singh	Pharmacokinetic and *in-vivo* efficacy evaluation of IHBT-PGD-1 in experimental animal model of obesity linked Alzheimer's disease
156	Ms. Shanvi Rana	B.Tech. Biotechnology	Shoolini University, Solan, Himachal Pradesh	1.5	Dr. Amitabha Acharya	"Hands-on training on spectroscopy, microscopy and basic cell-culture techniques
157	Ms. Priyal Chawla	B.Tech. Biotechnology	Guru Govind Singh Indraprastha University, Dwarka, New Delhi	1	Dr. Vivek Dogra	Fundamental Techniques in Molecular Biology
158	Ms. Ayushi Topwal	M.Sc. (Hons.) Biotechnology	Lovely Professional University, Phagwara, Punjab	1	Dr. Sarita Devi	Hands-on Training of Basic Microbiology Techniques
159	Ms. Astha	B.Sc. Biotechnology	CGC, Jhanjeri, Mohali, Chandigarh	1.5	Dr. Sarita Devi	Exploring basic microbiological techniques through hands-on training
160	Mr. Abhishek Thakur	M.Sc. Microbiology	Shoolini University, Solan, Himachal Pradesh	2	Dr. Sandopu Sravan Kumar	Influence of Partitioning Solvents on Bioactive Composition and Antioxidant Properties of Selected Medicinal Plants
161	Mr. MD Noor Hasan	BS-MS	IISER, Tirupati, Andhra Pradesh	2	Dr. Gaurav Zinta	Genetic transformation studies in Tobacco & Amaranth
162	Mr. Sayan Acharjee	M.Sc. Biotechnology	Shoolini University, Solan, Himachal Pradesh	2.5 months (68 Days)	Dr. Vipin Hallan	Analysis of the Impact of Apple Scar Skin Viroid Infection on Cucumber Plants
163	Ms. Jhalak Yadav	BS-MS	IISER, Pune, Maharashtra	2	Dr. Rituraj Purohit	Identification of natural bioactive molecules as DXPS Inhibitors: Mechanistic insights from virtual screening and Molecular Dynamics simulations
164	Ms. Ishani Dogra	MBA	UIAMS, Panjab University, Chandigarh	1.5	Dr. Sukhjinder Singh	Socio-Economic Impact of Startups Nurtured under CSIR-IHBT
165	Mr. Apoorab Mehra	B.Sc. (Hons.) Biotechnology	Sardar Patel University, Mandi, Himachal Pradesh	3	Dr. Vipin Hallan	Cloning and characterization of RAD51 gene from Whitefly *Bemisia tabaci*
166	Ms. Lagan Jakhar	B.Tech. Biotechnology	Jaipur National University	2	Dr. Rohit Joshi	Studies on biochemical and molecular parameters during *in-vitro* organogenesis in *Picrorhiza kurroa*

Sr. No.	Student Name	Course	Affiliation	Duration (Months)	Supervisor	Title
167	Ms. Khushi Chaplot	B.Tech Biotechnology	Jaipur National University, Rajasthan	2	Dr. Vishal Sharma	Studies on *in-vitro* polyploidy induction in Picrorhiza for improvement of industrially important molecules
168	Mr. Kavish Singh Tanwar	B.Tech. Biotechnology	Jaipur National University, Rajasthan	2	Dr. Bhavya Bhargava	Basic Tools and Techniques in Plant Tissue Culture and Biotechnology
169	Mr. Gagan Singhal	B.Tech. Biotechnology	Jaipur National University, Rajasthan	2	Dr. Bhavya Bhargava	Basic Tools and Techniques in Plant Tissue Culture and Biotechnology
170	Mr. Premraj Kailas Salunkhe	B.Tech. Food Technology	Shivaji University, Kolhapur, Maharashtra	2	Dr. Upendra Sharma	Essential Oil Extraction from *Eucalyptus globulus*: A Phytochemical Study Using Conventional and NADES-Based Green Solvents
171	Mr. Sumit	M.Sc. (Hons.) Biotechnology	Punjabi University, Patiala, Punjab	2	Dr. Rohit Joshi	Elucidating physiological, biochemical and molecular parameters of large cardamom (*Amomum subulatum*) to mannitol induced drought stress
172	Mr. Keshav Khanduri	Integrated M.Sc. Biotechnology	Hemvati Nandan Bahuguna Garhwal University, Pauri Garhwal, Uttarakhand	1	Dr. Yogendra Padwad	Hands-on Training in Animal Cell Culture and Molecular Biology Techniques involved in Anti-Cancer Studies
173	Ms. Srishti Chopra	M.Sc. Biotechnology	DAV University, Jalandhar, Punjab	2	Dr. Vishal Sharma	Studies on *in-vitro* polyploidy induction in Picrorhiza for improvement of industrially important molecules
174	Ms. Shailja	M.Sc. Biotechnology	Shoolini University, Solan, Himachal Pradesh	6	Dr. Ram Kumar Sharma	Expression studies of key genes associated with abiotic stress in contrasting genotypes
175	Ms. Archie	B.Sc. (Hons.) Biotechnology	GGDSD College, Chandigarh	1	Dr. Sarita Devi	Hands-on training on the fundamentals of microbiological techniques
176	Mr. Priyam Shakya	B.Sc. Biology	Amity University, Madhya Pradesh	1	Dr. Rajesh Kumar Singh	Hands-on training experience in molecular biology techniques
177	Ms. Muskan	M.Sc. Botany	GNDU, Amritsar, Punjab	4	Dr. Ashish Warghat, Dr. Aparna Maitra Pati, Dr. Vikas Kumar	Identification of plants; basic techniques in microbiology, and plant tissue culture
178	Ms. Akanksha Kapoor	Maters in Chemistry	DAV College, Amritsar, Punjab	2	Dr. Upendra Sharma	Synthesis of diversely substituted Isoquinolones and Benzamides and their characterization
179	Mr. Ashish Amoli	M.Sc. Microbiology	Hemvati Nandan Bahuguna Garhwal University, Pauri Garhwal, Uttarakhand	7	Dr. Vipin Hallan	Incidence and Identification of Major and Emerging Viruses Infecting Low-Chilling Apple Cultivars in India
180	Ms. Aayushi	M.Sc. Microbiology	Hemvati Nandan Bahuguna Garhwal University, Pauri Garhwal, Uttarakhand	7	Dr. Vipin Hallan	Deciphering SA-Mediated Defense Responses in Tomato: Y2H Interaction Studies and ICS1 Gene Silencing
181	Ms. Shambhavi	B.Sc. Life Sciences	Sri Venkateswara College, University of Delhi, New Delhi	2	Dr. Gaurav Zinta	Molecular Cloning of *StHSFA2* in pGADT7 for Yeast 1-Hybrid Assay

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182	Mr. Venkatesh Chakraborty	B.Sc. Life Sciences	Sri Venkateswara College, University of Delhi, New Delhi	1.5	Dr. Ravi Shankar	Structure-Based Virtual Screening and Dynamic Analysis of Cardiovascular Compounds Targeting LOX-1
183	Mr. Puneet Sharma	M.Sc. Bioinformatics	Jamia Millia Islamia, New Delhi	6.5	Dr. Vishal Acharya	Integrating chemical and protein for virtual screening: A-HIOT, a deep learning-based optimization framework
184	Ms. Lavanya Singh	M.Sc. Microbiology	Kurukshetra University, Kurukshetra, Haryana	2	Dr. Sarita Devi	Isolation and characterization of microbes with various Hydrolytic potential
185	Ms. Janvi	M.Sc. (Hons.) Chemistry (Completed)	DAV University, Jalandhar, Punjab	3.5	Dr. Pamita Bhandari	Isolation and characterization of specialized metabolites from *Swertia purpurascens*
186	Ms. Reeya Arora	M.Sc. Botany (Completed)	University of Delhi, New Delhi	1	Dr. Gaurav Zinta	Basic Techniques of Biotechnology
187	Ms. Anukrati Jaiswal	B.Sc. (Hons.) Biotechnology	Vikram University, Ujjain	3	Dr. Poonam Jyoti (Inspired Faculty)	Isolation and characterization of microbes degrading BTPX (Benzene, Toluene, Phenol, Xylene)
188	Mr. Ayush Mishra	B.Sc. (Hons.) Biotechnology	Vikram University, Ujjain, Madhya Pradesh	3	Dr. Aparna Maitra Pati	Bio-prospection of Novel Microbial Strains from Himalayan Ecosystems for Waste Management and Plant Growth Promotion
189	Mr. Ridham Singh	B.Sc. (Hons.) Biotechnology	Vikram University, Ujjain, Madhya Pradesh	3	Dr. Bhavya Bhargava	Application of Plant Tissue Culture and Molecular Genetic Approaches in Ornamental Crop Improvement
190	Ms. Yukti Verma	M.Sc. Biotechnology	Govt. VYT PG Autonomous College, Durg, Chhattisgarh	3	Dr. Vandana Jaiswal	Functional Insight into *FtGAPDH10*-Mediated Heat Stress Tolerance in Buckwheat via Transient Expression
191	Mr. Navdeep	B.Sc. Biotechnology	CGC, Jhanjeri, Mohali, Chandigarh	3	Dr. Arun Kumar	Gene cloning, heterologous expression and purification of an industrially important protein
192	Mr. Parvesh	B.Sc. Biotechnology	CGC, Jhanjeri, Mohali, Chandigarh	3	Dr. Gireesh Nadda	Identification, multiplication and biopesticidal potential of native entomopathogenic fungal isolate
193	Mr. Nandan .H	M.Sc. Chemistry (Completed)	Central University of Kerala, Kerala	3	Dr. Pralay Das	Catalytic approaches for the synthesis, isolation, and characterization of organic compounds
194	Mr. Akash Manglesh	M.Pharm	Shoolini University, Solan, Himachal Pradesh	3	Dr. Yogendra Padwad	Experimental Approaches to Infectious Disease Biology: *In-vivo* ETEC-induced Enteric Disease Model, Molecular Analyses, and Hands-on Experience in Animal Cell Line-Based Assays and their Applications
195	Ms. Falguni Sahu	M.Sc. Biotechnology	GD Rungta College of Science & Technology, Bhilai, Chhattisgarh	1	Dr. Vandana Jaiswal	Hands-on training of basic techniques of DNA fingerprinting

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196	Ms. Pari Sharma	M.Sc. Microbiology	Mahatma Jyoti Rao Phoole University, Jaipur, Rajsthan	6	Dr. Ravi Shankar	Integrative Multi-Omic Characterization of Prostate Cancer Circulating Tumor Cells
197	Ms. Swayambhoo Sharma	B.Sc. Life Sciences (Completed)	Shivaji College, University of Delhi, New delhi	2	Dr. Vandana Jaiswal	Basic Molecular Techniques in Plant Biotechnology
198	Mr. Shayam Singh Maina	M. Pharmacy (Completed)	Sagar Institute of Pharmacy & Technology, Bhopal, Madhya Pradesh	6	Dr. Sandopu Sravan Kumar	Extraction and Antioxidant Activities of Bioactives from Western Himalayan Medicinal Plant viz *Urtica* spp. using Sonication Methods
199	Ms. Ashmita Kanaujia	M.Sc. Biotechnology	Mahatma Jyoti Rao Phoole University, Jaipur, Rajsthan	6	Dr. Ravi Shankar	Deciphering Chromatin remodelling in cancer through Hi-C mapping of TADs and Loops
200	Ms. Neha Thakur	Ph.D. Pharmacology	UIPS, Panjab University, Punjab	6	Dr. Damanpreet Singh	Neuroprotective potential of Food-grade Phycocyanin in a Zebrafish model of Hemorrhagic Stroke
201	Ms. Chandni Behra	M.Sc. Biotechnology	GD Rungta College of Science & Technology, Bhilai, Chhattisgarh	1	Dr. Vishal Sharma	Hands-on training on instruments and techniques of plant tissue culture for mass multiplication of planting material
202	Ms. Nitu Kumari Yadav	B.Tech. Biotechnology	UIET, Kurukshetra University, Haryana	2	Dr. Rituraj Purohit	Molecular Insights into Structure-Based Computational Modelling
203	Ms. Avnita Singh	B.Tech. computer science	Graphic Era (Deemed to be) University, Dehradun, Uttarakhand	1.5	Dr. Ravi Shankar	Application of shallow machine learning algorithms in the analysis of biomolecular data
204	Mr. Harshit	M.Sc. Botany	Indira Gandhi University, Meerpur, Rewari, Haryana	3	Dr. Amit Chawla	Training in analytical biochemistry, laboratory equipment handling, plant physiology and molecular research techniques
205	Ms. Ankita Kumari	M.Sc. Botany (Completed)	Punjab University, Chandigarh	3	Dr. Amit Chawla	Comprehensive training on laboratory equipment and physiological instruments, biochemical estimation and molecular analysis
206	Mr. Diljaap Singh	M.Sc. Biotechnology	DAV University, Jalandhar, Punjab	2	Dr. Ashish R. Warghat	Tissue culture studies of commercially important crops
207	Ms. Divya Vijyal	B.Tech. Biotechnology	UIET, Kurukshetra University, Harayana	2.5	Dr. Gaurav Zinta	Effect of tryptophan priming in *Arabidopsis thaliana* under heat stress
208	Mr. Ankur Kapil	M.Pharm (Pharmaceutics)	Jiwaji University, Gwalior, Madhya Pradesh	5	Dr. Dinesh Kumar	Hands-on training in Phytochemical Testing, Chromatographic Techniques, and Formulation Development
209	Ms. Awantika Pandey	B.Sc. (Hons.) Biotechnology	Banasthali Vidyapith, Rajasthan	3	Dr. Ram Kumar Sharma	Evaluation of Morpho-physiological and biochemical parameters under abiotic stress
210	Ms. Sneha Anand	B.Sc. (Hons.) Biotechnology	Netaji Subhash University, Jamshedpur, Jharkhand	1	Dr. Vishal Sharma	Hands-on training on facilities, instruments and techniques of Plant Tissue Culture

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211	Ms. Shradha Sharma	M.Sc. Chemistry (Completed)	Guru Nanak Dev University, Amritsar, Punjab	3	Dr. Pamita Bhandari	Extraction and isolation of alkaloids from traditional medicinal plant: *Thalictrum foliolosum* DC
212	Ms. Antra Sharma	M.Sc. Zoology	SCVB Govt. College, Palampur, Himachal Pradesh	3	Dr. Gireesh Nadda	Molecular identification, multiplication and pesticidal evaluation of native fungal isolate against, *Tetranycus urticae*
213	Ms. Ishita	M.Sc. Zoology	SCVB Govt. College, Palampur, Himachal Pradesh	3	Dr. Gireesh Nadda	Pesticidal activity of plant extracts and their fractions against two-spotted spider mite, *Tetranychus urticae* Koch
214	Ms. Neelam Kumari	M.Sc. Zoology	SCVB Govt. College, Palampur, Himachal Pradesh	3	Dr. Gireesh Nadda	Preparation of plant extract/fractions and evaluation of their insecticidal activity against Cowpea aphid, *Aphis craccivora* Koch and mosquito larvae
215	Mr. Abhay	B.Sc. Biotechnology (Completed)	DAV University, Jalandhar, Punjab	3	Dr. Shashi Bhushan	Induction and flow cytometry analysis of *in vitro* callus culture of important Himalayan medicinal plants
216	Ms. Neha Katoch	M.Sc. Botany (Completed)	Shoolini University, Solan, Himachal Pradesh	3	Dr. Rajiv Kumar	Hands on Training on Molecular Biology Techniques
217	Ms. Shreya	B.Sc. Hons. Biotechnology (Completed)	PSR Govt. Degree College Baijnath, Himachal Pradesh	2.5	Dr. Ashok Kumar Pathera	Food Composition Analysis
218	Ms. Rupali Chauhan	M. Pharmacology	Chitkara University, Punjab	3	Dr. Damanpreet Singh	Experimental Research Internship on Molecular, Cellular, and Histopathological Techniques in Neuroscience and Biomedical Research using Zebrafish and Rodent Models
219	Ms. Jaskirat	M.Sc. Hons. Biotechnology (Completed)	Punjabi University, Patiala, Punjab	3	Dr. Rituraj Purohit	Computational Strategies in Structure-Based Drug Design: From Target Identification to Lead Optimization
220	Ms. Tanuja Kapoor	M.Sc. Biotechnology	Punjabi University, Patiala, Punjab	6	Dr. Arun Kumar	Cloning, heterologous expression and purification of an industrially important enzyme
221	Ms. Tiyasa Gupta	B.Sc. Botany	Lady Brabourne College, Kolkata, West Bengal	1	Dr. Dinesh Kumar	Hands on extraction, fractionation and isolation of molecules from Bioresources (plants) and further analytical techniques (UPLC-PDA)
222	Mr. Manoj Thapa	M.Sc. Botany (Completed)	Dr. Harisingh Gour University, Sagar, Madhya Pradesh	2	Dr. Gaurav Zinta	Basic Molecular Tools to Decode Plant Thermopriming
223	Dr. Akanksha	Ph.D Plant Pathology (Completed)	Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Solan, Himachal Pradesh	2	Dr. Vishal Sharma	Evaluating the effect of various biotic and abiotic stresses on growth of different genotypes of blueberry

Sr. No.	Student Name	Course	Affiliation	Duration (Months)	Supervisor	Title
224	Ms. Shiwani	M.Sc. Zoology (Completed)	HPU, Shimla, Himachal Pradesh (Pass out)	2	Dr. Gireesh Nadda	Rearing of insect and mite pests, and evaluation of plant extracts for pesticidal activities
225	Ms. Arushi Mishra	M.Sc. Biotechnology (Completed)	Swami Vivekanand Subharti University, Meerut, Utter Pradesh	8	Dr. Ram Kumar Sharma	Phenotypic and molecular studies to elucidate stress response in tea
226	Ms. Muskan Patial	M.Sc. Biotechnology	DAV University, Jalandhar, Punjab	5	Dr. Vidyashankar Srivatsan	Role of microalgae in sustainable agriculture: Evaluation of Spirulina and Chlorella as plant growth stimulants
227	Mr. Akhilesh Kumar Lautre	M.Sc. Biotechnology	Sage University, Indore, Madhya Pradesh	3	Dr. Rajesh Kumar Singh	Molecular cloning, characterization and relative expression of Aldehyde Dehydrogenase (ALDH3I1) gene from *Crocus sativus* L.
228	Mr. Ayush Thakur	M.Sc. (Hons.) Botany (Completed)	Panjab University, Chandigarh	4	Dr. Gaurav Zinta	Dissecting the regulatory network underlying starch biosynthesis in potato (*Solanum tubersum* L.) under high temperature stress
229	Mr. Aditya Thakur	M.Sc. (Hons.) Microbiology (completed)	DAV University, Jalandhar, Punjab	3	Dr. Gireesh Nadda	Isolation, Identification, and Biopesticidal Potential of Native Entomopathogenic Fungi
230	Ms. Navjot Kaur	B.Sc. (Hons.) Dietetics and Nutrition	Guru Nanak Dev University (GNDU), Amritsar, Punjab	6	Dr. Mahesh Gupta	Optimization of processing parameters for the extraction and formulation of soup premix incorporating *Ginkgo biloba* leaves
231	Ms. Neha Devi	M.Sc. Botany (Completed)	Swami Vivekanand Govt. College Ghumarwin, Himachal Pradesh	3	Dr. Gaurav Zinta	Cloning, expression and purification of AtHSFA2 recombinant protein in *E.coli*
232	Ms. Nitika Chouhan	B.Sc. (Hons.) Chemistry	MCM DAV College, Kangra, Himachal Pradesh	3	Dr. Pamita Bhandari	Hands-on Training in Extraction and Chromatographic Techniques
233	Ms. Harshia Sharma	M.Sc. (Hons.) Completed	Punjabi University, Patiala, Punjab	2	Dr. Vishal Sharma	Hands-on training on Basic Plant Tissue Culture Techniques
234	Ms. Nidhi Ravi	PhD Chemistry	Central University of Kerala	6	Dr. Upendra Sharma	Iron catalysed synthesis of quinoline and its derivatives"
235	Ms. Vishali Sarania	M.Sc. Zoology (Completed)	SCVB Govt. College, Palampur, Himachal Pradesh	3	Dr. Vikram Patial	Hands-on training in laboratory animal handling, histopathology and molecular techniques
236	Ms. Akanksha	B.Tech Biotechnology (Completed)	Punjab Agricultural University, Ludhiana, Punjab	3	Dr. Arun Kumar	Cloning and *in planta* transformation of a fungal lytic polysaccharide monoxygenase in *Arabidopsis thaliana*.
237	Mr. Gourav Sharma	B.Sc. (Hons.) Dietetics and Nutrition	Guru Nanak Dev University (GNDU), Amritsar, Punjab	6	Dr. Ashok Kumar Pathera	Effect of cold plasma processing on nutritional and antinutritional properties of horse gram
238	Mr. Pujan Tank	B.Sc. Biotechnology	GSFC University, Vadodara, Gujrat	1	Dr. Sarita Devi	Hands on Training of Basic Microbiological Techniques

Sr. No.	Student Name	Course	Affiliation	Duration (Months)	Supervisor	Title
239	Mr. Deepankar Mondal	PhD	Guru Ghasidas University, Bilaspur Chhattisgarh	6	Dr. Yogendra Padwad	Basic training in real time PCR and western blotting of markers in β-catenin pathway
240	Ms. Jyotsna	M.Sc. Biotechnology	IIT, Bombay, Mahapatra	1	Dr. Ravi Shankar	Identification of Biomarkers for Colon Tumor through Integrated Analysis of Transcriptomic profiles and DNA methylation patterns
241	Ms. Shambhavi Sharma	B.Tech. Biotechnology	Thapar Institute of Engineering & Technology, Patiala, Punjab	5	Dr. Vivek Dogra	Characterization of melatonin biosynthetic pathway in *Setaria italica*
242	Ms. Prerna	M.Sc. Botany (Completed)	Sardar Patel University, Mandi, Himachal Pradesh	2	Dr. Vishal Sharma	Hands-on training on basic plant tissue culture instruments, equipments and processes
243	Ms. Sanjna Kumari	M.Sc. Botany (Completed)	Sardar Patel University, Mandi, Himachal Pradesh	2	Dr. Vishal Sharma	Hands-on training on basic plant tissue culture instruments, equipments and processes
244	Mr. Rishabh Verma	M.Sc. Medical Biotechnology	Pt. JNM Medical College, Raipur, Chhattisgarh	6	Dr. Vikram Patial	*In vitro* studies on the efficacy of VP-CJ-01 extract on cytokine-induced hepatic cells
245	Mr. Praveen	M.Sc. Biotechnology	Guru Jambheshwar University, Hisar, Haryana	4	Dr. Ravi Shankar	Computational analysis to understand the compositional nature of repeats
246	Mr. Ankit	M.Sc. Biotechnology	Guru Jambheshwar University, Hisar, Haryana	4	Dr. Ravi Shankar	Fundamental of Bioinformatics
247	Mr. Vishal	M.Sc. Biotechnology	Guru Jambheshwar University, Hisar, Haryana	4	Dr. Ravi Shankar	Integrated analysis of gene expression and DNA methylation patterns in acute lymphoblastic leukemia biomarkers
248	Ms. Vishakha Choudhary	M.Sc. Hons. Microbiology (Completed)	DAV University, Jalandhar, Punjab	6	Dr. Sarita Devi	Vitamin B_{12} production by some potential probiotics isolated from traditional fermented foods of Western Himalayas
249	Ms. Nenakshi Thakur	M.Sc. Bioinformatics (Completed)	Central University of Himachal Pradesh Shahpur, Himachal Pradesh	3	Dr. Vandana Jaiswal	Hands-on training on basic techniques of plant molecular biology
250	Mr. Hanish Verma	M.Sc. Bioinformatics	Central University of Himachal Pradesh, Shahpur, Himachal Pradesh	3	Dr. Vandana Jaiswal	Hands-on training on basic techniques of DNA fingerprinting
251	Ms. Shagun Chambyal	M.Sc. Zoology (Completed)	Panjab University, Chandigarh	2	Dr. Gireesh Nadda	Basic techniques in biopesticide development
252	Ms. Tisha Sharma	M.Sc. Environment Science (Completed)	Panjab University, Chandigarh	3	Dr. Amit Kumar (Environmental Technology)	Machine Learning-based Mapping of Tea Plantation and Landscape Changes in Palampur Region of Western Himalaya
253	Ms. Priya	M.Sc. Biotechnology (Completed)	DAV, Jalandhar, Punjab	3	Dr. Vidyashankar Srivatsan	Cultivation of *Chlorella spp.* and characterization of its derived bio-stimulants extracts
254	Ms. Sonia	M.Sc. Botany (Completed)	NSCBM Govt. College, Hamirpur, Himachal Pradesh	3	Dr. Vidyashankar Srivatsan	Chemical characterization of commercially available microalgae based bio-stimulants for agricultural applications

Sr. No.	Student Name	Course	Affiliation	Duration (Months)	Supervisor	Title
255	Ms. Samridhi	M.Sc. (FYIP) Zoology	Guru Nanak Dev University, Amritsar, Punjab	1	Dr. Gireesh Nadda	Hands-on training in fundamental techniques of microbiology and molecular biology
256	Ms. Harleen Kaur	B.Tech. Biotechnology (Completed)	Punjab Agricultural University, Ludhiana, Punjab	5	Dr. Vivek Dogra	Isolating *Exovasidium vexans* and studying blister blight disease in Tea germplasm
257	Ms. Awantika Pathania	M.Sc. Microbiology (Completed)	Guru Nanak Dev University (GNDU), Amritsar, Punjab	7	Dr. Poonam Jyoti (Inspire Faculty)	Understanding plant-microbe interaction using 13C isotopic labeling & GC-MS analysis.
258	Mr. Shashank Rawat	M.Sc. Biotechnology	Shoolini University, Solan, Himachal Pradesh	1	Dr. Vandana Jaiswal	Hands-on training in basic molecular biology techniques.
259	Mr. Rohan Pradhan	M.Sc. Molecular biology & biochemistry (Completed)	Guru Nanak Dev University, Amritsar, Punjab	5	Dr. Vivek Dogra	Fundamental techniques in molecular biology.
260	Ms. Garjana	M.Sc. Botany (Completed)	Gautam College, Hamirpur, Himachal Pradesh	8.5	Dr. Poonam Jyoti (Inspired Faculty)	Root exudates collection and analysis from different soil matrices and characterization of plant growth promoting traits in bacteria
261	Ms. Arnima Sharma	M.Pharmacy (Completed)	Jiwaji University, Gwalior, Madhya Pradesh	3	Dr. Ankit Saneja	Development of electrospun proliposome of pterostilbene
262	Mr. Ankur	B.Sc. Medical (Completed)	GGDSD College, Rajpur, Himachal Pradesh	1	Dr. Vishal Sharma	Hands on training on plant tissue culture applications in mass propagation of plants
263	Ms. Savita	M.Sc. Microbiology	HPU, Shimla, Himachal Pradesh	1	Dr. Shiv Shanker Pandey	Basic techniques in molecular biology
264	Ms. Preeti Thakur	M.Sc. Microbiology	HPU, Shimla, Himachal Pradesh	1	Dr. Aparna Maitra Pati	Fundamental techniques of isolation and characterization of plant growth promoting bacteria
265	Ms. Eshika Sharma	M.Sc. Microbiology	HPU, Shimla, Himachal Pradesh	1	Dr. Aparna Maitra Pati	Fundamental techniques for the isolation and characterization of the hydrolytic bacteria
266	Ms. Kavita Devi	M.Sc. Botany (Completed)	Chandigarh University, Chandigarh	4	Dr. Amit Kumar	Isolation and characterization of plant growth promoting Rhizobacteria from Agricultural Soil.
267.	Ms. Pallavi	B.Sc. Biotechnology	CGC University, Mohali, Chandigarh	2	Dr. Rohit Joshi	Micropropagation, Biochemical and Molecular profiling of various medicinal and aromatic plant species
268	Ms. Neha Priyadarshinee Champaty	B.Sc. (Hons.) Agriculture (Completed)	Siksha 'O' Anusandhan University, Bhubaneswar, Odisha	9	Dr. Amit Kumar	Assessment of soil properties and plant performance of Dragon fruit and Avocado in the Western Himalaya.
269.	Ms. Mosmi Mohan Patil	M.Sc. Biotechnology	SVKM's Mithibai College, Mumbai, Maharashtra	4	Dr. Vandana Jaiswal	CRISPR-Cas9-mediated knockout of the *LOG1* gene in *Rosa Hybrida*.
270.	Ms. Sangeeta Rotela	M.Sc. Food Science &Technology (Completed)	Lovely Professional University, Phagwara, Punjab	6	Dr. Mahesh Gupta	Study the nutritional, functional and shelf stability of probiotic coated proso flakes.

Sr. No.	Student Name	Course	Affiliation	Duration (Months)	Supervisor	Title
271.	Mr. Ayush Dhar	M.Sc. Biotechnology (Completed)	Shoolini University, Solan, Himachal Pradesh	4	Dr. Ashish R. Warghat	Micropropagation of *Clitoria ternatea.*
272.	Mr. Krishna Gill	BE CSE AI&ML (Completed)	Chandigarh University, Chandigarh	7.5	Dr. Vishal Acharya	Development of A-HIOT 2.0: A GUI-Enabled Machine and Deep Learning Framework for Enhanced Automated Hit Identification and Optimization Tool in Drug Discovery
273.	Ms. Minakshi	M.Sc. Microbiology (Completed)	HPU, Shimla, Himachal Pradesh	6	Dr. Aparna Maitra Pati	Isolation and characterization of PGPRs for plant growth promoting traits, abiotic stress tolerance and phytotoxicity assessment

Department of Industry, Himachal Pradesh signed an MoU for implementation of H.P. state chief minister start-up incubation scheme at CSIR-IHBT, Palampur. Under this scheme, incubates shown interest to establish new start-up/enterprise in the state.

Total 78 startups joined CSIR-IHBT, Palampur and 68 startups already completed the tenure and developed their prototypes. Currently 10 startups are actively working in the area of process development, food processing, tissue culture, aeroponics, floriculture, aromatic crops and herbal products under the CM Startup scheme. CSIR- IHBT has also demonstrated the incubation facilities in various events organized at state and national level for encouraging young potential incubators for new startups.

List of the start-ups joined during April 2025 to March 2026 at incubation facility at CSIR-IHBT, Palampur with their information as below:

S. No	Name of Incubates	Idea of Start-up	Mentor
1	**Nitin Azad** Village Barain, P.O. Karot, Tehsil Sujanpur, Distt. Hamirpur. Pin – 176108 Cont. No. 8219163181 Email: azadnitin1410@gmail.com	Production of disease and virus free sub tropical fruit apple plants using tissue culturing techniques.	Dr. Bhavya Bhargav Email: bhavya@ihbt.res.in
2	**Chand Kishor** Village Dhara, P.O. Fozal Teh. & Distt. Kullu. Himachal Pradesh. Pin -175129 Cont. No. 8091832488 Email: tridevchild123@gmail.com	Development of Milk fat and Honey based emulsion spread	Dr. Mahesh Gupta Email: mgupta@ihbt.res.in
3	**Purushotam Lal** Village Dhara, P.O. Fozal, Teh. & Distt. Kullu. Himachal Pradesh. Pin – 175129 Cont. No. 7018135584 Email: purushotamlal721@gmail.com	Development of Beverages using honey with lemon, kala jeera and Rhododendron in different variants instead of sugar	Dr. Mahesh Gupta Email: mgupta@ihbt.res.in
4	**Nikita Chouhan** Village-Barohal, P.O. Punchrukhi, Tehsil-Palampur, Distt- Kangra. Himachal Pradesh. Cont. No. 9816428791 Email: nikita_karan@rediffmail.com	Hebal Tilak from natural sources with Himalayan fragrance	Dr. Pamita Bhandari Email: pamita@ihbt.res.in
5	**Sagar Chand** V.P.O. Dohag, Teh Jogindernagar, Distt. Mandi. Himachal Pradesh. 175015 Cont. No. 8679172420, 9857869213 Email: sgrchnd49@gmail.com	Withania somnifera under controlled Conditions using Hydroponic practices	Dr. Ashish Wargat Email: ashishwarght@ihbt.res.in
6	**Chirag Verma** V.P.O. Dhurkhari, Tehsil Baldwara, Distt. Mandi. Himachal Pradesh. Pin- 175034 Cont. No. 7018043501 Email: chirag051098@gmail.com	Saffron production under controlled Conditions using Hydroponic practices	Dr. Ashish Wargat Email: ashishwarght@ihbt.res.in
7	**Tanishq Sodhi** Village Rajpur, P.O. Tanda, Teh Palampur, Distt. Kangra. Cont. No. 7807649932 Email: sodhitanishq333@gmail.com	Development and Marketing of Green Tea/ Black Tea, Honey, Essential Oil and Rose Water	Dr. Sanatsujat Singh Email: sanatsujat@ihbt.res.in Dr. Bhavya Bhargav Email: bhavya@ihbt.res.in Er. Mohit Sharma Email: mohit@ihbt.res.in
8	**Gurinder Kumar Vashist** Green City, Raikot, Distt. Ludhiana. Punjab- 141109 Cont. No. 9478477039 Email: gurvast@gmail.com	Development of essential oil extraction and formulation from herbs and medicinal plants and bridging between farmers and market needs.	Dr. Rakesh Kumar Rana Email: rakeshkumar@ihbt.res.in
9	**Seema Kumari** V.P.O. Banuri, Teh Palampur, Distt. Kangra. Himachal Pradesh. Pin code 176061 Cont. No. 7876506493 Email: patiyalsimran04@gmail.com	Development of flower based resin encapsulated products such as coaster, paper weight, jewelry, table tops etc.	Dr. Poonam Kumari Email: poonam@ihbt.res.in
10	**Preeti Katoch** 22 Civil lines Dharamshala, Kangra. 176215 Cont. No. 9816111119 Email: preetikatochsalaria@gmail.com	Spirulina enrich 100% vegan diet for healthy munching to kids	Dr. Vidyashankar Srivatsan Email: vshankar@ihbt.res.in

The Academy of Scientific and Innovative Research (AcSIR) was established in 2010 (by a resolution of the Government of India on July 17, 2010) and formalized by an Act of Parliament vide The Gazette of India (dated February 7, 2012). Later, it was notified as an Institution of National Importance with the mandate to undertake high-quality teaching and research in frontier areas of Science and Technology on 3rd April 2012. Consequent to this, CSIR-IHBT started its Ph.D. programme in January 2011 in the Biological and Chemical Sciences faculties under the banner of AcSIR.

To date, 500 students were registered for Ph.D. under AcSIR at CSIR-IHBT in the faculty of Biological Sciences and Chemical Sciences (Fig. 1) and 224 students have been awarded their doctoral degrees.

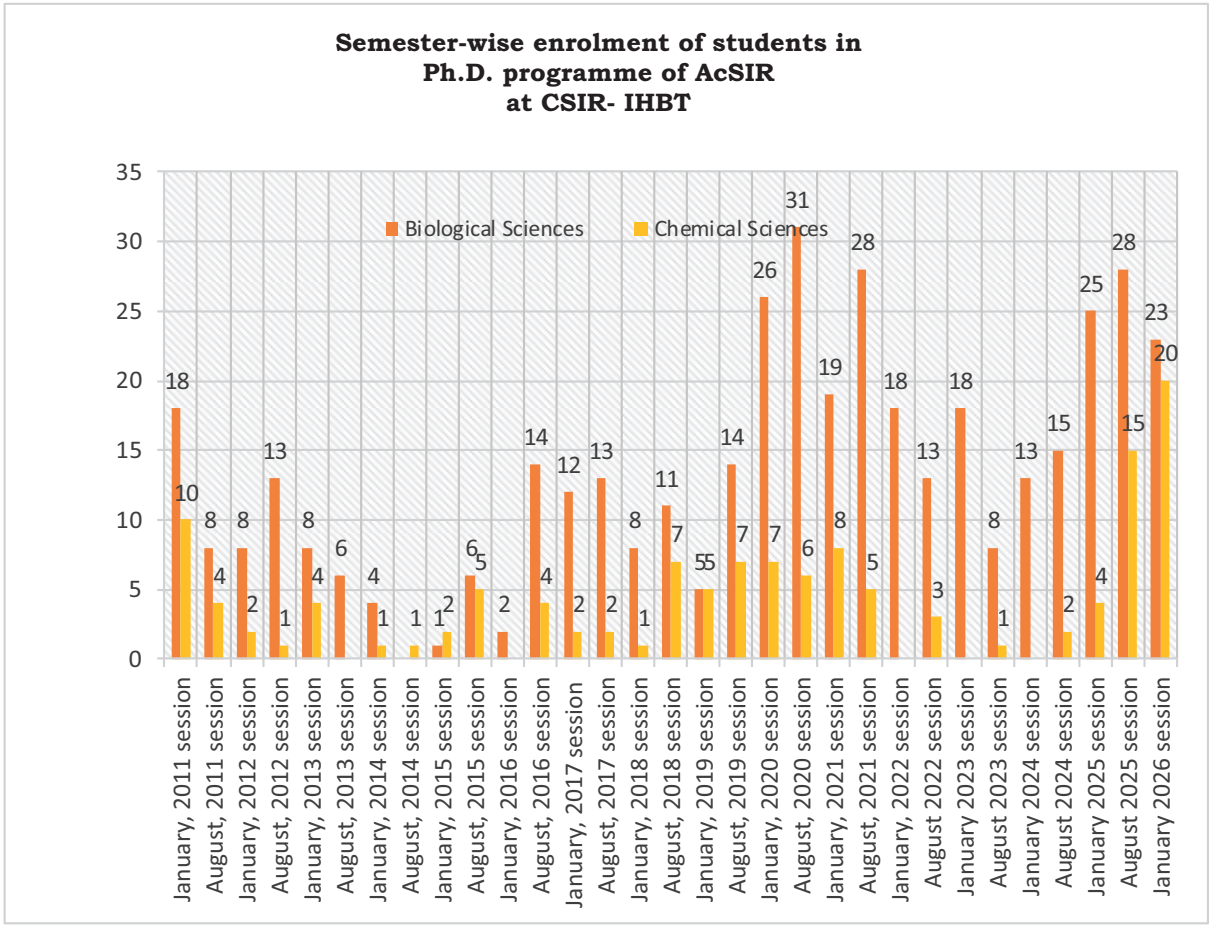

Fig. 1 Semester-wise enrolment of students in Ph.D. programme of AcSIR at CSIR- IHBT

From 1st April 2025to 31st March 2026, 33 students, successfully defended their thesis during the viva voce examinations and were awarded doctoral degree as per the following details:

Sr. No.	Enrollment No.	Name of Students	Supervisor	Faculty
1	10BB19J33007	Rahmatkar Shubham Nilkanth	Dr. Damanpreet Singh	Biological Sciences
2	10CC20J33035	Pushkar Mehra	Dr. Pralay Das	Chemical Sciences
3	10BB20J33020	Ajay Kumar	Dr. Sanatsujat Singh	Biological Sciences
4	10BB20J33011	Rahul Dev Gautam	Dr. Sanatsujat Singh	Biological Sciences
5	10BB18J33002	Bittu Ram	Dr. Amit Chawla	Biological Sciences
6	10BB16A33011	Nandita Mehta	Dr. Amit Chawla	Biological Sciences
7	10BB20J33026	Mamta Masand	Dr. Ram Kumar Sharma	Biological Sciences
8	10CC19A33031	Ashish Kumar	Dr. Pralay Das	Chemical Sciences
9	10BB19J33001	Anish Tamang	Dr. Vipin Hallan	Biological Sciences

Sr. No.	Enrollment No.	Name of Students	Supervisor	Faculty
10	10BB17J33010	Sunil Kumar	Dr. Amit Kumar	Biological Sciences
11	10CC19A33035	Rohit Bains	Dr. Pralay Das	Chemical Sciences
12	10BB20J33017	Vivek Dhiman	Dr. Amit Kumar	Biological Sciences
13	10BB20A33033	Ruchika	Dr. Ankit Saneja	Biological Sciences
14	10CC19A33034	Rishabh Kaundal	Dr. Dinesh Kumar	Chemical Sciences
15	10BB16J33002	Lakhbir Singh	Dr. Amit Chawla	Biological Sciences
16	10CC21J33005	Shivani Puri	Dr. Upendra Sharma	Chemical Sciences
17	10BB21J33006	Monika Kumari	Dr. Narendra Tirpude Vijay	Biological Sciences
18	10BB20J33016	Rakesh Kumar Dhritlahre	Dr. Ankit Saneja	Biological Sciences
19	10BB17A33003	Kanchan Yadav	Dr. Kunal Singh	Biological Sciences
20	10CC21A33004	Prateek Singh Bora	Dr. Upendra Sharma	Chemical Sciences
21	10BB20A33009	Savita Chaudhary	Dr. Vipin Hallan	Biological Sciences
22	10CC20J33039	Vandana Kumari	Dr. Dinesh Kumar	Chemical Sciences
23	10BB19A33014	Priyanka Bhardwaj	Dr. Shiv Shanker Pandey	Biological Sciences
24	10BB19J33011	Abhishek Goel	Dr. Yogendra S. Padwad	Biological Sciences
25	10BB20J33027	Priya Kumari	Dr. Vandana Jaiswal	Biological Sciences
26	10CC20A33006	Rajender Kumar	Dr. Dinesh Kumar	Biological Sciences
27	10BB19A33019	Savita Kumari	Dr. Damanpreet Singh	Biological Sciences
28	10BB20A33037	Shiwani Randhawa	Dr. Amitabha Acharya	Biological Sciences
29	10BB20A33005	Shikha Sharma	Dr. Ram Kumar Sharma	Biological Sciences
30	10BB20A33002	Amit Kumar	Dr. Damanpreet Singh	Biological Sciences
31	10BB20A33031	Ashwani	Dr. Rajiv Kumar	Biological Sciences
32	10BB20J33009	Babit Kumar Thakur	Dr. Probir Kumar Pal	Biological Sciences
33	10BB20A33003	Anita Kumar	Dr. Rohit Joshi	Biological Sciences
34	10BB20A33018	Pravesh Kundu	Dr. Gaurav Zinta	Biological Sciences
35	10BB20A33001	Komal Goel	Dr. Gaurav Zinta	Biological Sciences
36	10BB21A33001	Abhisha Roy	Dr. Vipin Hallan	Biological Sciences
37	10BB21J33030	Ravi Kumar	Dr. Vishal Acharya	Biological Sciences
38	10CC21J33001	Poonam Sharma	Dr. Pralay Das	Chemical Sciences
39	10CC21J33006	Raman Singh	Dr. Upendra Sharma	Chemical Sciences
40	10BB20J33018	Kiran Dhiman	Dr. Jeremy Dkhar	Biological Sciences
41	10BB21J33018	Nabab Khan	Dr. Ankit Saneja	Biological Sciences
42	10BB20J33001	Manju Kumari	Dr. Shiv Shanker Pandey	Biological Sciences
43	10BB20A33019	Dipanshu Ghosh	Dr. Vivek Dogra	Biological Sciences
44	10CC21J33003	Mehak Sharma	Dr. Upendra Sharma	Chemical Sciences
45	10BB20A33014	Sumanta Mahopatra	Dr. Vivek Dogra	Biological Sciences
46	10BB20A33032	Diksha Kalia	Dr. Rajesh Kumar Singh	Biological Sciences
47	10BB20A33021	Joel Jose S	Dr. Rajesh Kumar Singh	Biological Sciences
48	10BB20A33038	Vishek Choudhary	Dr. Vandana Jaiswal	Biological Sciences
49	10BB22J33018	Neha Bhardwaj	Dr. Ankit Saneja	Biological Sciences
50	10BB20A33012	Madhushree Dutta	Dr. Gaurav Zinta	Biological Sciences
51	10BB19A33012	Nymphaea Arora	Dr. Vishal Acharya	Biological Sciences
52	10BB20J33031	Ankita Thakur	Dr. Shiv Shanker Pandey	Biological Sciences

Summit on Smart & Sustainable Agriculture

Institute hosted a Summit on Smart & Sustainable Agriculture on April 22, 2025. Prof. Rajat Sandhir, Director, PU-IIT Ropar Regional Accelerator for Holistic Innovations (PI-RAHI) highlighted the role of smart & sustainable agriculture and its need in the changing time. He detailed about the summit objectives and stressed on adopting latest technologies that are not only environment friendly but also user friendly. Mr V.R. Lazaga, Vice-Chairman, Cooperative Development Authority, Network for the Development of Agricultural Cooperatives in Asia and the Pacific (NEDAC), Philippines, deliberated upon the role of NEDAC that has a prime focus on bringing together small rural producers to form large business ventures for exporting a wide range of agricultural products. Mr. Jyoti Saroop, Unati Co-operative Marketing-cum-Processing Society Ltd., Talwara, Punjab shared his views on how cooperatives have a key role to play in such initiatives. Prior to this, Dr. Sudesh Kumar Yadav, Director, CSIR-IHBT, presented the welcome address and dwelled in the detail about the bioresource based activities being carried out in the institute. He emphasized that through CSIR mission programmes like the Aroma Mission, Floriculture Mission, Phytopharmaceutical Mission; the institute has been able to sustainably boost the bioeconomy of the region through the formation of farmer clusters and by linking them to the industry. Participants from 10 states including Punjab, Haryana, and Himachal Pradesh participated in the programme.

13th Foundation Day of AcSIR

The 13th Foundation Day of AcSIR was celebrated on 3rd April, 2025 with great enthusiasm at CSIR-IHBT, Palampur. The event featured an engaging lineup of activities, including poster presentations, essay competitions, T-shirt painting, and a vibrant rangoli competition, all showcasing the creativity and enthusiasm of AcSIR students. The main ceremony was held in the SS Bhatnagar Auditorium of the CSIR-IHBT, Palampur. The event commenced with a welcome speech by the AcSIR Science Club Members of CSIR-IHBT. Dr. Sudesh Kumar Yadav, Director, CSIR-IHBT addressed the gathering, appreciating the enthusiasm and contributions of students and faculty members. Dr. Manoj Kumar Dhar, Director, AcSIR delivered a virtual talk, enriching the discussions with his expertise and providing valuable insights into contemporary research challenges and advancements. Dr. Ram Kumar Sharma, Associate Dean (BS) briefed about AcSIR's growth and achievements. A key highlight of the event was the presentations of published research papers by three AcSIR PhD scholars, each of whom showcased ground breaking work in their respective fields. The event also featured an expert lecture on "Ethical Practices in AI-Assisted Scientific Writing" by Dr. Aditya Nigam from IIT Mandi.

International Tea Day

Institute celebrated International Tea Day on May 21st, 2025 at CSIR-IHBT. Shri Brij Bihari Lal Butail, Chairman, Kangra Co-operative Tea Factory was the chief guest of the function. Also, Mr. Rajiv Sood, Founder, Himalayan Brew Tea Company and Mr. Hemchandra Agarwal, Factory Advisory Officer, Tea Board of India were the guest of honor of the function. Dr. Sudesh Kumar Yadav, Director, CSIR-IHBT, proudly deliberated the institute's remarkable efforts in conservation, characterization, and popularization of the renowned Kangra tea.

Through its scientific advancements and dedicated research, CSIR-IHBT continues to shape the future of sustainable tea cultivation. From the fascinating history of tea to its promising future, the event was a wonderful confluence of tradition, innovation, and sustainability, reinforcing tea's significance in our heritage and daily lives.

National Technology Day

Institute celebrated National Technology Day on 15th May, 2025 with Innovation and Impact. Ms. Suchita Singh delivered an insightful keynote lecture on harnessing nature-derived BioActive for modern therapeutics. The Institute marked National Technology Day with enthusiasm, showcasing India's technological strides and commitment to self-reliance. The event, inaugurated by Dr Sudesh Kumar Yadav, Director, CSIR-IHBT, where hehighlighted the institute's transformative role in advancing innovation. Under the Aroma, Floriculture & Phytopharma Missions, farmers are empowered with modern cultivation & processing techniques. Heeng saplings were distributed to farmers in Himachal Pradesh, supporting sustainable agriculture & livelihoods. It was an inspiring day celebrating science, partnerships, and progress.

World Environment Day

Institute celebrated World Environment Day on 5th June, 2025 on the theme "Beat Plastic Pollution". Dr. Sudesh Kumar Yadav, Director, CSIR-IHBT, welcomed the guests and extended his wishes on the occasion. He highlighted the activities of the institute in the areas of waste degradation, composting, ecological restoration, forest fires, climate change, and environmental conservation. He emphasized that it is our prime responsibility to protect the environment and curb the plastic menace. Dr. VM Tiwari, Director, CSIR - North East Institute of Science and Technology, Jorhat, delivered a lecture on "Water Management for Economy and Environment" wherein he stressed upon the importance of water in well-being and overall growth. Water scarcity and its implications were also presented by him. Prof. TR Sharma, ICAR National Professor, BP Pal Chair, Former DDG (Crop Sciences), ICAR National Institute for Plant Biotechnology, IARI, Pusa Campus, New Delhi, was the Chief Guest of the occasion. In his address, he emphasized that we owe our existence to the environment, and its degradation is threatening the survival of one and all. He raised concerns over the increasing microplastics and pesticides in the surroundings, and exhorted the gathering to protect the environment and to be the vigilant citizens. As a part of the programme, the institute signed four material transfer agreements. CSIR-IHBT also distributed ornamental plants to the school students from Cambridge International School, Palampur, under the CSIR-JIGYASA program.

International Yoga Day

Institute celebrated International Yoga Day on 21st June,2025 on the campus with this year's theme "Yoga for One Earth, One Health"., Dr. Sudesh Kumar Yadav, Director, CSIR-IHBT and staff members, including research scholars, have enthusiastically participated and benefited from the yogic exercises and meditation session demonstrated on this special day. The event was graced by the presence of a Yoga teacher, Sh. Hitesh Rai from The Art of Living, Palampur. He stressed the importance of performing daily Yoga for overall performance and mental wellness in a challenging profession of science. Director, CSIR-IHBT, Dr. Sudesh Kumar Yadav, in his address, also emphasises the need for the physical, mental, and spiritual benefits of yoga.

Brainstorming meet on sports health & nutrition

A brainstorming meet on sports, health and nutrition was held at CSIR-IHBT, Palampur on 16th June, 2025. Experts including Dr. Amrinder Singh _Guru Nanak Dev University, Amritsar_, Dr. Vani Bhushanam (Sports Authority of India, Delhi , and Dr. Ankush Jagota (Paprola Ayurvedic College, Paprola) () were invited to share their insights as speakers. The sessions were followed by a panel discussion.

CSIR-IHBT Foundation Day

CSIR-IHBT celebrated its 43rd Foundation Day on 2nd July, 2025 with grandeur and purpose. The event was graced by distinguished dignitaries: Dr. V.K. Paul, Hon'ble Member, NITI Aayog (Chief Guest), Dr. A.K. Tripathi, Director, IISER Mohali (Guest of Honour), and Dr. T.R. Sharma, National Professor, Ex-DDG (ICAR). On the occasion, the Dr. Sudesh K. Yadav, Director, CSIR-IHBT highlighted the institute's four-decade journey of scientific excellence and societal impact. Dr. T. R. Sharma delivered an inspiring talk on "How the discovery of a new gene created a silent revolution in rice breeding." He also emphasized IHBT's role in carrying forward the legacy of its founding visionaries. Guest of Honour, Dr. A. K. Tripathi, lauded IHBT's diverse research, especially under the CSIR-Aroma Mission, and emphasized the transformative power of science and technology. Chief Guest, Dr. V.K. Paul, commended the institute's contributions and underscored the importance of research methodology, execution, and societal relevance in scientific pursuits. On this special occasion, dignitaries also participated in a tree plantation drive, symbolizing IHBT's commitment to sustainability.

Herbal Sector Stakeholder Meet

National Level Herbal Sector Stakeholder Meet 2025 was organised at CSIR-IHBT on 02-03 July, 2025. Over 250 participants from industry, academia, policymaking bodies, NGOs, FPOs, and progressive farmers from different states such as Himachal Pradesh, Punjab, Haryana, Odisha, Leh, Jammu, and Uttarakhand participated in the meet. The conference aimed to catalyze innovation, inclusivity, and collaboration in herbal product development under the theme "From Challenges to Collaboration.

One Day as a Scientist

One Day as a Scientist (ODAS) was celebrated at CSIR-IHBT from 21-25 July, 2025. A total of 454 students participated from 26 different schools from 04 districts of Himachal Pradesh. CSIR-IHBT ranked 1st position in student participation amongst Biological Labs and 4th in all 37 CSIR labs, as per online registration portal data.

राज्य स्तरीय पंडित चंद्रधर शर्मा गुलेरी जयंती

भाषा एवं संस्कृति विभाग द्वारा सी. एस.आई.आर.–हिमालय जैव संपदा प्रौद्योगिकी संस्थान,पालमपुर, के सहयोग से राज्य स्तरीय पंडित चंद्रधर शर्मा गुलेरी जयंती का आयोजन 7 जुलाई, 2025 को संस्थान में किया गया। कार्यक्रम में मुख्य अतिथि के रूप में डॉ. सुदेश कुमार यादव निदेशक, सी. एस.आई.आर.,पालमपुर उपस्थित रहे। कार्यक्रम में विशिष्ठ अतिथि के रूप में वरिष्ठ साहित्यकार डॉ. गौतम शर्मा व्यथित तथा पंडित चंद्र शर्मा गुलेरी जी के वंशज डॉ. अदिति गुलेरी और डॉ. आशुतोष गुलेरी उपस्थित रहे।

79th Independence Day

CSIR-IHBT celebrated the 79th Independence Day of India on 15 August, 2025 with pride, joy, and patriotism. Dr. Sudesh Kumar Yadav, Director, CSIR-IHBT, while speaking on this occasion, has emphasised the role of science and technology in bringing societal changes and positively contributing to the growth of the nation. He inspired and motivated CSIR-IHBT staff and scholars by narrating the science success story within CSIR-IHBT, CSIR, and India for achieving the goal of Viksit Bharat @2047. The Director also flagged hosting virtually at CSIR-IHBT high-altitude centre, CeHAB, Ribling, Lahul Spiti. On this occasion, various sports activities were also organized for staff members, their children, and research scholars, followed by a vibrant and talented cultural programme. A great enthusiasm and active participation was seen, and that has created a very cheerful and patriotic environment. The occasion also witnessed the inauguration of the Creche by Mrs. Kavita Yadav, President of the Ladies Club, CSIR-IHBT, in the scientist's apartment, to facilitate the staff members and to create a nurturing and safe environment for the kids, while their parents are working. The function was concluded with the prize distribution for various Independence Day sporting events held in the month of August and on the occasion of Independence Day 2025.

National Sports Day

CSIR-IHBT celebrated National Sports Day 2025 on 28th Aug,2025 with a spirited observance of the FIT India Pledge, administered by Dr. Sudesh Kumar Yadav, Director, CSIR-IHBT. Staff and scholars gathered with enthusiasm, reaffirming their commitment to fitness, well-being, and a healthier lifestyle. The event gained momentum with a walkathon that traced a scenic route from the Admin Block to IHBT Apartments (D-type) and back to the Colony Cricket Ground. The initiative not only promoted physical activity but also fostered a sense of unity and collective motivation among participants. With this energetic beginning, CSIR-IHBT set a dynamic tone for the upcoming National Sports Day activities, reinforcing the institute's dedication to holistic wellness and community engagement.

National symposium on sustainable development and conservation of Himalayan Bioresources

The "National symposium on sustainable development and conservation of Himalayan Bioresources" held by the CSIR-Institute of Himalayan Bioresource Technology,Palampur concluded on 2-3 September, 2025, with over 100 participants. In his inaugural address, Dr. Sudesh Kumar Yadav, Director of CSIR-IHBT, welcomed guests and described the institute's recent activities in conservation, value addition, and bioprospection aimed at generating bio-economy. Dr. Rakesh Sehgal from the National Institute of Technology, Hamirpur, praised the event and emphasized the importance of collaborative problem-solving. Dr. PK Joshi from Jawaharlal Nehru University discussed the application of sensor-based imaging technologies for resource mapping and temporal analysis.

The symposium featured 15 oral and 57 poster presentations by students. Two technology transfer agreements were signed, and an exhibition showcased related products. Winners of various competitions were also recognized.

Himalaya Diwas

CSIR-IHBT celebrated Himalaya Diwas 2025 on Thursday, 4th Sep, , 2025, with the theme "Himalaya and Disasters". The event featured a keynote lecture by Prof. Ambrish Kumar Mahajan, Central University of Himachal Pradesh, Dharamshala on "Increasing Himalayan Disasters and the Need for Disaster-Resilient Infrastructures". Prof. Mahajan highlighted the growing risks posed by anthropogenic activities and stressed the urgent need for robust frameworks and policies to safeguard our fragile mountain ecosystems. The session sparked vibrant discussions and insightful questions from attendees, reaffirming our collective commitment to the region.

Ayurveda Day

Institute celebrated the 10th National Ayurveda Day on 23rd Sep, 2026 by organising a medical health camp with the consultation of Dr. Satish Gandharv, Dean In-Charge of the National Institute of Ayurveda, Panchkula. The event highlighted the significance of integrating traditional Ayurvedic practices into the modern healthcare system for holistic health and well-being.

National Pharmacovigilance Week

National Pharmacovigilance Week was successfully celebrated in the Institute on 25th Sep, .2025. In the event, expert talks on 'Pharmacovigilance and Materiovigilance' were delivered by Prof. Bikash Medhi, Professor, Dr Ajay Prakash, Additional Professor, and Dr. Vipul Bharti, Junior Resident Physician, PGIMER, Chandigarh. Other than staff and students of CSIR-IHBT, the event witnessed enthusiastic participation of medical and paramedical staff and students from Rajiv Gandhi Government PG Ayurvedic College, Paprola, Vivekanand Medical Institute, VMRT, and Capt. Saurabh Kalia Memorial Nursing College, Palampur. The event highlighted the importance of prioritizing patient safety and advancements in pharmacovigilance.

हिंदी पखवाड़ा

संस्थान में 9 से 23 सितम्बर, 2025 तक हिंदी पखवाड़ा का आयोजन किया गया। 23 सितम्बर 2025 को हिंदी दिवस के मुख्य समारोह का आयोजन किया गया। इस अवसर पर संस्थान की पत्रिका हिमसंपदा वैज्ञानिकी का विमोचन भी किया गया। विभिन्न प्रतियोगिताओं के विजेताओं को पुरस्कृत भी किया गया।

CSIR Foundation Day

CSIR-IHBT celebrated the 84th CSIR Foundation Day on 08th Oct, 2025 with fervor and gaiety. Dr. Sudesh Kumar Yadav, Director, CSIR-IHBT, welcomed all the guests and wished them on the occasion. He highlighted the role of CSIR and the activities of the institute towards nation-building. Prof. RP Tiwari, Hon'ble Vice Chancellor, Central University of Punjab, Bathinda, was the Chief Guest of the function. He complimented the CSIR and the institute on its glorious journey. He exhorted the gathering to adopt a nature-friendly lifestyle and play a role in the conservation and management of Himalayan bioresources. He referred to Himalaya as the living laboratory that provides goods and services for human well-being. Dr. Ravikrishna Chebolu, Distinguished Scientist and Head of the CSIR-Innovation Complex, Mumbai, was the Guest of Honor. He delivered the keynote address on Global Trends in Healthcare and India's Alignment. Dr. Ravikrishna lucidly expressed the opportunities and advantages that India has in this sector and how it can promote global good. He emphasized the emergence of personalized healthcare and the role of artificial intelligence in this context.

India International Science Festival (IISF) Curtain Raiser

Institute organised Curtain Raiser Program of India International Science Festival (IISF) 2025 on 14th Nov, 2025. On this occasion, 220 students and 21 faculty members from PM SHRI Girls School Rampura Mandi (Distt. Bathinda, Punjab), GSSS Jol Sappar (Distt. Hamirpur, H.P.), PM SHRI GSSS Nagrota Suriyan (Distt. Kangra H.P.), and Neugal Public School, Palampur (Distt. Kangra H.P.) have participated.

77th Republic Day

Institute celebrated the 77th Republic Day of India on 26th Jan,, 2026 with great enthusiasm and patriotic spirit. Addressing the gathering, Dr. Sudesh Kumar Yadav, Director, CSIR-IHBT highlighted India's remarkable progress across diverse sectors, driven by science, technology, and innovation. He underscored the pivotal role of CSIR in nation-building and its contributions towards the vision of Viksit Bharat. Emphasizing inclusivity, he also spoke about the significant role of women in science and CSIR's continued efforts in aligning research and innovation with national development goals. Several indigenous technologies developed by CSIR and now globally recognized were cited as examples of India's growing scientific leadership.

National Science Day

Institute celebrated National Science Day on 6th March, 2026 on the theme "**Women in Science: Catalyzing Viksit Bharat**". The program was graced by eminent dignitaries including Dr. Shekhar C. Mande as Chief Guest, Prof. S.K. Sopory as Guest of Honor, and Dr. Sridevi Annapurna Singh. Dr. Sudesh Kumar Yadav, Director, CSIR-IHBT, highlighted key achievements in bio-economy, livelihood development, floriculture, and aroma missions. Major highlights included the release of variety of *Inula racemosa* "*Him Pushkarmool*," inauguration of Jaivsampada Udyan, 06 technology transfer agreements, an MoU with Chitkara University, and the launch of stevia-based products. Women staff members were also honored on this occasion for their contributions in science of the institute.

International Women's Day

Institute celebrated International Women's Day on 13th March, 2026. The day is celebrated to commemorate women's fight for equality and liberation, as part of the women's rights movement. Dr. Sudesh Kumar Yadav, Director, CSIR-IHBT, in his welcome address, highlighted the importance of the day and the role of women in science, society, sports, and other fields. He emphasized equal opportunities for women and their safety. Dr. (Mrs.) Jatinder Kaur Arora, Advisor, Northern Region Science & Technology Cluster: PI- RAHI, Punjab State Council for Science and Technology, was the chief guest of the occasion. She highlighted women in changing times and the various initiatives they have led. Advocate Adarsh Sood and Mrs. Nitika Bhandari were the guests of honour. Mr. Sood presented on various legal initiatives and deliberated in detail on the POSH Act, while Mrs. Bhandari highlighted the social movement and societal issues relating to women. Felicitation of inspiring women entrepreneurs and female administrative staff of the institute was also carried out during the programme. On the occasion, a workshop on "Strengthening of Inner-Self" for the female staff and students of the institute was also organized with an exhibition of creative.

National workshop on Science Popularization

The two-day national workshop jointly organized by CSIR-IHBT and CSIR-NIScPR commenced on a high note on 14th October, 2025, bringing together over 150 enthusiastic student participants from across India. The workshop aims to foster inclusive science communication and empower young minds to connect science with society. The inaugural session began with the lighting of ceremonial diyas, symbolizing the illumination of knowledge and collaboration. Dr. Geetha Vani Rayasam, Director, CSIR-NIScPR, delivered the welcome address, setting the tone for the workshop's vision. Shri C.B. Singh, Chief Scientist, CSIR-NIScPR, outlined the workshop's objectives and structure for the guests and participants. Shri Balendu Dadhich and Dr.

K.G. Suresh emphasized the strategic use of technology, AI, and media in enhancing the reach and impact of science communication. Dr. Manoj Kumar Patairiya, former Head of NCSTC, shared his deep insights on the critical role of science communication in shaping an informed and empowered society. Dr. Sudesh Kumar Yadav, Director, CSIR-IHBT, highlighted the importance of inclusivity in science outreach and the role of digital tools in making science accessible to all. He encouraged participants to engage not only with the scientific community but also with the broader public. The session concluded with a heartfelt vote of thanks by Dr. Manish Mohan Gore, CSIR-NIScPR, acknowledging the collaborative spirit and inspiring contributions of all speakers and participants.

Empowering Chamba (aspirational district)

A conference entitled "Empowering Chamba (aspirational district): Driving sustainable growth with CSIR-IHBT's cutting-edge technologies" held at CSIR-IHBT Palampur during 19-20 November, 2025. More than 150 farmers, scientists, start-ups, industry people, self-help group, students participated in this conference.

NEW FACULTY SCHOLAR SEMINAR SERIES

Under the direction of Director Dr. Sudesh Kumar Yadav, the Institute launched the "New Faculties-Scholar Seminar Series" to further strengthen academic exchange and foster collaboration between faculty and research scholars. This initiative was designed to provide a platform for newly recruited scientists to share their research interests and for doctoral students to present their ongoing work, thereby enriching the intellectual environment of CSIR-IHBT.

The series officially commenced on 23rd May 2025 under the coordination of Dr. Amit Kumar, Ms. Priya Chaudhary and student coordinator Ms. Shivani Randhawa. Over the course of the program, six newly recruited scientists delivered talks highlighting their research areas and innovative ideas, while ten doctoral students presented their work, offering valuable insights into their scholarly pursuits.

Each session was marked by active participation, with stimulating discussions and constructive feedback from peers and faculty members. The initiative not only showcased the diverse expertise of new faculty but also provided students with an opportunity to refine their presentation skills and engage in meaningful academic dialogue.

The New Faculties-Scholar Seminar Series concluded successfully on 7th November 2025, leaving a lasting impact by encouraging fresh perspectives, fostering collaboration, and strengthening the academic fabric of the Institute.

PATENTS / PUBLICATIONS

INTELLECTUAL PROPERTY

PATENT FILED

1. Anmol, Sharma M, Sharma M and Sharma U (2025) Hydro distillation process for extraction of essential oil from the peel of citrus species by using natural deep eutectic solvent as cosolvent. (087NF2025/IN Filling date 09-Apr-2025, Application No. 202511035298).
2. Saiyed T, Reddy SGE, Patel PB, Jayamma SM and Nagaraj AB (2025) Crude ethyl acetate leaf extract, a composition, processes of preparation and application thereof. (0045NF2025/WO Filling date 08-Oct-2025, Application No. PCT/IN2025/051627).
3. Hallan V, Tamang A, Pandey SS, Kumar Y, Singh RM and Kumar D (2025) A process for enhancing secondary metabolite content in medicinal plants. (0140NF2024/WO Filling date 26-Dec-2025, Application No. PCT/IN2025/052148).
4. Anmol, Sharma, R and Sharma U (2026) A process for preparation of crystalline atisinium chloride from non-alkaloid reaction. (0187NF2025/IN Filling date 07-Jan-2026, Application No. 202611001930).
5. Acharya A, Dhiman R, Kaur H, Randhawa S, Saini TC, Bathla M, Pal PK and Yadav SK (2025) Antibacterial formulation comprising of peppermint oil nanoemulsion and cellulose nanocrystals of *Mentha piperita*. (0233NF2024/WO Filling date 30-Jan-2026, Application no. PCT/IN2026/050162).

PATENT GRANTED

1. Das P, Chauhan AS and Kumar A (2025) Metal catalyst and hydrogen gas free approaches for selective reduction of aldehyde to methyl group of different substituted furans (2022). 3NF2019/CN Filing date: 22-Sep-2022, Application No.: 202180023466.1, Grant date: 31-Mar-2025, Patent No.: ZL 202180023466.1.
2. Agnihotri VK, Kumar B and Gautam HK (2025) A synergistic formulation against acne and a process for the preparation thereof (2021). 0193NF2018/JP Filing date: 28-Sep-2021, Application No.: 2021-557843, Grant date: 16-May-2025, Patent No.: 7682800.
3. Kumar V, Kumar S and Singh D (2025) A bioprocess for the simultaneous production of polyhydroxybutyrate and violacein pigment from Himalayan bacterium Iodobacter sp. PCH 194 (2020), 041NF2020/IN Filing date: 12-Sep-2020, Application No.: 202011039834, Grant date: 10-Dec-2025, Patent No.: 575620.
4. Das P, Yamini, Bharti R, Shankar R, Kumar VB, Purohit R, Singh D, Anand P and Padwad SY (2026) Bioactive benzocycloheptane analogues from himachalenes useful for the treatment of PI3K and MK2 related disorders (2020), 0053NF2020/IN Filing date: 19-Oct-2020, Application No.: 202011045582, Grant date: 20-Feb-2026, Patent No.: 581106.
5. Das P, Chauhan AS and Kumar A (2026) Metal catalyst and hydrogen gas free approaches for selective reduction of aldehyde to methyl group of different substituted furans (2022), 0143NF2019/US Filing date: 18-Aug-2022, Application No.: 17/800701, Grant date: 10-Mar-2026, Patent No.: 12570624.

PUBLICATIONS

1. Aroor M, Kachra A and Gupta M (2025) Effect of Postharvest Drying Techniques on Metabolomic Variation in *Myrica esculenta* Fruits. ACS Food Science and Technology, https://doi.org/10.1021/acsfoodscitech.5c00251.
2. Arora N, Rana AK, Singh D and Acharya V (2025) Differential Roles of Neuro-Inflammatory Regulator, MAPK11 in Cortex and Hippocampus Following Post-Stroke Cognitive Impairments in Rats. Journal of Neuroimmune Pharmacology, https://doi.org/10.1007/s11481-025-10255-w.
3. Bains R, Kumar M, Chauhan AS, Kumar A and Das P (2026) Synthetic approach for the oxidative depolymerization of biomass-derived lignin to vanillin, vanillic acid, and acetovanillone compounds. Bioresource Technology Reports, https://doi.org/10.1016/j.biteb.2026.102676.
4. Baliyan N, Goel A, Sharma SK, Gupta M, Padwad YS and Kumar R (2025) Integration of Conjugated Linoleic Acid–Producing Probiotic Strains Having Anti-adipogenic Properties with Honey and Oyster Mushrooms for the Formulation of Non-dairy Probiotic Beverage. Probiotics and Antimicrobial Proteins, https://doi.org/10.1007/s12602-025-10525-2.
5. Bathla M, Saini TC, Teji N, Randhawa S, Bhardwaj R and Acharya A (2025) Nanoenabled Sequestration of Redox Copper Modulates Lysozyme Aggregation

and Maintains Lipid Homeostasis to Alleviate Mitochondrial Health. Small, http://DOI:10.1002/smll.202508683.

6. Bhardwaj N, Kaliya K, Yadav SK and Saneja A (2025) Synthesis, characterization and biological evaluation of formononetin derivatives as anticancer agents. Medicinal Chemistry Research, 34: 1974–1988.

7. Bhardwaj P, Jain R, Rawat N, Joshi R, Kumar A, Pandey SS and Kumar S (2025) Naganishia liquefaciens ARY7, a psychrophilic yeast endophyte improves plant low temperature acclimation through auxin and salicylic acid signaling. Physiologia Plantarum, 177: e70267.

8. Bhardwaj P, Singh RM, Dhyani D and Hallan V (2026) First report of wild roses as natural hosts of apple stem grooving virus in India. Journal of Plant Pathology, https://doi.org/10.1007/s42161-025-02013-x.

9. Bhardwaj R, Kumar A, Sharma R, Pati AM and Agnihotri VK (2026) Unveiling the chemical composition and biological potential of essential oils from distinct parts of *Solidago virgaurea* L. from Western Himalayas. Natural Product Research, https://doi.org/10.1080/14786419.2026.2625895.

10. Bharti A, Sharma A and Uniyal SK (2025) Traditional foods of Pangwal and Bhot communities: a cross-cultural comparison in Pangi Valley, Himachal Pradesh, India. Discov Food, https://doi.org/10.1007/s44187-025-00448-w.

11. Bittu Ram and Chawla A (2026) Understanding the carbon-growth trade-off in the Himalayan shrubline forming shrub species: insights from non-structural carbohydrates dynamics. Plant Physiology Reports,https://doi.org/10.1007/s40502-026-00941-z.

12. Chandar R, Sharma R and Agnihotri VK (2025) Natural β-Citronellol Derivatives as Potential Dual Enzyme Inhibitors for the Treatment of Type 2 Diabetes and Alzheimer's Diseases. Natural Product Research, https://doi.org/10.1080/14786419.2025.2572038.

13. Chaudhary N, Bhangalia T, Walia S, Vaghela PK, Ghosh A and Kumar R (2025) Evaluation of red seaweed derived biostimulants and nutrients effect on quinoa (*Chenopodium quinoa* Willd.) performance in the Western Himalayas. Journal of Applied Phycology, https://doi.org/10.1007/s10811-025-03633-7.

14. Choudhary A, Mali S, Pandey K, Thorat SA, Kundu P, Vishal, Singh S, Pandey GK and Zinta G (2026) Long-distance trafficking of mineral elements from soil to seed under climate change impacts crop nutritional quality. Plant, Cell & Environment, https://doi.org/10.1111/pce.70507.

15. Chouhan M, Kumar P and Kumar R (2025) iTRAQ-Based Proteomic Approach to Study Stress Memory Responses in Plants. Plant Stress memory, Methods and Protocols, https://doi.org/10.1007/978-1-0716-4981-7.

16. Chouhan M, Saini V, Singh RK and Kumar R (2026) Method development for virus-induced gene silencing in *Picrorhiza kurroa*, as an alternative tool for functional genomics. The Nucleus, https://doi.org/10.1007/s13237-026-00648- 4.

17. Dar AI, Randhawa S, Verma M, Saini TC and Acharya A (2025) Debugging the dynamics of protein corona: Formation, composition, challenges, and applications at the nano-bio interface. Advances in Colloid and Interface Science, 342: 103535.

18. Dev K, Sharma R, Sharma SK, Pati AM and Agnihotri VK (2025) Comparative chemical profiling, antimicrobial potential, and integrative network pharmacological assessment of *Pinus roxburghii* Sarg. essential oils. Natural Product Research, https://doi.org/10.1080/14786419.2025.2598055.

19. Dev R and Gupta M (2026) Development and Optimization of Nutritional, Functional and Shelf Stable Kodo Millet-Incorporated Beverage Mix. Journal of Food Process Engineering, https://doi.org/10.1111/jfpe.70445.

20. Dev R, Chauhan P, Shambhvi and Gupta M (2025) Development of finger and barnyard millet-based probiotic soup mix incorporated with bioactive flower waste of Himalayan region. Food Chemistry Advances, https://doi.org/10.1016/j.focha.2025.101084.

21. Devi B, Dogra V, Mali Sm, Nayyar H, Rathour R and Sharma KD (2025) *Sugar transporter protein* (STP) genes in Chickpea. Tropical Plant Biology, https://doi.org/10.1007/s12042-025-09421-4.

22. Devi F, Bhardwaj R and Singh A (2026) Assessment of population status and distribution modelling of *Polygonatum cirrhifolium* (Wall.) Royle: an astavarga medicinal plant in the Himachal

Pradesh, India. Proceedings of Indian National Science Academy, https://doi.org/10.1007/s43538-026-00699-w.

23. Devi J, Dhrek MS and Bhushan S (2025) Cultivating Natural Pigments: A Cellular Approach. Journal of Human Nutrition & Food Science, 13(2): 1198.

24. Devi K, Sharma A, Kumar P, Pal PK and Kumari A (2025) Comparative evaluation of mogroside extraction parameters in fresh and dried *Siraitia grosvenorii* fruits using a validated UPLC-DAD method. Food Measurement and Characterisation, https://doi.org/10.1007/s11694-025-03984-2.

25. Devidas SB, Kashyap U, Bhandari P and Reddy SGE (2025) Insecticidal activities of agro waste of *Carya illinoinensis* (Wangenh.) K. Koch for the management of sucking pests. Biocatalysis and Agricultural Biotechnology, https://doi.org/10.1016/j.bcab.2025.103837.

26. Dhiman K, Devi M and Dkhar J (2025) The acid phosphatase-containing digestive fluid secreted by *Nepenthes khasiana* pitchers inhibits plant growth, possibly due to the presence of heat-stable growth-inhibitory molecules. Botany Letters, 1-13.

27. Dhiman P, Kumar R and Singh D (2026) Nitric oxide synthase dysregulation in hyperammonemia: opportunities and challenges toward therapeutic targeting to combat neurological complications. Neurochemical Research, DOI: 10.1007/s11064-026-04706-w.

28. Dhiman R, Kumar P, Pawar L, Rai SK, Purohit R and Yadav SK (2026) Cobalt-based hybrid nanoflowers for the sustainable synthesis of a high-value health sugar D-sorbose. International Journal of Biological Macromolecules, 150829.

29. Dhiman S, Garla A, Kumari A, Jariyal S, Jamwal S, Kumar A and Kumar R (2026) Post-harvest handling effect on chemical composition and antibacterial properties of rose-scented geranium essential oil cultivated in the Western Himalayas. Indian Journal of Natural Products and Resources (IJNPR), https://doi.org/10.56042/ijnpr.v17i1.21499.

30. Dhiman S, Negi N, Sharma AK, Kumari A, Ghosh A and Kumar R (2026) Seaweed-Derived Organic Fertilizer Enhances Biomass, Essential Oil Yield, and Bioactive Compounds in *Pelargonium graveolens* L'Her.: A Sustainable Approach to Agricultural Productivity. Journal of Essential Oil Bearing Plants, https://doi.org/10.1080/0972060X.2025.2604608.

31. Diman A, Mishra A, Singh R, Swarnkar M, Kumari P and Dogra V (2025) Glandular Prickles in *Rosa hybrida* Accumulate specific sesquiterpenes implicated in defense against aphid pests. Biocatalysis and Agricultural and Biotechnology, https:doi.org/10.1016/j.bcab.2025.103785.

32. Dogra S, Lepcha A, Yadav SK and Pati AM (2026) Microplastic Pollution in Agricultural Soils: Microbial Interactions, Food-Chain Risks, and Management Strategies with special reference to High-Altitude Agroecosystems. Environmental Research, https://doi.org/10.1016/j.envres.2026.123949.

33. Dubey N, Mathan L, Patidar S and Singh K (2025) The *StTNLC7G2T1* enhances resistance to biotic stress in Arabidopsis via pathogen triggered immunity. Physiology and Molecular Biology of Plants, https://doi.org/10.1007/s12298-02501681-4.

34. Gahlaut V and Jaiswal V (2025) Transposable elements: mediators of epigenetic inheritance in plants. Trends in Plant Science, https://doi.org/10.1016/j.tplants.2025.12.003.

35. Gangwar H, Gahlaut V and Jaiswal V (2025) Myo-inositol phosphate synthase (MIPS) as a molecular hub: Regulating plant growth and stress adaptation. Plant Science, https://doi.org/10.1016/j.plantsci.2025.112936.

36. Ghosh D, Thakur S, Bali S, Sharma S and Dogra V (2026) Comparative genome-wide analysis in *Setaria italica* and *Arabidopsis thaliana* revealed functional conservation of specific FtsH proteases under high light and heat stress. Plant Cell Reports, https://doi.org/10.1007/s00299-026-03754-4.

37. Gore DD, Mishra N, Kumar D, Jena G, Jachak SM, Tikoo K, Bansal AK and Singh IP (2025) Anti-inflammatory activity, stability, bioavailability and toxicity studies on seabuckthorn polyphenol enriched fraction and its phospholipid complex (Phytosomes) preparation. International Journal of Biological Macromolecules, 297: 139919.

38. Gupta A and Purohit R (2025) Decoding ROCK1 Inhibition: A Comprehensive Computational Analysis of Key Binding Determinants for Rational Design of Novel Neurotherapeutics. Archives of

Biochemistry and Biophysics, https://doi.org/10.1016/j.abb.2025.110643.

39. Gupta A, Thind AS and Purohit R (2025) EGFR AP: a predictive machine learning model for assessing small molecule activity against the epidermal growth factor receptor. RSC Medicinal Chemistry, https://doi.org/10.1039/D5MD00361J.

40. Gupta H, Kapoor P, Soni V and Bhargava B (2026) Silver nanoparticles and graphene oxide synergistically improves the postharvest life of *Narcissus tazetta* L., a wild ornamental flower. Postharvest Biology and Technology, 232: 113954.

41. Gupta S, Jyoti, Bhati U, Kesarwani V and Shankar R (2025) PTF-Vāc: An explainable and generative deep co-learning encoders-decoders system for ab-initio discovery of plant transcription factor binding sites. Plant Communications, https://doi.org/10.1016/j.xplc.2025.101543.

42. Gupta S, Kumar A, Kesarwani V, Bhati U and Shankar R (2025) DMRU: generative deep learning to unravel condition-specific cytosine methylation in plants. Briefings in Bioinformatics, 26(6): bbaf579.

43. Gupta SS, Kesarwani V, Shankar R and Sharma U (2025) Chemoinformatic Exploration of Synthetically Accessible N-Heterocycles: Uncovering New Antifungal Lead Candidates. In Silico Pharmacology, 13: 74, https://doi.org/10.1007/s40203-025-00359-9.

44. Gupta T, Upadhyay J, Yadav SK and Joshi R (2025) Integrating herbgenomics with systems biology approaches for sustainable utilization of medicinal plant resources. Drug Discovery Today, 31(1): 104555.

45. Gusain S, Joshi S, Kumar V, Kumar A, Yadav SK and Joshi R (2025) Inter-relationship between biomass accumulation, photosynthetic efficiency, and antioxidant mechanism during culm proliferation of *Berberis lycium* and *Zanthoxylum armatum*. Plant Physiology Reports, https://doi.org/10.1007/s40502-025-00907-7.

46. Gusain S, Kumar R and Joshi R (2025) Abscisic acid-mediated modulation of morpho-physiological traits and transcript accumulation improves drought resilience in *Crocus sativus* L. Biochimica et Biophysica Acta (BBA)-General Subjects, 1869(11): 130849.

47. Gusain S, Kumar R and Joshi R (2025) Elicitation with $CaCl_2$ and SNP enhance antioxidant defense and regulate transcriptional changes in drought-stressed saffron. Plant Cell Reports, https://doi.org/10.1007/s00299-025-03590-y.

48. Harsh B, Kumar R, Asrani RK, Santoshrao JG, Bisht E, Katoch S, Sharma V, Patial V and Kumar A (2025) Synergistic hepatoprotection by supplementing *Saussurea costus* (falc.) lipsch and *Glycyrrhiza glabra* L. in combination against Diethylnitrosamine-induced liver damage in rats. Drug and Chemical Toxicology, https://doi.org/10.1080/01480545.2025.2564431.

49. Hopak NE and Chawla A (2025) Key eco-physiological leaf traits suggest a moderate to high level of thermal tolerance of alpine plants in the Western Himalaya. Frontiers in Plant Physiology, 3: 1652412.

50. Jamwal S, Kumar R, Asrani RK, Verma A, Bisht E, Katoch S and Patial V, Sharma V, Kuma A and Patil RD (2025) Ameliorative effect of *Inula racemosa* Hook. F root extract against diethyl nitrosamine induced hepatic damage in murine model. Journal of Ayurveda and Integrative Medicine, 16(4): 101173.

51. Jaryal P, Pathak P, Jaiswal V and Warghat AR (2025) Identification of an endangered and medicinally important Himalayan orchid, *Dactylorhiza hatagirea* D.Don Soo using DNA barcodes and development of an efficient in vitro propagation protocol utilizing embryo culture technique. In Vitro Cellular & Developmental Biology – Plant, https://doi.org/10.1007/s11627-025-10556-y.

52. Joshi S, Nath J, Bagri J, Kumari K, Roy A, Yadav SK, Pareek A and Joshi R (2025) High-Efficiency Regeneration and Transformation System in *Nardostachys jatamansi* for Functional Genomics and Bioactive Compounds Enrichment. Plant, Cell & Environment, https://doi.org/10.1111/pce.70263.

53. Kalia D, Santhi JJ, Sheikh FR and Singh RK (2026) Florigen Activation Complex Dynamics and SVP-Mediated Repression Orchestrate Temperature-Regulated Flowering in Saffron. Plant Biotechnology Journal, https://doi.org/10.1111/pbi.70361.

54. Kandpal KC, Meenakshi, Shambhavi, Anchal S, Verma A, Venkat GS and Kumar A (2025) HimMedCrop—A Unique Digital Geo-tagged Repository of Medicinal

Plants under Cultivation in the Indian Northwestern Himalayas. National Academy Science Letters, https://doi.org.10.1007/s40009-025-01839-4.

55. Kandpal KC, Yog Raj, Manisha, Meenakshi, Kumar R and Kumar A (2025) Hyperspectral remote sensing and machine learning approaches for precise prediction of *Ocimum basilicum* L. Yield. International Journal of Remote Sensing, https://doi.org/10.1080/01431161.2025.2562604.

56. Kanika, Ashrita, Pandey SS, Kumar P, Kumar D and Warghat AR (2025) Insight into hydroponic nutrient solution mediated morpho-physiological, iridoid glycosides accumulation and gene expression modulations in *Picrorhiza kurroa* Royle ex Benth. Plant Biotechnology Reports, 19: 741–761.

57. Kapoor S, Mehta P, Patiala V, Pandey R and Padwad YS (2025) Phloretin induced modulation in gut microbiome, mitigates colonic inflammation and alleviates colitis-associated colorectal cancer in mice. Computational and Structural Biotechnology Journal, https://doi.org/10.1016/j.csbj.2025.06.016.

58. Kashyap A and Kumar A (2026) Climate-driven landscape transitions and emerging ecological instability in the Western Himalayas revealed by machine learning (1994–2024). Theoretical and Applied Climatology, 157: 2.

59. Kaundal R and Kumar D (2025) Current demands for standardization of Indian medicinal plants: A critical review. Medicine in Drug Discovery, DOI: https://doi.org/10.1016/j.medidd.2025.100211.

60. Kaundal R and Kumar D (2025) *Viola* species of western Himalayas as a potential medicinal spice for health benefits: A comprehensive review on ethnobotany, pharmacology and phytochemistry. Pharmacological Research-Natural Products, 15: 100179.

61. Kaundal R, Kumar A, Sharma A, Kumar R, Tirpude NV and Kumar D (2025) Validated UPLC-PDA method for concurrent estimation of polyphenols and anti-inflammatory evaluation of edible *Viola canescens*. Wall. x Roxb. Food and Humanity, https://doi.org/10.1016/j.foohum.2025.100790.

62. Kaundal R, Kumar R and Kumar D (2025) Optimized extraction technique and solvent to enhance the recovery of bioactive polyphenols from *Viola canescens* wall. Ex Roxb. A case study using OFAT and chemical characterization using UPLC-PDA, UHPLC-Q-TOF-IMS and GC–MS. Microchemical Journal, 212: 113170.

63. Kaur E and Acharya V (2025) Computational prediction of *Homo sapiens*–Candida albicans protein–protein interactions reveal key virulence factors using dual RNA-Seq data analysis. Archives of Microbiology, 207: 115.

64. Kaushal P and Pati AM (2025) Unleashing rhizobacteria for sustainable soil remediation: PGPR roles in heavy metal tolerance, detoxification, and plant productivity. Frontiers in Microbiology, https://doi.org/10.3389/fmicb.2025.1662000.

65. Kaushal P and Pati AM (2026) Mechanistic insights of bioremediation potential of *Bacillus altitudinis* and its impact on rice grown under contaminated soil. Archives of Microbiology, https://doi.org/10.1007/s00203-026-04757-1.

66. Khan N and Saneja A (2025) Spectroscopic and structural investigations of quercetin/sulfobutylether-β-cyclodextrin inclusion complex incorporated pH – responsive electrospun nanofibers for colon – specific delivery. Journal of Molecular Structure, https://doi.org/10.1016/j.molstruc.2025.142652.

67. Khan N and Saneja A (2026) Development and characterization of a solid self-emulsifying delivery system to enhance dissolution of naringenin using maltodextrin as wall material. Journal of Food Measurement and Characterization, 20: 2280–2295.

68. Khan N, Bhardwaj N and Saneja A (2026) Structural and physicochemical characterization of formononetin encapsulated β-cyclodextrin nanosponges for improved anticancer activity. Journal of Molecular Structure, https://doi.org/10.1016/j.molstruc.2025.144904.

69. Khan N, Rana N and Saneja A (2026) Development of a Sustainable Ready-to-Brew Edible Film Using Pullulan/PVA-PEG Copolymer for Instant Beverage Applications. Food Bioprocess Technology, https://doi.org/10.1007/s11947-026-04251-y.

70. Khan N, Yadav SK and Saneja A (2025) Development of electrospun pullulan nanofibers encapsulating naringenin/

sulfobutylether-β-cyclodextrin inclusion complex for rapid dissolution and antioxidant activity. International Journal of Biological Macromolecules, https://doi.org/10.1016/j.ijbiomac.2025.147961.

71. Km Swati and Bhandari P (2025) Comparative analysis of chemical profiles of *Swertia* species. Indian Journal of Chemical Society, DOI: https://doi.org/10.1016/j.jics.2025.101781.

72. Kumar A and Kumar SS (2026) A comprehensive review on phytoconstituents, health benefits and post-harvest processing of *Amomum subulatum* Roxb. Journal of Food Science and Technology, 63: 401–417.

73. Kumar A and Singh D (2025) Temporal dynamics of c-Fos expression in a Zebrafish larva model of pentylenetetrazole-induced seizures. Zebrafish, http://doi:10.1177/15458547251401472.

74. Kumar A, Kaundal R and Kumar D (2025) Development and validation of a rapid and accurate ultra performance liquid chromatography-photodiode array method for concurrent quantification of thirty-two polyphenols in edible fruit of *Cordia myxa* Linn. Journal of Chromatography A, https://doi.org/10.1016/j.chroma.2024.465609.

75. Kumar A, Partap M and Warghat AR (2025) From Growth to Survival: Aux/IAA Genes in Plant Development and Stress Management. Plant Science, 112750.

76. Kumar A, Saini SK and Singh D (2025) Embryonic exposure to flaxseed oil during early development protects against seizures in zebrafish larvae via targeting BDNF/TrkB-mediated GABAergic inhibition. Food Bioscience, 68: 106701.

77. Kumar A, Thakur S and Kumar R (2026) Digital convergence in Agri-Tech: Reviewing the role of advanced technologies in enabling precision and sustainability. Agronomy Journal, 118(2): e70310.

78. Kumar K, Joel Jose-Santhi, Mandal A, Yadav SK and Singh RK (2026) Development of a Cell Suspension System and Efficient Protoplast Transfection for Functional Genomics in Saffron (*Crocus sativus* L.). South African Journal of Botany, https://doi.org/10.1016/j.sajb.2026.03.017.

79. Kumar M, Bhardwaj R, Kumar A and Kumar D (2025) New Insights into the Quality Control Strategies of *Inula racemosa* Hook. F.(Pushkarmula) and *Saussurea lappa* Decne. (Kuth): Medicinal Crops of Alpine Himalaya. Journal of Chromatographic Science, 63(2): bmaf009.

80. Kumar N and Jaiswal V (2025) Complete Chloroplast Genomes of two medicinal orchids from the Himalaya *Habenaria intermedia* and *Herminium edgeworthii*: Implications for DNA barcoding, phylogenetics, and conservation. South African Journal of Botany. https://doi.org/10.1016/j.sajb.2025.10.054.

81. Kumar P and Purohit R (2025) Refining the Trapping of Therapeutic Agent Silybin A in Functionalized β- and γ-Cyclodextrin Cavitands for Improved Supramolecular Complexation. Journal of Chemical Information and Modeling, https://doi.org/10.1021/acs.jcim.5c00625.

82. Kumar P, Anmol, Awasthi S, Tonk RK, Sharma M and Sharma U (2025) A benchmark UPLC-based method for concurrent analysis of seventeen *Stevia rebaudiana* metabolites (steviol, isosteviol, and fifteen steviol glycosides) in a single analytical run and its implementation in diverse products. Food Chemistry International, https://doi.org/10.1016/j.foodres.2025.117931.

83. Kumar R, Dhiman P and Singh D (2025) Zebrafish as a model organism to study neurotoxicity: A potential tool for neuroprotective drug discovery. Current Drug Metabolism, http://doi:org/10.2174/0113892002418502251128110509.

84. Kumar R, Dhiman P, Saini SK and Singh D (2025) Downregulation of glycogen synthase kinase-3 beta by Urtica dioica L. contributes to neuroprotection against aluminum chloride-mediated neurotoxicity in zebrafish larvae. Molecular Neurobiology, 62(12): 16431-16447.

85. Kumar R, Dkhar J and Kumar V (2025) *Cremanthodium kalaiselviae* (Asteraceae), A new species from the Indian Himalaya. Annales Botanici Fennici, 62: 183-188.

86. Kumar R, Kaur R, Ranout AS and Nadda G (2025) A Review on Novel Formulations and Delivery Systems of Botanical Insecticides for Enhanced Efficacy. Neotropical Entomology, 54: 81.

87. Kumar R, Kaur R, Ranout AS, Singh S, Chauhan R, Singh S and Nadda G (2026) First Record of *Myzus persicae* (Hemiptera: Aphididae) Infesting Heeng, *Ferula assa-foetida* L. International Journal of Tropical Insect Science, https://doi.org/10.1007/s42690-026-01766-x.

88. Kumar R, Rana S, Kaundal R and Kumar D (2025) Isolation and characterisation of acetylcholinesterase, tyrosinase enzyme, and free radical inhibitors from aerial part of *Allium semenovii* Regel. Natural Product Research, https://doi.org/10.1080/14786419.2025.2559761.

89. Kumar S, Hegde AS, Srivatsan V and Padwad YS (2026) UHPC-QTOF-IMS-based phytochemical characterization and evaluation of antimicrobial Potential of *Prunus cerasoides* Fruit Extract Against Gastrointestinal Pathogens. Food Research International, https://doi.org/10.1016/j.foodres.2026.119025.

90. Kumar S, Kumar V and Singh D (2025) Secretory expression and optimization of type II L-asparaginase from *Pseudomonas* sp. PCH199. Journal of Chromatography B, 1267: 124814.

91. Kumar V, Chandel S, Rana S and Singh D (2025) Comparative genomics and functional analysis of *Rahnella* sp. PCH160 revealed metal stress tolerance and plant growth-promotion traits. Microbiological Research, 128264.

92. Kumar V, Prasad A, Goel A, Sharma VK, Lore JS and Kumar A (2026) Host-induced silencing of Rhizoctonia solani 5-enolpyruvylshikimate-3-phosphate synthase impairs its virulence in rice. Plant Biotechnology Journal, https://doi.org/10.1111/pbi.70582.

93. Kumar V, Thakur K, Kirschner J and Štěpánek J (2025) A new species of *Taraxacum* (Compositae, Crepidinae) from Arunachal Pradesh, India: Sexual reproduction detected in the group of *Taraxacum sikkimense*. Phytotaxa, 720(3): 263-272.

94. Kumar R, Kaundal R and Kumar D (2025) Cloud point extraction, antioxidant, α-glucosidase, and tyrosinase enzyme inhibition activities of *Allium semenovii* Regel. Separation Science and Technology, https://doi.org/10.1080/01496395.2025.2534918.

95. Kumari A, Bhati U, Shankar R, Yadav SK, Sopory SK and Joshi R (2025) Genome-wide identification, characterization, and expression pattern analysis of the glyoxalase gene family in *Phyllostachys pubescens* during abiotic stresses. BMC Plant Biology, 25: 1364.

96. Kumari A, Devi K, Sharma P, Sharma RK and Joshi R (2026) Optimization of an efficient micropropagation system from the axillary buds of *Phyllostachys pubescens*: Chinese moso bamboo. In Vitro Cellular and Developmental Biology-Plants, https://doi.org/10.1007/s11627-025-10590-w.

97. Kumari A, Joshi R and Yadav SK (2025) Prospects and potential for sustainable food and nutritional security in North Western Himalayan region. (2025). Indian Journal of Plant Genetic Resources, 38(02): 145-154.

98. Kumari A, Kaundal R, Kumari P and Kumar D (2025) Comprehensive UHPLC-Q-TOF-IMS based non-targeted metabolome analysis of *Rhynchostylis retusa*. L Blume revealed chemometric variations. A case study from Western Himalayas. Biochemical Systematics and Ecology, 123: 105092.

99. Kumari A, Kumari V, Sharma P, Kumar D, Sharma RK and Joshi R (2025) Development of a robust in vitro propagation protocol, assessment of genetic fidelity, and metabolite analysis of *Ajuga parviflora* Benth. In Vitro Cellular and Developmental Biology-Plant, 61: 738–758.

100. Kumari G, Sood M and Kumari P (2025) Micropropagation of Miniature Rose cv. Ice Fairy: Impact of growth regulators on *in-vitro* shooting and rooting. Journal of Environmental Biology, 46(5): pp.739-747.

101. Kumari K, Mittal S, Sharma K, Singh S, Upadhyay J, Acharya V, Kadyan V, Yadav SK and Joshi R (2025) Deep learning and machine learning modeling identifies thidiazuron as a key modulator of somatic embryogenesis and shoot organogenesis in *Ferula assa-foetida*. Biology, 14(12): 1703.

102. Kumari K, Devi K, Kaachra A, Yadav SK and Rohit Joshi (2026) UV-C mediated regulation of key biosynthetic genes for higher accumulation of pharmacologically significant bioactive secondary metabolites in friable callus cultures of *Ferula assa-foetida*. Journal of Photochemistry and Photobiology B: Biology, 274: 113348, https://doi.org/10.1016/j.jphotobiol.2025.113348.

103. Kumari M, Kumar P, Saini V, Joshi R, Shankar R and Kumar R (2025) Transcriptional landscape illustrates the diversified adaptation of medicinal plants to multifactorial stress combinations linked with high altitude. Planta, 261(5): 1-25.

104. Kumari P and Jaiswal V (2025) Exploring LOG genes: drivers of prickle evolution in the plant kingdom. Plant Molecular

Biology, https://doi.org/10.1007/s11103-025-01657-8.

105. Kumari P, Gangwar H, Gahlaut V, Kumari P and Jaiswal V (2025) Identification of a natural *RcLOG1* allele linked to prickle development in Rose (*Rosa* spp.). Planta, https://doi.org/10.1007/s00425-025-04817-8.

106. Kumari P, Kaundal R, Kumar R, Walia YK and Kumar D (2026) Metabolome Analysis and Functional Activities of *Euphorbia royleana* Boiss. Indicating Potential Health Benefits. Chemistry & Biodiversity, https://doi.org/10.1002/cbdv.202503217.

107. Kumari V, Kumar D, Kumar M and Kumar D (2025) Pharmacognostical Traits and GC–MS-Based Chemical Profiling of *Ajuga parviflora* Benth as Quality Control Perspectives. Microscopy Research and Technique, 88(7): 2085-97.

108. Kundu P, Thorat SA, Kiran A, Goel K and Zinta G (2025) Plant-derived triterpenoid saponins: multifaceted roles and bioengineering prospects. Plant Cell Report, 44(8): 172.

109. Majeed A, Devi A, Sharma B, Masand M, Sandal S and Sharma RK (2025) Microsatellite marker resource, genetic diversity, bottleneck, and expected habitat inferences for conservation of critically endangered *Saussurea costus* (Falc.) Lipsch. Journal of Applied Research on Medicinal and Aromatic Plants, https://doi.org/10.1016/j.jarmap.2025.100673.

110. Mamta, Pandey SS, Kaachra A, Vashisath S, Kumar D and Kumar S (2025) Optimization of carbon and nitrogen utilization for enhanced photosynthesis, biomass and yield by coexpression of phosphoenolpyruvate carboxylase, aspartate aminotransferase and glutamine synthetase in *Brassica juncea*. Plant Biotechnology Journal, https://doi.org/10.1111/pbi.70120.

111. Manisha, Kandpal KC, Meenakshi, Dhiman V, Pati AM and Kumar A (2025) High-performance hyperspectral remote sensing and machine learning algorithms for detection of blister blight in *Camellia sinensis*. Agronomy Journal, 117(2), 10.1002/agj2.70060.

112. Manisha, Ranjan A, Aggarwal SG, Singh S, Uniyal SK, Bambal VK and Sharma SK (2026) Long-Term Relationship of Atmospheric Trace Gases, Aerosols and Meteorology Over the Western Himalayan Region of India. MAPAN, https://doi.org/10.1007/s12647-026-00916-3.

113. Maurya AK, Priya and Agnihotri VK (2025) Metabolic profiling for analyzing chemotype variation in vegetative parts of *Valeriana jatamansi* Jones using NMR, GC-MS and UPLC/ESI-MS/MS. Natural Product Research, DOI:10.1080/14786419.2025.2568208.

114. Maurya AK, Yadav V, Aggarwal G, Vashisath S and Agnihotri VK (2025) Chemical profiling and α-glucosidase activity of *Artemisia maritima* and *Artemisia dracunculus* from Northwestern Himalaya, India. Journal of Essential Oil Research, 37: 239-248.

115. Meghana, Arvind, Verma A, Phenome India Consortium and Patial V (2026) Burden of MASLD and liver fibrosis: evidence from Phenome India cohort. The Lancet Regional Health – Southeast Asia, 45: 100723.

116. Mehara P, Sharma P and Das P (2025) Advances in Transition Metal-Catalyzed Carbonylation Reactions for α,β-Unsaturated Carbonyls: Applications, Challenges, and Opportunities. The Chemical Record, DOI:https://doi.org/10.1002/tcr.202500071

117. Mehara P, Sharma P and Das P (2025) Supported Pd-Catalyzed Carbonylative Transformation of Biomass-Derived Furfural to 2,5-Furandicarboxylic Acid. Catalysis Science & Technology, 15: 5514-5521.

118. Mittal GK, Singh S, Yadav D, Beckmann M, Mur LAJ and Yadav RS (2025) Genome-wide association study for dissecting lipid and fatty acid variation in a global collection of pearl millet germplasm. Journal of Food Composition and Analysis, 144: 107679.

119. Mohapatra S, Ghosh D, Bali S, Twinkle, Gautam A and Dogra V (2025) An Improved Method for Isolating Intact Chloroplasts from Different Plant Species. Journal of Plant Growth Regulation, https://doi.org/10.1007/s00344-025-11911-4.

120. Mohapatra S, Mishra A, Godara R, Bali S, Twinkle, Kumar A, Kumar R, Kumar N, Kumar P, Acharya V and Dogra V (2025) Oxidative stress-induced proteolytic activation of polyphenol oxidase triggers an oxidized flavonoids-mediated stress signaling in *Camellia sinessis*. bioRXiv, https://doi.org/10.1101/2025.09.23.677533.

121. Nag D, Sneha, Tamanna and Singh D (2025) Enzymatic potential of dairy microbes from high-altitude niches: emerging resource with industrial applications. Extremophiles, 29(3): 41.

122. Nath J, Joshi S and Joshi R (2025) Optimized protoplast isolation and PEG-mediated transient gene expression for high-altitude medicinal plant *Picrorhiza kurrooa*. Plant Physiology Reports, 30: 604-615.

123. Nath J, Kumari A, Joshi S, Gusain S, Kumari K, Yadav SK, and Joshi R (2025) Understanding the molecular landscape of de novo organogenesis: Insights into cell fate reprogramming. Discover Biotechnology, 2: 27.

124. Neha Y, Kumar R, Dhiman R and Srivatsan V (2025) Characterization of Nutritional and Biological Properties of Microalgae Species from the *Tetradesmus* Genus for Their Use as Novel Dietary Ingredients. ACS Food Science & Technology, 5(5): 1841-1857.

125. Pandey P, Sharan H, Verma S, Kaur N, Chauhan R, Singh S and Singh S (2025) Integrative assessment of morphological and SSR based molecular diversity patterns in lavender (*Lavandula angustifolia* Mill.). Journal of Applied Research on Medicinal and Aromatic Plants, https://doi.org/10.1016/j.jarmap.2025.100690.

126. Partap M, Chandel A, Sharma D, Verma K, Parmar P, Soni V, Srivatsan V and Bhargava B (2025) Morphological Traits and Biochemical and Volatile Compound Composition along with Gene Expression Profiling in *Chrysanthemum morifolium* Ramat. Grown under Soil and Soil-Less Conditions. ACS Agricultural Science & Technology, 5(5): 701-713.

127. Partap M, Deekshith HN, Gupta H, Birsanta G, Kapoor P, Soni V and Bhargava B (2025) Morphological and biochemical analysis along with gene expression dynamics in Lilium 'Brunello' under supplemented effect of blue and red light treatment in pin tray soil-less cultivation system. Photochemistry and Photobiology B: Biology, https://doi.org/10.1016/j.jphotobiol.2025.113168.

128. Patial M, Devi K, Kumari K, Sharma P, Singh S, Sharma RK, Yadav SK and Joshi R (2026) Deciphering molecular signaling and metabolite dynamics during *In vitro* clonal propagation in *Ferula assa-foetida*. In Vitro Cellular and Developmental Biology-Plants, https://doi.org/10.1007/s11627-025-10617-2.

129. Pawar L, Kumar P, Dhiman R, Mittal D, Kumar A, Purohit R and Yadav SK (2025) Advance biocatalyst for the green conversion of 5-hydroxymethylfurfural to a biopolymer precursor 2, 5-furandicarboxylic acid. Biotechnology for Biofuels and Bioproducts, doi; 10.1186/s13068-025-02705-7.

130. Phian P and Gupta M (2025) Evaluating the Sustainable Processing on Nutritional, Functional, Phenolics, *In Vitro* Protein Digestibility, and Antioxidant Bioavailability of Himalayan Peas. Sustainable Food Proteins, 3(4): e70045.

131. Punia A, Satyakam, Saini V, Chouhan M, Chakraborty N and Rajiv Kumar (2026) Dancing to the tune of the light regime: from perception to secondary metabolite biosynthesis in plants. Critical Reviews in Biotechnology, https://doi.org/10.1080/07388551.2026.2619534.

132. Puri S, Kashyap U, Sharma U and Reddy SGE (2025) Insecticidal activities and mechanism of action of extracts, fractions and isolated compounds from *Achyranthes bidentata* against *Aphis craccivora* and *Planococcus lilacinus*. Journal of Pest Science, https://doi.org/10.1007/s10340-025-01956-5.

133. Puri S, Rahmatkar SN, Bora PS, Singh D and Sharma U (2025) UPLC-IM-Q-TOF-MS/MS-based Biochemometrics Unveils Neuroprotective Effects of *Achyranthes bidentata* Blume Seeds: Neurochemical Alterations Driving Neuroprotection in Zebrafish Models. Food Biosciences, 71: 107377.

134. Rahim MS, Kumari S, Bhat V, Kumar R and Sharma RK (2025) High-density QTLs mapping and transcriptome validation identify potential genes explain the genetic basis of Blister blight tolerance in tea. Plant Physiology and Biochemistry, https://doi.org/10.1016/j.plaphy.2025.110748.

135. Rai S, Gurung B, Kumar D, Mishra A, Sahoo D and Bhardwaj PK (2025) Ginsenosides analysis in different aged rhizomes of *Panax sokpayensis*: A Panax species from Indian Himalaya. Next Research, 2(2): 100231.

136. Raj Y, Ali N, Pati AM, Kumar R and Kumar R (2025) St. John's wort root-associated beneficial bacteria with vermicompost augment specialized metabolites without penalizing biomass yield by improving photosynthesis and soil microbial properties. Journal of Applied Research on Medicinal and Aromatic Plants, 49: 100670.

137. Rana A, Gangwar H and Jaiswal V (2025) *Glyceraldehyde-3-phosphate dehydrogenase 7 (FtGAPDH7)* confers heat stress tolerance in buckwheat [*Fagopyrum tataricum* (L.) Gaertn]. Plant Cell Reports, https://doi.org/10.1007/s00299-025-03669-6.

138. Rana N, Ruchika and Saneja A (2026) Development of multifunctional and sustainable starch/polyvinyl alcohol–polyethylene glycol copolymer films reinforced with green tea extract for food packaging. Sustainable Food Technology, https://doi.org/10.1039/d5fb00838g.

139. Randhawa S, Saini TC, Bathla M, Bhardwaj R, Dhiman R and Acharya A (2025) Nanomaterials in targeting amyloid-β oligomers: current advances and future directions for Alzheimer's disease diagnosis and therapy. Beilstein Journal of Nanotechnology, 16: 561-580.

140. Randhawa S, Saini TC, Bathla M, Teji N and Acharya A (2025) Biofilm Biology to Brain Health: Harnessing Microbial Wisdom to Uncover Amyloid Dissociating Bifunctional Nano Chaperones for Alzheimer's Therapeutics. ACS Chemical Neuroscience, 16(9): 1647-1661.

141. Rathore S and Kumar R (2025) Assessing growth performance and agrometeorological indices of *Matricaria chamomilla* L. governed by growing season length and salicylic acid in the Western Himalaya. Horticulturae, 11(5): 485.

142. Rathore S, Walia S, Rana M, Dhyani V and Kumar R (2026) Revitalizing Tagetes minuta L. in the Western Himalayas: A Nutrient-Driven Approach to Enhance Biomass and Essential Oil Composition. Journal of Soil Science and Plant Nutrition, http://doi.org/10.1007/s42729-025-02833-x.

143. Roy A, Bhattacharjee B and Hallan V (2025) Dancing with the enemy: symbiotic relationships between plant RNA viruses and their hosts. Frontiers in Plant Science, https://doi.org/10.3389/fpls.2025.1716996.

144. Roy A, Girish TR, Nori SS, Narayan SS, Bhattacharjee S and Hallan V (2025) Marine Algae Oligosaccharides: Eco-Friendly Elicitors for Sustainable Agriculture. Algal Research, 89: 104093.

145. Roy A, Tamang A, Swarnkar MK, Girish TR, Nori SS, Narayan SS, Bhattacharjee S and Hallan V (2025) Seaweed-Derived Oligosaccharides Confer Broad-Spectrum Antiviral Defenses in Tomato and Arabidopsis Plants. Physiologia Plantarum, 177(5): e70562.

146. Roy A, Thakur V, Joshi R, Bairwa MC, Kumar P, Daroch A, Purohit R, Bhattacharjee S and Hallan V (2025) Viral Suppressor AC4 encoded by tomato leaf curl Palampur virus hijacks SA Signaling to Promote Pathogenesis. Plant Physiology and Biochemistry. https://doi.org/10.1016/j.plaphy.2025.110789.

147. Roy T, Chaudhary A, Mishra A, Arora S, Kumari A and Singh K (2025) Advancement in rhizospheric microbial diversity analysis: An updated perspective. Plant Biochemistry and Biotechnology, https://doi.org/10.1007/s13562-025-01013-3.

148. Ruchika, Kumar A, Singh D, Yadav SK and Saneja A (2025) Nanofibers Derived Self-Assembled Liposomes of α-lipoic acid Mitigates Pentylenetetrazol-Induced Seizures in Zebrafish Larvae. Food Bioscience, 107429. https://doi.org/10.1016/j.fbio.2025.107429.

149. Ruchika, Rana N, Yadav SK and Saneja A (2026) Development of active bioplastic films from sodium alginate/polyvinyl alcohol-polyethylene glycol copolymer incorporating syringic acid for postharvest mushroom preservation. Bioresource Technology, https://doi.org/10.1016/j.biortech.2026.134077.

150. Ruchika, Rana N, Yadav SK and Saneja A (2026) Development of multifunctional composite films based on κ-carrageenan/polyvinyl alcohol–polyethylene glycol copolymer blended with epigallocatechin gallate for strawberry preservation. International Journal of Biological Macromolecules, https://doi.org/10.1016/j.ijbiomac.2026.150884.

151. Ruchika, Yadav SK and Saneja A (2025) Electrospun proliposomes and the quest to overcome liposome instability. Drug Discovery Today, 104548.

152. Sachin, Sharma T, Rav S and Sharma U (2025) Ru(II)-Catalysed, Inherent-Directing Group Enabled Site-selective C-H Vinyltrifluoromethylation of Isoquinolones and Benzamides. Chemical Communications, 61: 17416-17419.

153. Saini TC, Randhawa S, Bathla M, Nisha A, Teji N and Acharya A (2025) Nanoengineered Polyphenol-Quantum Dot Conjugates Inhibit Biofilm Protein-Aβ42 Heterotypic Fibrillogenesis, Restore

Synaptic Transmission, and Suppress Apoptosis in Alzheimer's Disease. ACS Chemical Neuroscience, 16(23): 4458–4478.

154. Samkaria S, Sharma S, Sharma S and Kumari P (2026) Salicylic Acid-Mediated Enhancement of Growth and Bioactivity in Edible Flowers of Pot Marigold (*Calendula officinalis* L.). New Zealand Journal of Crop and Horticultural Science, 54(1): p.e70021.

155. Sengupta S and Phenome India Consortium (Patial V) (2025) Study research protocol for Phenome India-CSIR Health Cohort Knowledgebase: A prospective multi-modal follow-up study on a nationwide employee cohort. Biology Methods and Protocols, 10(1): bpaf061.

156. Seth R, Devi A, Dolkar P, Parmar R, Sharma S, Sharma B, Dhyani P, Stobdan T and Sharma RK (2025) Unveiling transcriptional regulation underpinning chilling and frost stress response in Trans-Himalayan *Hippophae tibetana* L. Plant Molecular Biology, https://doi.org/10.1007/s11103-025-01619-0.

157. Shagun, Dogra S and Patial V (2026) Iridoids in liver diseases: Mechanistic insights and molecular mechanism. Journal of Integrative Medicine, https://doi.org/10.1016/j.joim.2026.01.008.

158. Shambhvi and Gupta M (2025) Evaluation of Nutritional, Functional and Probiotic Millet-Based Fermented Steamed Dumplings. Journal of Culinary Science & Technology, https://doi.org/10.1080/15428052.2025.2520555.

159. Sharma A, Bharti A, Sharma K, Gupta S, Dolma S, Srivatsan and Uniyal SK (2025) Traditional foods and wild edible plants of Spiti valley, Indian Trans Himalaya. Indian Journal of Traditional Knowledge, 24(11): 1043-1054.

160. Sharma A, Katoch S, Aditya, Patial V and Nadda G (2026) Ophiocordyceps indica from Indian Himalayas ameliorates IgA nephropathy in mice. Applied Biochemistry and Biotechnology, https://doi.org/10.1007/s12010-026-05588-y.

161. Sharma A, Kumar R,Kaur R, Kumari P and Nadda G (2025) Exploring Beauveria bassiana associated with Ophiocordyceps indica for biocontrol: Effects on Plutella xylostella, Aphis craccivora, and Tetranychus urticae. Archives of Phytopathology and Plant Protection, 58(17): 947–965.

162. Sharma A, Uniyal SK and Batish DR (2025) Socio-Cultural Determinants of Traditional Knowledge of Fodder Plant Species Among the Bhangalis of Chhota Bhangal, Western Himalaya. Journal of Sustainable Forestry, DOI: 10.1080/10549811.2025.2593000.

163. Sharma B, Singh R and Purohit R (2025) Mechanistic insights into the identification of phosphodiesterase 2 inhibitors from acridine analogues. Materials Chemistry and Physics, https://doi.org/10.1016/j.matchemphys.2025.131477.

164. Sharma B, Singh R, Kumar A, Das P and Purohit R (2026) Expanding the therapeutic landscape of PDE10A inhibition through alchemical absolute binding free energy calculations and in-vitro evaluation. Protein Science, 35(2): e70472.

165. Sharma D, Katoch M, Rana S, Bodh R, Chandel A and Bhargava B (2025) Evaluating the Benzene Removal Efficiency of Ficus elastica in Closed-Chamber Conditions. Water, Air, & Soil Pollution, 236(13): p.871.

166. Sharma H, Ira R, Sood D, Kumar R, Devi S and Prakash T (2026) Comparative analysis using 16S rRNA metagenomics to explore the microbial diversity of plant based fermented foods. Food Safety and Risk, https://doi.org/10.1186/s40550-026-00136-2.

167. Sharma K, Aroor MS, Das S, Bora B, Gupta M and Srivatsan V (2025) Comprehensive review on the current scenarios in onion processing and addressing the grand onion challenge of India. Scientia Horticulturae, 355, 114152.

168. Sharma K, Chaudhary S, Tamang A, Devi NP, Bhardwaj P, Kumar R, Sharma N, Bhardwaj PK and Hallan V (2025) Prevalence, genetic diversity, and phylogenetic analysis of apple stem grooving virus in low-chilling apple cultivars. Virusdisease. doi: 10.1007/s13337-025-00931-z. PMID: 41281979.

169. Sharma M, Anmol and Sharma U (2025) A new sesquiterpenoid from the roots of *Nardostachys jatamansi* (D.Don) DC. Natural Product Research, https://doi.org/10.1080/14786419.2025.2575764.

170. Sharma M, Anmol, Sood V, Singh D, Sharma M and Sharma U (2025) Supercritical fluid assisted extraction of volatile/ non-volatile concentrate from *Nardostachys jatamansi* (D.Don) DC: A comparative study of extraction yield, composition, and antimicrobial efficacy with hydrodistillation

and NADES-based approaches. Journal of Essential Oil Research, https://doi.org/10.1080/10412905.2025.2509310.

171. Sharma MK and Chawla A (2025) Alpine plant species advance green-up but delay leaf senescence in response to experimental early snowmelt. Plant Biology, 178: 180.

172. Sharma MK and Chawla A (2025) Elevation-dependent effects of early snowmelt on species and functional diversity in Himalayan alpine plant community. Climatic Change, 178(10): 1-18.

173. Sharma P, Mehra P, Kumar A and Das P (2025) Pd/C-Catalyzed Hydrocarboxylation and Carbonylative Esterification of Indoles to Indole-3-carboxylic Acids and Esters. Organic Letters, 27: 10974-10979.

174. Sharma R and Acharya V (2025) Lightweight Vision Transformer with transfer learning for interpretable Alzheimer's disease severity assessment. Scientific Reports, http://doi:10.1038/s41598-025-28243-8.

175. Sharma R, Bhardwaj R, Singh A, Bhushan S and Agnihotri VK (2026) Comparative essential oil composition and bioactivity profiling of Junipers berries from North-western Himalaya, India. Journal of Essential Oil Research, DOI: 10.1080/10412905.2026.2622540.

176. Sharma R, Bharti A, Kumar A and Uniyal SK (2025) Traditional knowledge and quantitative assessment of ethnomedicinal uses of plants in Lahaul valley of Himachal Pradesh. Ethnobotany Research and Applications, 31: 1–15.

177. Sharma R, Dev K, Sharma SK, Kumar R and Agnihotri VK (2025) Integrative network pharmacology and in vitro antimicrobial assessment of Cryptomeria japonica essential oil from North-western Himalaya. Journal of Biologically Active Products from Nature, 15: 138-155.

178. Sharma S and Sharma RK (2025) Trade-off between rice epigenome and cold adaptation. Trends in Plant Science, https://doi.org/10.1016/j.tplants.2025.08.007.

179. Sharma S, Kaundal R and Kumar D (2025) Polygonatum verticillatum (L.) All.: Systematic information on ethnomedicine, phytochemistry and pharmacological properties. Indian Journal of Natural Products and Resources (IJNPR) [Formerly Natural Product Radiance (NPR)], 16(1): 49-59.

180. Sharma S, Kumari S, Pal P, Masand M, Sharma P, Sharma B, Rahim MS and Sharma RK (2025) A Unique Morpho-Physiological, Metabolomics, and Transcriptional Shift Under Combined Drought and Salinity Stress in *Stevia rebaudiana* Bertoni. Physiologia Plantarum. https://doi.org/10.1111/ppl.70305.

181. Sharma S, Kumari S, Verma N, Sharma P, Dharwal S, Masand M and Sharma RK (2026) Physiochemical and transcriptional reprogramming of mild salinity mediated modulation of Steviol Glycoside biosynthesis in *Stevia rebaudiana* Bertoni. Plant Physiology and Biochemistry, https://doi.org/10.1016/j.plaphy.2026.111048.

182. Sharma V, Kumar R, Joshi R, Srivatsan V and Patial V (2025) Malnutrition induces steatohepatitis by impairing hepatic lipid metabolism, mitochondrial function and the gut-liver axis. Journal of Physiology and Biochemistry, https://doi.org/10.1007/s13105-025-01125-3.

183. Sheetal, Kumar S and Das P (2025) Multifaceted Role of Oxalic Acid in Organic Synthesis: A Sustainable C_1 and Hydrogen Surrogate for Catalytic Transformations. The Chemical Record, 2025: e202500226.

184. Sheikh FR, Majeed A, Joel Jose-Santhi, Kalia D, Sharma RK and Singh RK (2025) An Integrated Metabolomics and Transcriptomics Analysis Unveils the Temperature-Mediated Regulation of Floral Induction in Safron (*Crocus sativus* L.). Journal of Plant Growth Regulation, https://doi.org/10.1007/s00344-025-11741-4.

185. Shivani, Anmol, Kumar S, Bora PS and Sharma U (2026) Investigating the Bioactive Phytoconstituents of *Cocculus hirsutus* (L.) W.Theob.: UHPLC-PDA-based Quantification, UHPLC-Q-TOF-MS-based Qualitative Analysis and Network Pharmacology-Based Target Prediction. South African Journal of Botany, 190: 424-434.

186. Shivani, Thakur BK, Kumar A, Kumar A, Meena RL, Kumar D, Kumar R and Pal PK (2025) Optimizing Drying Conditions for *Valeriana jatamansi* Jones: Effects on Essential Oils and Bioactive Compounds. Chemistry & Biodiversity, e00413. https://doi.org/10.1002/cbdv.202500413.

187. Shukla AK, Bathla M, Nisha A, Yadav SK and Acharya A (2025) Carbon nanomaterials as functional biomimetics:

unveiling synthesis, and factors affecting their nanozyme potential. Proceedings of the Indian National Science Academy, 1-27.

188. Singh A and Samant SS (2025) Fuelwood Burning: Utilization Trends for Forest Sustainability in the Cold Desert of Trans Indian Himalaya. Indian Forester, 151(4): 345-351.

189. Singh A, Bhardwaj R, Kaushal A, Katoch G, Rawat B and Kumar D (2026) Population assessment, domestication of *Sinopodophyllum hexandrum* (Royle) Ying - a threatened species in the high altitudes of Himachal Pradesh, India. Journal of Asia-pacific Biodiversity, https://doi.org/10.1016/j.japb.2025.12.009.

190. Singh P, Devi A and Sharma RK (2025) Organ-specific transcriptional analysis reveals spatial molecular intricacies of picrosides biosynthesis in endangered *Picrorhiza kurroa*. Food Bioscience, 74:107967.

191. Singh PP, Urvashi, Sangeetha, Sharma U and Reddy SGE (2025) Insecticidal activities and mechanism of action of steroidal saponins from *Trillium govanianum* Wall. ex D. Don against *Plutella xylostella* (L.) and Aphis craccivora Koch. Neotropical Entomology, 54: 67.

192. Singh R, Chandel S, Rav S, Anmol, Aggarwal G, Singh D and Sharma U (2026) A hyphenated approach of chemical profiling, anti-bacterial assays, and molecular docking to validate the traditionally claimed anti-bacterial (Krimiroga) potential of *Cyperus rotundus* L. Microbial Pathogenesis, 211: 108220.

193. Singh R, Sharma B and Purohit R (2025) Plant-Derived HMG-CoA Reductase Inhibitor: Computational and Experimental Insights for Cardiovascular Disease Management. Journal of Molecular Liquids, https://doi.org/10.1016/j.molliq.2025.128792.

194. Singh S, Kumar M and Joshi R (2025) Techno-economic efficiency of micropropagated industrially important crop plants heeng, monk fruit and bamboo. Agricultural Reviews, R2724: 1-11.

195. Sukriti, Mahato H, Joel Jose-Santhi and Singh RK (2026) Flowering Promoting Factor-Like Genes: Emerging yet Mechanistically Unresolved Regulators of Floral Transition and Plant Development. Journal of Experimental Botany, https://doi.org/10.1093/jxb/erag138.

196. Sukriti, Santhi JJ, Kumari D, Misra A, Kumari N, Kalia D, Kandpal Y, Dkhar J and Singh RK (2026) Temperature-Responsive FPF1 Homologs Regulate Floral Transition in Saffron. Physiologia Plantarum, 178(2): e70873.

197. Sumit, Sarthi, Aggarwal V, Kachore A, Verma PK and Sharma U (2026) Organic N-nitro reagents in organic synthesis. Synthesis, DOI: 10.1055/a-2779-3996.

198. Swati KM, Goel A, Sharma S, Padwad YS and Bhandari P (2025) Bioactive fractions of Swertia species protect myotubes and improve insulin sensitivity by regulating myogenic factors in differentiated skeletal muscle cells. Bioorganic Chemistry, 168: 2026, 109362.

199. Tamang A, Chaudhary S, Pandey SS and Hallan V (2026) Plant viruses and the microbiome: a complex network shaping plant health and disease resistance. Archives of Virology, https://doi.org/10.1007/s00705-026-06531-6.

200. Tamang A, Devi NP, Rana S, Bhardwaj P, Kumar R and Hallan V (2026) First Report of Apple Chlorotic Leaf Spot Virus Infecting Guava (*Psidium guajava*) in India. New Disease Reports, https://doi.org/10.1002/ndr2.70118.

201. Thakur BK, Kharwal N and Pal PK (2025) The soil-plant-microbe nexus: Mechanisms, interactions, and implications for sustainable agriculture. Pedosphere, https://doi.org/10.1016/j.pedsph.2025.12.001.

202. Thakur D and Chawla A (2025) Aspect outweighs elevation in influencing plant functioning at high elevations of Himalaya. Plant Ecology, https://doi.org/10.1007/s11258-025-01567-1.

203. Thakur N, Raturi V, Sreeprakash A, Sen S, Yadav SK, Zinta G and Saneja A (2026) Methyl salicylate/methyl-β-cyclodextrin inclusion complex modulates plant defense against cold and heat stress. Chemical and Biological Technologies in Agriculture, https://doi.org/10.1186/s40538-026-00915-1.

204. Thakur N, Tirpude NV and Saneja A (2025) Development and Characterization of α-Lipoic Acid Amorphous Solid Dispersion for Improved Oral Bioavailability and Modulation of Allergic Airway Inflammation. Colloids and Surfaces B:

Biointerfaces, https://doi.org/10.1016/j.colsurfb.2025.114836.

205. Thakur P, Kumari R, Kumar A, Bhatia A, Sharma U and Chaudhary A (2025) Uncovering the Mechanisms of Angelica glauca Edgew. in Breast Cancer: A Combined *In Vitro* and *In Silico* Approach. Chemistry and Biodiversity, DOI:10.1002/cbdv.202402554.

206. Thakur R, Baghla S, Vishvamitera S, Singh V, Singh S, Singh S and Chauhan R (2025) Alleviation strategies of seed dormancy for conserving important medicinal plant diversity of western Himalaya. Discover Plants. 2: 111.

207. Thakur S, Bhardwaj A, Awasthi S, Shrivastav A, Kumar P, Sharma M and Sharma U (2026) UHPLC-PDA Method for Monitoring Catechins and Caffeine in Tea Samples and Assessment of Postharvest-Associated Variability across Multilocation Samples. Journal of Food Composition and Analysis, 109031.

208. Thakur S, Walia S, Thakur B, Ghosh A and Kumar R (2025) Unleasing the potential of seaweed biostimulants—a comparative evaluation for enhancing saffron (*Crocus sativus* L.) yield with different corm sizes in the Western Himalayas. BMC Plant Biology, https://doi.org/10.1186/s12870-025-06955-3.

209. Verma A, Dogra V, Shree B, Chandel SS, Nayyar H, Rathour R and Sharma KD (2026) Identification, Characterization and Expression Analysis of Calmodulin and Calmodulin-Like Protein Genes with Emphasis on Reproductive Organs of Chickpea (*Cicer arietinum* L.). Plant Molecular Biology Reporter, https://doi.org/10.1007/s11105-026-01689-4.

210. Verma K, Kumari K, Rawat M, Devi K and Joshi R (2025) Crosstalk of Jasmonic acid and Salicylic acid with other Phytohormones Alleviates Abiotic and Biotic Stresses in Plants. Journal of Soil Science and Plant Nutrition, 25: 4997–5019.

211. Verma N, Devi A, Masand M, Sharma B, Kumari S, Sharma P, Sharma S, Dharwal S, Yadav S and Sharma RK (2025) Organ-specific transcriptional and untargeted metabolome analysis demystifies molecular insights and regulation of Gallic acid and flavonoid biosynthesis in Bergenia ciliate. Functional & Integrative Genomics, 25(1): 1-19.

212. Verma V, Priti, Thakur D, Devi R, Verma K and Bhargava B (2025) A high-efficiency tissue culture protocol for the domestication and mass propagation of *Incarvillea Emodi* (Wallich ex Royle) chatterjee: a valuable wild ornamental and medicinal plant species. Plant Cell, Tissue and Organ Culture (PCTOC), 162(1): p.12.

213. Vishal, Mali S, Dutta M, Choudhary A and Zinta G (2025) Potato Microtuberization: its regulation and applications. Critical Reviews in Biotechnology, 14: 1-24.

214. Yadav N, Singh M, Saini A, Pandey P, Thakur G, Chauhan R, Singh S and Singh S (2025) Characterizing trait-specific populations and genetic diversity patterns in clary sage (*Salvia sclarea* L.) using SSR markers. Journal of Applied Research on Medicinal and Aromatic Plants, 47: 100646.

215. Yadav S, Ghosh D, Twinkle and Dogra V (2025) Bipaternal plastid inheritance and its implications in plastid gebome engineering. Plant Cell Reports, https://doi.org/10.1007/s00299-025-03631-6.

216. Yog Raj and Kumar R (2025) Optimizing seaweed extract for enhanced biomass yield and pharmacologically active speacialized metabolites in St. John's wort. South African Journal of Botany. 189: 30-39.

BOOKS/ BOOK CHAPTERS

1. Chandoliya R, Patial A, Kumari A, Gusain S, Kumari K, Sharma V and Joshi R (2026) Nanoparticle transportation in plants mechanisms and applications in plant tissue culture. In: Intelligent Nanotechnology in Plant Science and Agriculture, (Eds. Chen, J.T.) CRC Press Boca Raton, Pp. 130-147. https://doi.org/10.1201/9781003629603.

2. Chandoliya R, Sharma S, Sharma V and Joshi R (2025) Impact of climate change on plant-microbe interaction under agroecosystems. In: Cyanobacterial response to extreme environments: A molecular understanding for a sustainable future, (Eds. Singh PK, Panwar JS, Kumar A and Elster J), CAB International, UK. Pp. 234-249, https://doi.org/10.1079/9781800626911.0010.

3. Gusain S, Patial A, Chandoliya R, Sharma V and Joshi R (2025) Metabolomics and High-throughput Approaches to Assessing Drought-Stress Tolerance in Crops. In: High Throughput Plant Metabolomics, (Eds. Chen, JT), CAB International, UK. Pp. 201-215, https://doi.org/10.1079/9781800626911.0010.

4. Kaur N, Verma S and Singh S (2026) Grain Amaranth (Amaranthus spp.): The Sacred Seed of Ancient Civilizations. In: Fasting Superfoods, Springer Nature Singapore, pp. 45–76.

5. Kumar R, Kumar M, Tanna B and Bhargava B (2025) Molecular diagnostic techniques utilized in viral diseases. In Viral Diseases: History and new developments in diagnostics and therapeutics, IOP Publishing, UK, pp. 5-20.

6. Kumari K, Gusain S, Nath J, Kumari A, Joshi S, Rawat M and Joshi R (2026) Advancements in artificial intelligence and machine learning to optimize plant cell and tissue culture. In: Plant Molecular Farming, (Eds. Gaur RK, Gupta R, Yadav D and Albrectsen BR), Springer, Singapore. Pp 367-398, https://doi.org/10.1007/978-981-95-3823-2_15.

7. Pandey K and Zinta G (2025) Single-Base Resolution DNA Methylation Analysis Through Targeted Locus-Specific Bisulfite Sequencing in Plants. In: Plant Stress Memory: Methods and Protocols, New York, Springer, pp. 53-70.

8. Panwar S, Chaithra, Namita, Gurjar A, Panigrahi S, Kumari P, Chauhan C, Bhanu Murthy KC and Girish PM (2026) Karanja Seeds (*Pongamia pinnata*). In: Underutilized Seeds: Sustainable Solutions for Health, Industry, and Environment, Singapore: Springer Nature, pp. 107-139.

9. Patial A, Chandoliya R, Gusain S, Sharma V and Joshi R (2025) Insights into Medicinal Herbs based on Metabolomics and High-throughput Technologies. In: High Throughput Plant Metabolomics, (Eds. Chen, JT), CAB International, UK. Pp. 350-370, https://doi.org/10.1079/9781800626911.0018.

10. Patial A, Chandoliya R, Kumari K, Sharma V and Joshi R (2026) Deep Learning and Neural Network Modeling to Optimize Tissue Culture of Medicinal Plants. In: Deep Learning in Plant Science and Agricultural Biotechnology, (Eds. Chen, JT), CAB International, UK. Pp. 356-378, https://doi.org/10.1079/9781836991120.0018.

11. Punia A, Satyakam and Kumar R (2025) Mass Spectrometry-Based Methods for Plant Metabolite Profiling. In: Plant Stress Memory, Methods and Protocols, Pages 103-117, https://doi.org/10.1007/978-1-0716-4981-7.

12. Rani S, Kumar A and Warghat AR (2025) Role of Nanotechnology in Aeroponics and Hydroponics. In: Nanobiotechnology in Agri-food Sector, Singapore, Springer Nature, pp. 81-102.

13. Roy T, Arora S, Das S, Singh K and Majumdar S (2025) Molecular Insights into Plant Polyamines and Its Role in Biotic and Abiotic Stresses. In: Recent Trends and Applications in Plants, Microbes and Agricultural Sciences, Springer Nature, pp. 167-179, https://doi.org/10.1007/978-3-031-90139-3_15.

14. Sharma A and Tirpude NV (2025) In-vivo Methods for Drug Repurposing in Antiviral Therapy. In: Drug Repurposing for Antivirals, Bentham Science, pp. 121-153, DOI: 10.2174/9798989811143125010007.

15. Singh S, Chauhan R and Yadav SK (2025) Spices under Extreme Environments of Indian Himalayan Region. In: Golden Jubilee Souvenir, (Eds. Krishnamurthy K, Sivaranjani R, Shamsudheen M, Sarathambal C), ICAR-Indian Institute of Spices Research, Kozhikode, Kerala, pp. 99–113.

16. Sopory SK and Joshi R (2025) Innovative Approaches in Crop Design. In: Custom-Designed Crop Breeding: Advanced Technologies, (Eds. Jain SM, Al-Khayri JM, Sopory SK, Wani MA) Volume 1, John Wiley & Sons Ltd, UK. Pp 3-34, https://doi.org/10.1002/9781394192595.ch01.

17. Thakur A, Kaur H, Patial V, Yadav SK and Acharya A (2026) Nanotechnological interventions to enhance growth and secondary metabolite content in medicinal plants. In: Transforming medicinal plant agriculture: Implementing soil-less systems and AI innovations for smart farming, Springer, (ISBN 978-981-95-3962-8), pp 131-151, https://doi.org/10.1007/978-981-95-3963-5.

18. Thakur I, Kharwal N, Thakur BK and Pal PK (2026) The role of nitrogen to sustain global food security. In: Non-Point Source Nitrogen Pollution. Elsevier, pp. 471-491, https://doi.org/10.1016/B978-0-443-29070-1.00022-7.

19. Tirpude NV and Sharma A (2025) In-vivo Methods for Drug Repurposing in Antiviral Therapy. In: Drug Repurposing for Antivirals, Bentham Science, pp. 78-120, DOI: 10.2174/9798988111431250 10006.

20. Twinkle S, Ghosh D, Yadav S and Dogra V (2025) Posttranslational modifications in proteins under stress and memory. In: Plant Stress Memory: Methods in Molecular Biology, Springer Nature, pp. 119-136, https://doi.org/10.1007/978-1-0716-4981-7_11.

POPULAR ATICLES

1. Bhargava B, Acharya A, Deekshith HN and Soni V (2025) Petals of change: Two women cultivating beauty and change in Ladakh's cold desert. Floriculture Today, 30(06).
2. Deekshith HN, Acharya A, Bhargava B, Soni V and Chandel A (2026) Beyond the Doctorate: A Ph.D. Horticulturist's Entrepreneurial Leap in the Himalayas. Floriculture Today, 30(09).
3. Sharma S and Kumari P (2025) Rose Waste Valorisation: innovative Uses of Petals, Residues, and By-products. Rose Souvenir, 59-61.
4. पूनम कुमारी और दिक्षा खरवाल (2026) शुष्क पुष्प तकनीकरू महिला सशक्तिकरण का नया आयाम। विज्ञान प्रगति, फरवरी 2026, pg 33–36.
5. हरीश, काजल संदल, विवेक डोगरा और अमित चावला (2026) हिमालयी क्षेत्रों में हानिकारक यूवी विकिरण और शीत तनाव के प्रति पौधों का अनुकूलन, विज्ञान प्रगति, फरवरी 2026, 37–41.
6. Vashishtha N and Bhargava B (2025) Harnessing Nature's Resilience: Limonium as a Salt-Tolerant Crop in Agriculture. Indian Horticulture, 70(3), 43-45.

THESIS/DESSERTATIONS/REPORTS

Abhishek Thakur (2025) Influence of partitioning solvents on bioactive composition and antioxidant properties of selected medicinal plants. Dissertation Supervised by Dr Sandopu Sravan Kumar.

Akanksha Parashar (2025) Characterization of nutritional and nutraceutical potential of endangered and underutilized medicinal plants. Dissertation Supervised by Dr Sandopu Sravan Kumar.

Akshita (2025) An Experimental study to evaluate the nephroprotective activity of Vishaghana Mahakashaya in Cisplatin induced Nephrotoxicity. Dravyaguna. Co- supervised by Dr Dinesh Kumar.

Amit Kumar (2025) Development and validation of chronic epilepsy models of Zebrafish for screening of antiepileptic agents, CSIR-IHBT, Palampur. Supervised by Dr Damanpreet Singh.

Anita Kumari (2025) Integrated macroand micro propogation with multi omic studies to decipher molecular regulation of rhizome development and abiotic stress response in Phyllostachys pubescens mazed ex. Houzeau de lahaie. Supervised by Dr Rohit Joshi.

Anupam Bhatt (2025) Ecological Characterization of High Altitude Vegetation of Chandrabhaga Catchment Area in Western Himalaya. Guru Nanak Dev University. Supervised by Dr. Amit Chawla.

Ankita Thakur (2026) Evaluation of role of endophytes for amelioration of stress tolerance in *Valeriana jatamansi* Jones. Supervised by Dr Shiv Shanker Pandey.

Nymphaea Arora (2026) Molecular insights of post-stroke cognitive impairments in global ischaemia through integrated in vivo-in silico approaches. From AcSIR, CSIR-IHBT, Palampur. Co-Supervised by Dr Damanpreet Singh.

Ashish Kumar (2025) An in vivo study to evaluate the Prativisha properties of Tankana (Borax) in Vatsanabha Vishakatata. From Rajiv Gandhi Govt. Post Graduate Ayurvedic College and Hospital, Paprola, H.P., M.D. Ayurveda (Agada Tantra). Co-Supervised by Dr Damanpreet Singh.

Babit Kumar Thakur (2025) "Agro-physiological and Biochemical Responses of Stevia [Stevia rebaudiana (Bertoni)] to Nitrogen Sources and Integrated Nutrient Management". AcSIR program. Supervised by Dr Probir Kumar Pal.

Bhanu Parsad (2025) Pharmacokinetic and in-vivo efficacy evaluation of IHBT-PGD-1 in experimental animal model of obesity linked Alzheimer's disease. From Maharaja Ranjit Singh Punjab Technical University, Bathinda, Punjab. M. Pharmacy (Pharmacology). Supervised by Dr Damanpreet Singh.

Bittu Ram (2025) Studies on the role of dominance of shrubs on ecosystem functioning in the alpine region of western Himalaya. AcSIR program. Supervised by Dr. Amit Chawla.

Chitrakar Thepra (2026) Effect of LED light on induction and multiplication of callus from Valeriana jatamansi. Supervised by Dr Shashi Bhushan.

Isha Thakur (2025) A Pharmacognostical study on ethnomedicinal plant Thangi (Corylus jacquemontii Decne.) and to evaluate itshepatoprotective activity in an experimental model. Dravyaguna. Co- supervised by Dr Dinesh Kumar.

Jhilmil Nath (2025) Metabolomic and functional genomics studies to elucidate WOX mediated organogenesis and abiotic stress response in Picrorhiza kurrooa royle. Supervised by Dr Rohit Joshi.

Kanchan Yadav (2025) Exploration of microbial and chemical growth modulators for flower enhancement and corm multiplication in Crocus sativus L. AcSIR Program. Supervised by Dr Kunal Singh.

Kavita Devi (2026) Isolation and characterization of plant growth promoting rhizobacteria from agriculture soil. Supervised by Dr Amit Kumar.

Khushbu Kumari (2025) Studies on molecular signaling and secondary metabolite dynamics during in vitro organogenesis of Ferula assa-foetida L. Supervised by Dr Rohit Joshi.

Kiran Dhiman (2026) Studies on the endophytes and the digestive fluid of the carnivorous plant Nepenthes khasiana with emphasis on plant growth promotion. AcSIR program. Supervised by Dr Jeremy Dkhar.

Lakhbeer Singh (2025) Elucidating vegetation structure and ecosystem functioning of timberline forests of western Himalaya. AcSIR program. Supervised by Dr. Amit Chawla.

Mamta Masand (2025) Haplotype resolved genomic studies to unveil the complexity of steviol glycoside biosynthesis in stevia rebudianaSupervisor, AcSIR, INDIA. Supervised by Dr Ram Kumar Sharma.

Manju Kumari (2026) Elucidating the role of endophytes in secondary metabolite biosynthesis in *Podophyllum hexandrum* Royle. Supervised by Dr Shiv Shanker Pandey.

Manjul Sharma (2025) An experimental and randomized clinical study to evaluate the comparative efficacy of Suvarnaprashan yoga and Samangadi leha on growth and development in infants. From Rajiv Gandhi Govt. Post Graduate Ayurvedic College and Hospital, Paprola, H.P. M.D. Ayurveda (Kaumarbhritya-Balroga). Co-Supervised by Dr Damanpreet Singh.

Mehak Sharma (2026) Phytochemical Investigation of Commercially Important Himalayan Medicinal Plant Nardostachys jatamansi (D.Don) DC. Supervised by Dr Upendra Sharma.

Monika Kumari (2025) Pharmacological validation of Linum usitatissimum extract in modulation of inflammation associated rheumatoid arthritis AcSIR program. Supervised by Dr Narendra V. Tirpude.

Nandita Mehta (2025) Studies on adaptation response of plant species along the elevational gradients in Western Himalaya AcSIR program. Supervised by Dr. Amit Chawla.

Neha Priyadashinnee (2026) Assessment of soil properties and plant performance of dragon fruit and avocado in the western Himalaya. Supervised by Dr Amit Kumar.

Parteek Singh Bora (2025) A Biochemometric Approach for the Characterization of Bioactive Steroidal Alkaloids from Fritillaria cirrhosa D.Don. Supervised by Dr Upendra Sharma.

Pratyush Vyas (2025) Spatio-temporal assessment of atmospheric pollution (aerosols, black carbon) and snow cover dynamics in Himachal Pradesh using Sentinel-5P data (2020, 2022, 2024), M Tech. (Environmental Science & Technology), Thapar Institute of Engineering and Technology (TIET), Patiala, Punjab. Supervised by Dr Amit Kumar.

Priyanka Bhardwaj (2025) Studies on endophytes of *Arnebia euchroma* modulating plant performance. Supervised by Dr Shiv Shanker Pandey.

Puja Devi (2025) A phytochemical analysis, toxicity and Hepatoprotective study on Titaati i.e Roylea cinerea (D.Don) Baill. in an experimental animal model. Dravyaguna. Co- supervised by Dr Dinesh Kumar.

Rahmatkar Shubham Nilkanth (2025) Identification of neuroprotective molecular mechanism of selected natural products. From AcSIR, CSIR-IHBT, Palampur. Supervised by Dr Damanpreet Singh.

Rajender Kumar (2025) Exploration of chemical and therapeutic potential of Allium semenovii Regel. Supervised by Dr Dinesh Kumar.

Raman Singh (2026) Phytochemical Investigation of Cyperus rotundus L. for Insecticidal and Antimicrobial Leads. Supervised by Dr Upendra Sharma.

Rishabh Kaundal (2025) Exploration of chemical and therapeutic potential of Viola canescens Wall. Ex Roxb. From western Himalayas. Supervised by Dr Dinesh Kumar.

Rohini Sharma (2025) Optimization of pansy (*Viola* x *wittrockiana*) infusion: Bioactive profiling and evaluation of antioxidant activities. Dissertation Supervised by Dr Sandopu Sravan Kumar.

Ruchi Dashora (2025) In vivo efficacy testing of IHBT/BZ-01 in a hypoxia/reoxygenation zebrafish larva model. From Bhupal Nobles' College of Pharmacy, Udaipur. M. Pharmacy (Pharmacology). Supervised by Dr Damanpreet Singh.

Savita Kumari (2025) Development and preclinical evaluation of a modified ketogenic diet in experimental animal models of epilepsy and associated comorbidities. From AcSIR, CSIR-IHBT, Palampur. Supervised by Dr Damanpreet Singh.

Shayam Singh Maina (2025) Extraction and antioxidant activities of bioactives from Western Himalayan medicinal plants viz. Dissertation Supervised by Dr Sandopu Sravan Kumar.

Shikha Sharma (2025) Transcriptional and Epigenomic studies for elucidation of abiotic stress response in Stevia rebaudiana Bertoni. Supervised by Dr Ram Kumar Sharma.

Shivani Puri (2025) Phytochemical Investigation of Achyranthes bidentata Blume Seeds for Bioactive Molecules. Supervised by Dr Upendra Sharma.

Shiwani Randhawa (2025) Design and development of functional metallic nanoparticles for the inhibition of target protein aggregates. AcSIR program. Supervised by Dr Rakesh Kumar.

Shubham Joshi (2025) Unravelling Regulatory Mechanism of Low Temperature Response in Nardostachys jatamansi (D. Don) DC. Supervised by Dr Rohit Joshi.

Suman Gusain (2025) Physiological, biochemical and molecular studies for deciphering drought stress response in Crocus sativus L. Supervised by Dr Rohit Joshi.

Sunil Kumar (2025) Geospatial studies on forest fires in context of changing climatic scenario in Indian western Himalaya. AcSIR program. Supervised by Dr. Amit Kumar.

Tisha Sharma (2025) Machine Learning–based Mapping of Tea Plantation and Landscape Changes in Palampur Region of Western Himalaya, Masters in Geoinformatics, Panjab University, Chandigarh, Punjab. Supervised by Dr Amit Kumar.

Udit Verma (2025) A phytopharmacogostical study of Nirgundi mool (Vitex negundo Linn.) and to evaluate its antiepilepstic efficacy in experimental models. From Rajiv Gandhi Govt. Post Graduate Ayurvedic College and Hospital, Paprola, H.P., M.D. Ayurveda (Dravyaguna). Co-Supervised by Dr Damanpreet Singh.

Vandana Kumari (2025) Phytochemical investigation and therapeutic potential of Ajuga parviflora Benth. Supervised by Dr Dinesh Kumar.

Vivek Dhiman (2025) Study on uncertainty in various approaches of biomass estimation and scope of their improvement in the context of northwestern Himalayan forests AcSIR program. Supervised by Dr Amit Kumar.

CONFERENCE/TRAINING/WORKSHOP/ SYMPOSIUM PRESENTATIONS

Kumari P (2025) Delivered an online presentation titled "Wild Edible Flowers of the Indian Himalayan Region: Traditional Uses and Potential Health Benefits as a Pathway to Food and Nutritional Security" at the 32nd European Nutrition and Dietetics Conference, in Zurich, Switzerland, July 07–08.

Joshi R (2025) Biotechnological interventions in Himalayan Bioresources: Advances in Plant Tissue Culture. In: Himalaya Calling 2025 Global Summit. Organized by Himalayan Institute for Learning and Leadership (HILL), UPES University, Dehradun. September 09-11.

Joshi R (2025) Harnessing Tissue Culture and Genetic Engineering potential for Commercial-Scale Propagation and Genetic improvement of crops. In: Entrepreneurship Avenues in Plant Sciences for undergraduate students. Organized by The Department of Botany's "Fragrance -The Botanical Society" at Shivaji College (University of Delhi). September 26.

Chaudhary P (2025) Expert talk on "Role of Scientists in Science Communication" delivered during the two-day national workshop "Communicate to Connect: Science for All" organized in collaboration with CSIR-NIScPR at CSIR-IHBT, Palampur, Himachal Pradesh, October 14–15.

Roy T, Arora S, Yadav K and Singh K (2025) Diversity and Functional Characterization of P-Solubilizing Psychrotolerant Bacteria from Rohtang Rhizospheric Soil. In: National Conference on Unraveling the Mysteries of Plant Science. Organised by Bethune College, Kolkata. November.

Pal PK (2025) Red algae (*Kappaphycus alvarezii*) extract improves growth and secondary metabolites in Stevia rebaudiana under well-watered and water-deficient conditions. Sixth International Agronomy Congress on Re-Envisioning Agronomy for Smart Agri-food Systems and Environmental Stewardship. THE INDIAN SOCIETY OF AGRONOMY ICAR-Indian Agricultural Research Institute, New Delhi-110 012. Organized by CSIR-National Physical Laboratory, New Delhi, India. November 24-26.

Chaudhary P (2025) Presentation on "Impact of Climate Change on Plant Migration" during the inaugural VOICE Fellowship, a five-day residential training programme on climate, environment, and public health communication. In: The CARE Project (Communicating Action and Resilience for Environmental Health in India), IISER Pune. December 16–20.

Samkaria S, Sharma S, Chauhan P and Kumari P (2026) Oral presentation on the topic "Comparative evaluation of drying techniques on bioactive compounds, nutritional quality, and

anti-nutrients of Kachnar (*Bauhinia variegata* L.) flowers in 4th Indian Horticulture Summit-cum-International conference-2026 at RLBCAU, Jhansi. January 28-30.

Kumari A and Joshi R (2026) Integrated multi-omics dissection of rhizome architecture, somatic embryogenesis, and stress resilience in moso bamboo (Phyllostachys pubescens). In: 47th Annual Meeting of Plant Tissue Culture Association (India) Symposium & Industry Conclave on Plant Tissue Culture for Boosting Biomanufacturing, Nutritional Security, and Climate Resilience. Organized by BRIC-National Institute of Plant Genome Research, New Delhi in association with Plant Tissue Culture Association (India). February 17-20.

Chauhan P, Samkaria S and Kumari P (2026) Oral presentation on the topic "Comprehensive Nutritional, Biochemical, and Phenolic Profiling of Rose (*Rosa hybrida* L.) Hips: Implications for Functional Food Development" In: 9th AMIFOST-2026 International conference on "Bio-Convergence & Next-Gen Food Systems: Towards Sustainable Nutrition and Global Food Resilience, Amity University Uttar Pradesh, March 17-18.

CONFERENCE/TRAINING/WORKSHOP/ SYMPOSIUM ATTENDED

Agnihotri VK (2025) Participated in the meeting of the Bureau of Indian Standards (BIS), held in Delhi, May 19.

Tirpude NV (2025) Attended three days training programme on "Project and Technology Management' organized by CSIR-HRDC Campus, Ghaziabad. May 26-28.

Joshi R (2025) Participated in Herbal Sector Stakeholder Meet (HSSM2025) "From challenges to collaboration: Empowering herbal product development", at CSIR-IHBT, Palampur. July 02-03.

Kumar R and Yadav SK (2025) Participated in 4th FICCI Fragrance Business Summit 2025 "The Fragrance Industry: Driving Innovation & Powering Growth" in Mumbai. August 20.

Pal PK (2025) Capacity Building Commission's 3-Day Karmayogi Facilitators' Training Programme under the Rashtriya Karmayogi Large Scale Jan Seva Programme on 30.08.2025, at CSIR-HRDC. August 28-30.

Agnihotri VK (2025) Participated in the meeting of the Bureau of Indian Standards (BIS), held in Lucknow, September 01.

Kumar SS (2025) Attended Applications of Statistical Tools in Research and Data Analysis, organized by the CSIR-Human Resource Development Centre, Ghaziabad. September 15-18.

Sharma M (2025) Participated in the 8th Industrial Green Chemistry World Convention & Ecosystem 2025 at The Westin Mumbai Garden City, Mumbai. October 06-08.

Kumar A (2025) Certified Trainer Programme for Herb Growers conducted by the Agriculture Skill Council of India. October 17.

Kumar SS (2025) Attended Training course on implementation of the Rashtriya Karmayogi Jan Seva Program under Capacity Building Commission, Government of India, organized at CSIR-IHBT, Palampur (H.P). October 30.

Agnihotri VK (2025) Attended 12th Convention of Society for Ethnopharmacology India (SECON 2025) & International Conference on "Traditional Medicine – Ancient & Modern Concordance" at Jamia Hamdard, New Delhi, October 30-31.

Patial V (2025) National Conclave on Longitudinal Cohort Research – Cohort Connect organized at the CSIR–Institute of Mineral and Materials Technology (CSIR-IMMT), Bhubaneswar, jointly by CSIR–IGIB and CSIR–IMMT. November 13–14.

Patial V (2025) National One Health Mission Assembly 2025 on theme" "Translating Knowledge to Practice- One Earth, One Health, One Future" at Bharat Mandapam Convention Centre, New Delhi, November 20–21.

Kumar R (2025) Attended Sixth International Agronomy Congress on "Re-envisioning Agronomy for Smart Agri-food Systems and Environmental Stewardship" held at CSIR-NPL, New Delhi, India. November 24–26.

Patial V (2025) LASAICON-2025 Conference on "From Preclinical to Clinical: Connecting the Dots of Research, Animal Welfare, Drug Discovery, and Pharma Innovation for Viksit Bharat" at the CSIR-Institute of Microbial Technology (IMTech), Chandigarh, December 01-02.

Tirpude NV (2025) Attended one week national programme on "Transformative Pathways of Science, Technology and Innovation for Attaining the Sustainable Development Goals". Sponsored by DST December 08-12.

Chaudhary P (2025) Participation in the inaugural VOICE Fellowship, a five-day residential training programme on climate, environment, and public health communication. In: The CARE Project (Communicating Action and Resilience for Environmental Health in India), IISER Pune. Priya Chaudhary featured among the first cohort of over 40 grassroots journalists and storytellers drawn from diverse regional and community contexts across India, reflecting distinguished

recognition within a highly competitive national pool. December 16–20.

Agnihotri VK (2026) Participated in the meeting of the Bureau of Indian Standards (BIS), held online, February 04.

Sharma M (2026) Participated in RMP Training Program on ISO/IEC 17034:2016 & ISO 33405:2024 held at Delhi. February 10-13.

Kumar P, Devi J, Kumar D and Bhushan S (2026) Sustainable production of naphthoquinone pigments via elicitor-mediated metabolic modulation in Arnebia euchroma adventitious root cultures. 47th Annual Meeting of the Plant Tissue Culture Association (India), Symposium & Industry Conclave at JNU convention centre, New Delhi, India. February 17-20.

Kumar R (2026) Participated in workshop on smart agrotechnologies for soil & crop health at RARS Kumarakom, Kottayam, Kerela. March 05-06

Sharma M (2026) Participated in the 26th World Aroma Ingredient Congress & Expo 2026 held at Hotel Fairmont, Mumbai, India. Organized by Essential Oil Association of India. March 16-18.

Kumar R, Sharma M and Kumari A (2026) Attended World Aroma Ingredient Congress & Expo 2026 (WAICE) held in Mumbai, India from March 16-18.

CONFERENCE/TRAINING/WORKSHOP/ MEETING ORGANIZED

Kumari P (2025) Conducted a training-cum-awareness programme on Dry Flower Technology at Gram Panchayat Utrala, Baijnath. Over 20 women actively participated in the training and gained practical knowledge about the potential of value-added floriculture products, May 26.

Chawla A and Dogra V (2025) Organized a “Hands-on Training on Plant Physiological Techniques: Two Days Workshop for College Teachers”, CSIR-IHBT, Palampur (H.P.) June 02-03.

Kumar A (2025) Organized World Environment Day. On this occasion, Dr. VM Tiwari, Director, CSIR - North East Institute of Science and Technology, Jorhat, Assam delivered a lecture on “Water Management for Economy and Environment Sustainability and LiFE”. June 05.

Agnihotri VK (2025) Organized training programs entitled “R&D Activities for Standardization of Electrohomeopathic Medicines & it’s Botanical Studies” at CSIR-IHBT, Palampur, HP. June 12-13.

Joshi R (2025) Resource person to deliver lecture on “Types of bamboo and its management” in Bamboo workshop for agriculture officers on 18-06-2025 and artisans on 26-06-2025 at Regional Horticulture Research and Training Station, Jachh, Nurpur, H.P. June 18-26.

Chauhan R (2025) Co-organized the Herbal Sector Stakeholder Meet (HSSM 2025) titled “From Challenges to Collaboration: Empowering Herbal Product Development” as a conference co-nodal officer. July 02–03.

Kumari P (2025) Under the Janjatiya Gaurav Varsh initiative, organized a training-cum-awareness programme on “Dry Flower technique/value addition of floral waste” at Village Bhalai, District Chamba, over 20 women actively engaged in the training, gaining hands-on experience and practical insights into value-added floriculture products, July 29.

Joshi R (2025) Resource person to deliver lecture on “Types of bamboo and its management” in the training program for farmers on “Bamboo Cultivation” at Department of Biology and Environmental Sciences, College of Basic Sciences, CSKHPKV, Palampur, H.P. August 18-22.

Kumar R (2025) Organized a training on “Agro technology of low chilling apple varieties in non tadditional areas” at Imphal, Haraorou, East Imphal, and Hiyangthang, BRICS- IBSD Imphal, Manipur. September 21-24.

Kumar R (2025) Organized a training cum awareness program on “Aromatic crops and high value plants for the farmers of Jammu” at CSIR-IHBT Palampur. October 06-07.

Joshi R (2025) Co-ordinator in CSIR-Integrated Skill Initiative Phase III course entitled “Bamboo Grower” at CSIR-IHBT, Palampur, H.P. September 01to October 10.

Chaudhary P, Nadda G and Singh S (2025) Organized a two-day national workshop on “Communicate to Connect: Science for All,” in collaboration with CSIR-NIScPR at CSIR-IHBT, Palampur, HP. October 14-15.

Kumar R (2025) Organized a workshop on “Value Addition of Himalayan Essential Oils and Their Marketing Regulation” at CSIR-IHBT Palampur. October 28.

Kumar R (2025) Organized a training program on “Improved agro and process technology of aromatic grasses. Inauguration of FDU” at Phlanwanbroi, East Khasi Hills, Meghalaya. November 04.

Kumar R (2025) Organized a workshop on “Improved agro and process technologies of aromatic plants” for the farmers’ industrialists of J&K and HP” at CSIR-IHBT, Palampur. November 13.

Kumar R (2025) Organized a workshop on "Empowering Chamba (aspirational district): Driving sustainable growth with CSIR-IHBT's cutting-edge technologies", at CSIR-IHBT, Palampur. November 19-20.

Chauhan R (2025) Organized four (04) training program under Aroma Mission-III, at CSIR-IHBT, Palampur i.e. on 04.04.2025, 22.04.2025, 24.09.2025, 13.11.2025.

Singh D (2025) Organised a hands-on training session on the use of Zebrafish in Pharmacology Research during pre-conference of the 55th Annual Conference of the Indian Pharmacological Society at Panjab University, Chandigarh, November 18.

Kumari P (2025) A one-day training-cum-awareness programme on dry flower technology as a home-based enterprise was organized at Panchayat Samudayik Kendra, Surpura, Vikas Khand Bhatiyat (Sihunta), District Chamba (Himachal Pradesh) under the ongoing project "Enhancing the Livelihood of Tribal Women through Dry Flower Technology". The programme was attended by 30 women participants. The training aimed to create awareness about the scope, benefits, and low-cost nature of dry flower technology, encouraging women's participation in sustainable, income-generating activities and promoting rural entrepreneurship, November 27.

Kumari P (2025) A one-day training-cum-awareness programme on entrepreneurship development and business planning in dry flower technology was organized at Gram Panchayat and Vikas Khand Bharmour, District Chamba (Himachal Pradesh) under the ongoing project "Enhancing the Livelihood of Tribal Women through Dry Flower Technology". The programme was attended by 15 tribal women, November 28.

Chauhan R (2025) Coordinated the Indian International Science Festival (IISF) 2025 for the sub-theme "Science-Focused S&T for Northwest India (including western Himalayan states & UTs)". December 06–09.

Singh D (2026) Organized a session "Food and Nutrition: Health and Regulatory Perspectives" as an invited speaker in a Guru Dakshta Faculty Induction Programme" Organized UGC Malaviya Mission Teacher Training Centre, Punjabi University, Patiala. January 15.

Singh D (2026) Organized a session "Beyond Guidance: Supervisors as Guardians of Research Integrity" as an invited speaker in a Refresher Course on Research Methodology" Organized UGC Malaviya Mission Teacher Training Centre, Punjabi University, Patiala. January 22.

Kumar R (2026) Organized a training program on "Improved agro and process technology of aromatic plants at West Tripura district. & Tripura University". January 05-06.

Kumari P (202) A one-day training-cum-awareness programme on Value Addition of Flowers through Dehydration Technology was organized by CSIR- Institute of Himalayan Bioresource Technology (IHBT), Palampur at Kalpa, District Kinnaur (Himachal Pradesh) under the ongoing project "Enhancing the Livelihood of Tribal Women through Dry Flower Technology". The programme was attended by 17 tribal women. January 08.

Kumar R (2026) Organized a Training cum awareness program of aromatic plants for the farmers of Mandi districts at CSIR-IHBT Palampur. January 21.

Singh D (2026) Organized a session "Beyond Guidance: Supervisors as Guardians of Research Integrity" as an invited speaker in a Refresher Course on Research Methodology" Organized UGC Malaviya Mission Teacher Training Centre, Punjabi University, Patiala. January 22.

Kumar R (2026) Organized Skill Development Course on "Medicinal and Aromatic Plants Grower" at CSIR-IHBT Palampur. January 27 to April 3, 2026.

Kumar R (2026) Organized a Training program on "Intercultural operations of low chilling apple plants and agrotechnology of aromatic plants for the tribal farmers of Durtlang and Sihphir villages", in Aizawl, Mizoram. February 03.

Kumar R (2026) Organized a Training cum awareness program of "Aromatic plants for the tribal farmers of Bharmour from the aspirational district Chamba, HP"at CSIR-IHBT Palampur. March 11.

Joshi R (2025) Co-ordinator in CSIR-Integrated Skill Initiative Phase III course entitled "Bamboo Cultivator" at CSIR-IHBT, Palampur, H.P. February 25 to April 08.

Chauhan R (2025) Organized twenty (20) training programs under CSIR-Phytopharmaceutical Mission-III and DBT project in different locations of Himachal Pradesh, Ladakh, Uttarakhand and Jammu & Kashmir viz., Thunag, Mandi (08.05.2025), Kafnoo, Katgaon, Meeru, Kinnaur (24.05.2025), Pangi, Kunnu, Spillow, Leo, Kinnaur (25.05.2025), Rappe, Lahaul & Spiti (24.05.2025), Tabo, Kaza, Lahaul & Spiti (14.10.2025), Khimi, Ladakh (30.10.2025), Ayee, Ladakh, (30.10.2025), Kargil, Ladakh (01.11.2025), Pangi, Killar, Chamba (20.11.2025), Kuffa, Killar, Chamba (21.11.2025), Jobrang, Rashil, Lahaul & Spiti (27. 11.2025), Holi, Chamba (14.01.2026), Salooni, Chamba (16.01.2026),

Kasol, Manikaran, Kullu (31.01.2026), Banjar, Manali, Kullu (22. 02.2026), Doda, Jammu & Kashmir (27.02.2026), Atholi, Kishtwar, Jammu & Kashmir (28.02.2026), Gulabgarh, Jammu & Kashmir (28.02.2026), Joshimath, Chamoli, Uttarakhand (03.03.2026), Surithota, Chamoli, Uttarakhand (05.03.2026).

LECTURE INVITED/DELIVERED

Dr Damanpreet Singh (2025) Delivered a lecture entitled "Plant-Derived Antiepileptic Agents: Mechanisms of Action and Therapeutic Potentials" as a key note speaker in 87th webinar series of the Society of Pharmaceutical Sciences and Research (SPSR), India. April 20.

Dr Arun Kumar (2025) Delivered lecture on "Enzymes for Sustainable World" in the National Conference on "Nurturing Young Minds for Scientific Innovations–2025 (NYMSI-2025)" at Shahpur Campus of CUHP, Himachal Pradesh. May 15-16.

Dr Upendra Sharma (2025) Delivered lecture on "Merging C-H Activation with Photocatalysis: Chiral Architectures Synthesis" at International Conference On Recent Advances in Fundamental and ChemicalSciences (RAFCS – 2025), HPU, Shimla. May 17.

Dr Sarita Devi (2025) Delivered a lecture on "Awareness of IP rules and Bioresources" in an Intellectual Property (IP) related programme of CSIR-Traditional Knowledge Digital Library Unit under the theme "Rashtriya Boudhik Sampada Mahotsav" on May 29.

Dr Upendra Sharma (2025) Delivered lecture on "Innovative Approaches for the Prospection of Medicinal and Aromatic Plants" in Five Days International Faculty Development Programme on "Implications and applications of Biotechnology in Pharmaceutical Industry and Environment", (13th June), Organised by Internal Quality Assurance Cell (IQAC), GNIPST Auditorium in hybrid mode, Guru Nanak Institute of Pharmaceutical Science and Technology, 157/F Nilgunj Road, Panihati, Kolkata-700114. June 11-15.

Dr Sarita Devi (2025) Delivered a lecture on "Fermentation Technology: Opportunities and Challenges" in a Training programme on "Orientation, QC and Standardization of Electrohomeopathic medicines & botanical studies" at CSIR-IHBT, Palampur, (H.P.), 176061, India. June 12-13.

Dr Damanpreet Singh (2025) Delivered a lecture entitled "Preclinical Evaluation of Plant-based Drugs" as a speaker in a Training programme on "R&D Activities for Standardization of Electrohomeopathic Medicines & it's Botanical Studies" at CSIR-IHBT. June 13.

Dr Vijai K. Agnihotri (2025) Delivered a lecture entitled "Theoretical background of instruments used for analytical works" in training programs entitled "R&D Activities for Standardization of Electrohomeopathic Medicines & it's Botanical Studies" at J.C. Bose Conference Hall, CSIR-IHBT, Palampur June 13.

Dr Damanpreet Singh (2025) Delivered a lecture entitled "Decoding the Brain: Insights into Neurological Disorders Using Zebrafish Models" as an invited speaker via online mode at DHR-sponsored "National Workshop on Zebrafish Husbandry and Research Applications" MGM Institute of Health Sciences, Navi Mumbai. June 20.

Dr Damanpreet Singh (2025) Delivered lecture entitled "Zebrafish in Preclinical Research: A Refinement and Reduction Alternative in Line with the 3Rs" as an invited speaker at a Faculty Development Program on "Empowering Educators for Excellence in Academia and Research" organized by Shiva Institute of Pharmacy Ghumarwin in collaboration with IIT Bombay. June 21.

Dr Sandopu Sravan Kumar (2025) Delivered online lecture on the topic entitled "Bridging chemistry and microbiology: Modern approach in metabolite purification" at Markaz Arts and Science College, Athavanad, Kerala. June 27.

Dr Gireesh Nadda (2025) Delivered a lecture on "Skill development programmes at CSIR-IHBT Palampur" Herbal Sector Stakeholder Meet (HSSM 2025). July 02-03.

Dr Upendra Sharma (2025) Delivered lecture on "Indian Certified Reference Materials (CRMs)/ Bhartiya Nirdeshak Dravya' (BND) of Phytochemicals for Scientific Validation, Quality and Safety Assurance of Himalayan Medicinal Plants and Product thereof" in HERBAL SECTOR STAKEHOLDER MEET (HSSM 2025) From Challenges to Collaboration: Empowering Herbal Product Development (under Viksit Bharat), (2nd July), Organised by CSIR-IHBT, Palampur, India. July 02-03.

Dr Dinesh Kumar (2025) Delivered a keynote lecture on title "Phytopharmaceuticals: Recognition for plant derived natural products in modern health care system" in Herbal Sector Stakeholder Meet (HSSM)-2025 at CSIR-IHBT Palampur. July 02-03.

Dr Mohit Sharma (2025) Delivered an expert lecture entitled Natural Non-nutritive Sweetener from Stevia rebaudiana: From Farm to Table during the Herbal Sector Stakeholder Meet 2025, From Challenges to Collaboration: Empowering Herbal Product Development (under Viksit Bharat). July 02-03.

Dr Rakesh Kumar (2025) Delivered a lecture on the topic entitled "Harnessing the Potential of Himalayan Medicinal Plants: Agrotechnological Innovations and Captive Cultivation" in Herbal Stakeholder meet (HSSM 2025) at CSIR-IHBT Palampur. July 02-03

Dr Damanpreet Singh (2025) Delivered a talk on "Navigating the Regulatory Landscape: Herbal Product Development in India" in Session II on Quality control and scientific validation of herbal formulations during Herbal Sector Stakeholder Meet (HSSM 2025) on "From Challenges to Collaboration: Empowering Herbal Product Development" at CSIR-IHBT. July 03.

Dr Amit Kumar (2025) Delivered online lecture on "Science Led Activities/Glimpse of CSIR-IHBT and Student Career Opportunities in India" at DAV SR SEC PUBLIC SCHOOL Barmana, Bilaspur. July 10.

Dr Sukhjinder Singh (2025) Delivered online talk on 'Tools and tactics for academic research and high impact publications' during International one-week faculty development program on Academic Research and Publishing High Impact Research: Tips, Tolls, and Tactics jointly organized by Dept. of English, Mohamed Sathak College of Arts and Science, Chennai, India and Cape Comorin Trust and Harvest International Multidisciplinary and Multilingual Research Journal from July 25-31.

Dr Gireesh Nadda (2025) Delivered an invited lecture on "Exploring indigenous fungi from Himalayan niches for industrial applications" in the National Conference on Recent Trends in Science & Technology held at Mahatma Fule Arts, Commerce & Sitaramji Chaudhari Science Mahavidyalaya, Warud–Amravati, Maharashtra. August 02.

Dr Rohit Joshi (2025) Delivered lecture on "Bamboo species identification and post-harvest processing" at Department of Horticulture, Centre of Excellence, Sidhpur, Dhrampur, Mandi, H.P. August 23.

Dr Amitabha Acharya (2025) Delivered lecture on "Therapeutic Applications of Carbon-Based Nanomaterial–Derived Nanozymes and Nanoenzymes". In 2nd International Conference on "Molecules to Materials: Chemistry for Sustainable Future (M2ChemSF-2025)"Department of Chemistry, National Institute of Technology (NIT) Hamirpur, India. September 05.

Dr Damanpreet Singh (2025) Served as a Keynote Speaker for the Technical Session at 3rd International Conference on "Mesoscience: Integrating Sciences and Technology in Healthcare and Medical Devices" held at Laureate Institute of Pharmacy, Kangra in collaboration with the Faculty of Medicine, University Sultan Zainal Abidin, Malaysia. September 20-21.

Dr Rohit Joshi (2025) Integrating Plant Tissue Culture and Genomics for Conservation and sustainable Utilization of Himalayan Bioresources. In: Refresher Course "Biodiversity, Climate Change, Food & Nutritional Security: A Global Challenge" (Online) for teachers of Universities and Colleges, UGC - Malviya Mission Teacher Training Centre, Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur, U.P., India. September 09–22.

Dr Sukhjinder Singh (2025) Delivered talk on "Marketing Strategies for Aromatic Crops" in the two days training program organized for the farmers of Jammu at CSIR-IHBT Palampur on October 06-07.

Dr Vijai K. Agnihotri (2025) Delivered a lecture entitled "सगंधित फसलों की गुणवत्ता की जानकारी एवं टेस्टिंग" in Training programme on "जम्मू छेत्र के किसानो के लिए सगंधित एवं उच्च मूल्यों वाली फसलों के बारे मे प्रशिच्छन एवं जागरूकता कार्यक्रम" अरोमा मिशन चरण–III के अंतर्गत, at J.C. Bose Conference Hall, CSIR-IHBT, Palampur, October 07.

Dr Sukhjinder Singh (2025) Delivered talk on "Science Communication for Technology Outreach" in the "Two-Day National Workshop "Communicate to Connect: Science for All" organised at CSIR-IHBT, jointly organised by CSIR-NIScPR and CSIR-IHBT from October 14-15.

Dr Mohit Sharma (2025) Delivered an expert lecture entitled Aroma Processing Technologies during a one-day workshop on value addition of Himalayan essential oils and their marketing regulation. Organized by Himalayan Phytochemicals Association, Mandi, HP. October 28.

Dr Sukhjinder Singh (2025) Delivered talk on "Marketing Regulations of Essential Oils" in the workshop on "Value addition of Himalayan Essential Oils and Their Marketing Regulation" organised at CSIR-IHBT, jointly organised by CSIR-IHBT and Himalayan Phytochemical Association (HIMPA), Mandi, October 28.

Dr Sukhjinder Singh (2025) Delivered talk on 'Strategies for Technology Transfer (Knowhow and IPR based)' during a 'Two Day National Level Intellectual Property (IP) Yatra Programme' jointly organized by PHD Chamber of Commerce and Industry, with the support of the Office of the Development Commissioner (MSME), Ministry of MSME, Govt. of India at Hotel Peterhoff, Shimla (Himachal Pradesh). Also showcased CSIR-IHBT technologies, October 30-31.

Dr Vijai K. Agnihotri (2025) Delivered a lecture entitled "Phytochemistry: An integrated approach for Human Health" in "12th Convention of Society for Ethnopharmacology India (SECON 2025) & International Conference on "Traditional Medicine – Ancient & Modern Concordance" at Jamia Hamdard, New Delhi, October 31.

Dr Damanpreet Singh (2025) Served as a Distinguished Guest for the Panel Discussion during the National Conference on Enhancing Ethical and Sustainable Animal Research (EESAR 2025) organised by the Lovely Professional University, Phagwara, Punjab. November 01.

Dr Vishal Sharma (2025) Delivered Invited Lecture in National Conference on Recent Advances in Medicinal and Aromatic Plant Biotechnology (MAPBio 2025) held at Graphic Era (Deemed to be University), November 10-12.

Dr Amit Chawla (2025) Delivered an Invited Keynote lecture in a one-day Online National Conference on the theme "Empowering Tribal India: Honouring Bhagwan Birsa Munda's Legacy through Unity, Sustainable Development, Cultural Revitalization and Inclusive Governance" organized by Govt. College, Killar (Pangi), District Chamba, November 14.

Dr Amit Chawla (2025) Delivered a lecture "Conservation and Sustainable Utilization of Plant Wealth of Pangi, a Pristine Eco-region of Western Himalaya" in conference "Empowering Chamba (aspirational district): Driving sustainable growth with CSIR-IHBT's cutting-edge technologies" organized at CSIR-IHBT on November 19-20.

Dr Sukhjinder Singh (2025) Delivered talk entitled, 'Skill development and Market linkages' in the event entitled "Empowering Chamba (aspirational district): Driving sustainable growth with CSIR-IHBT's cutting-edge technologies" at CSIR-IHBT Palampur, November 19-20.

Dr Vikram Patial (2025) Delivered invited key note talk on the topic "Preclinical assessment of natural product-based interventions for liver diseases" at LASAICON-2025 Conference on "From Preclinical to Clinical: Connecting the Dots of Research, Animal Welfare, Drug Discovery, and Pharma Innovation" for Viksit Bharat" at the CSIR-Institute of Microbial Technology (IMTech), Chandigarh, December 01-02.

Dr Sukhjinder Singh (2025) Delivered lecture on 'Entrepreneurship Development and Livelihood Generation' in India International Science Festival (IISF), 2025 organised at Panchkula, Haryana, December 08.

Dr Amit Chawla (2025) Delivered an Invited lecture in two-day National Conference on "Biodiversity and Climate Change: Challenges and Solutions" organized by Department of Botany, University of Jammu, Jammu, December 22-23.

Dr Amit Chawla (2026) Delivered an online lecture in Refresher Course in Life Sciences being conducted by the Department of Botany, Jammu University under MMTTC on the theme 'Climate Change', January 06.

Dr Vikram Patial (2026) Delivered invited talk on the topic "Animal Models in Biomedical Research" in "Hands on traning in animal handling and workshop in biomedical research" organized by Department of Pharmacology, KIMS and NISER Bhubaneshwar, January 07-10.

Dr Ashok Singh (2026) Delivered a lecture on "Prevalence of high altitude bioresources and ex-situ conservation strategies of important threatened medicinal plant species" to the trainees of 5 days National Training Program on "Climate Resilient Agriculture for Management of Dryland Ecosystems of the Himalayas" at G.B. Pant National Institute of Himalayan Environment, HP Regional Centre, Mohal, Kullu, Himachal Pradesh. January 16.

Dr Sukhjinder Singh (2026) Delivered lecture entitled 'Bio-resource based Livelihoods' in the programme, 'Thematic Scientific Consultation on Himalayan Issues' at NDMA Bhawan New Delhi, January 29-30.

Dr Arun Kumar (2026) Delivered lecture on "Pinpointing the molecular determinants of rice - Rhizoctonia solani interactions to develop sheath blight tolerance in rice" in an ICAR sponsored short course on "Biotechnological and conventional tools for biotic and abiotic stress management" at School of Agricultural Biotechnology, PAU, Ludhiana. February 10-19.

Dr Amit Chawla (2026) Delivered Invited Talk on topic "Validation of Authentic Plant Material: Requirements & Challenges" in a two-day Industry–Academia Meet (IAM-2026) organized by CSIR-IIIM Jammu, February 12-13.

Dr Vishal Sharma (2026) Invited Speaker at 47th Annual Meeting of Plant Tissue Culture Association (India) and Symposium & Industry Conclave on Plant Tissue Culture for Boosting Biomanufacturing, Nutritional Security, and Climate Resilience at NIPGR, New Delhi, February 17-20.

Dr Amit Chawla (2026) Delivered an online lecture "Fostering Scientific Temper & Innovation in Himalayan Region" to school children studying in Grade 6-8 classes for encouraging scientific temper and inspiring students to take up science career under the aegis of Rashtriya

Avishkar Abhiyan (RAA) Govt Utkrisht Sen Sec School Manikaran, District Kullu, March 02.

Dr Upendra Sharma (2026) "New Molecules from Himalayan Medicinal Plants: Advanced Approaches and CRMs/BNDs Development" in National Conference on Translational Opportunities in Natural Products Research (ToNPR-2026). CSIR-IICT Hyderabad, India, Organised by CSIR-IICT, Hyderabad and NIPER Guhati, India. March 05-06.

Dr Poonam Kumari (2026) Delivered STEM awareness and motivational lectures under the Vigyan Jyoti and CSIR-Jigyasa programmes at JNV Paprola, reaching ~70 students and promoting career opportunities in agriculture, horticulture, and floriculture, with emphasis on women in STEM, March 11.

Dr Sarita Devi (2026) Delivered an interactive lecture on "Joy of learning STEM: Boundless Opportunities" under the Vigyan Jyoti (supported by DST, Govt. of India) and CSIR-Jigyasa Pregramme on March 11.

Dr Rohit Joshi (2026) Delivered lecture on "Baans ke prakar aur unka prabandhan: vividhta, visheshtain evam sanrakshan", at RHRTS, Jachh, Nurpur. March 12.

Dr Damanpreet Singh (2026) Delivered a lecture entitled "Bridging Multi-Omics and Neurology: A New Era of Biomarker Discovery" as a keynote speaker at National conference on "Pharmaceutical Innovation, Research and Regulatory Excellence" at Shanti Niketan College of Pharmacy, Ratti, Mandi, HP. March 19.

RADIO/TELEVISION TALK

Dr Rakesh Kumar (2026) Delivered a talk on "Sugandhit evam aushdhiye paudhon ki vaigyanik vidhi se kheti " on All India Radio Dharamshala. February 24.

ABSTRACT PRESENTED

Puri S and Sharma U (2026) Chemometric-Guided Isolation of New Oleanane-Type Triterpenoid Saponins from Achyranthes bidentata Seeds: Biochemometric-Driven Scientific Validation of their Biological Effects. 13th International congress of Society of Ethnopharmacology and International conference on Translational Research in Ethnopharmacology-Integrating Traditional Medicine in Modern Healthcare (SFEC-ICTRE 2026). NIPER Mohali, India. February 26-28.

Sharma M and Sharma U (2026) Unlocking the Phytochemical Wealth of Nardostachys jatamansi: A Study of Its Medicinally Significant Compounds. National Conference on Translational Opportunities in Natural Products Research (ToNPR-2026CSIR-IICT Hyderabad, India. March 05-06.

AWARDS AND RECOGNITIONS

Khushbu Kumari (2025) Biopatrika published interview on artificial intelligence for callus proliferation. https://biopatrika.com/academia/researcher-spotlight/artificial-intelligence-pioneering-a-new-era-in-plant-tissue-culture.

Sharma RK (2025) Received B.R. Barwale Award for Application/ Excellence in PGR.

Sharma RK (2025) Nominated Convener, National Academy of Agricultural Sciences (NAAS) Palampur Chapter.

Kumari P (2025) Received Woman Scientist Award by Vigyan Varta Foundation.

Kumar R, Sharma M, Singh S and Yadav SK (2025) Awarded Rashtriya Vigyan Puraskar.

Joshi R (2025) Reviewing Board of 30 peer-reviewed journals and reviewed 89 Manuscripts. April 01, 2025 to March 31, 2026.

Joshi S (2025) Awarded as DBT-CTEP Travel Grant for participating in SIVB 2025 In Vitro Biology Meeting to be held in Norfolk, Virginia, USA. April 03.

Joshi R (2025) Nominated Subject Editor of Plant Physiology in Pantnagar Journal of Research. April 08.

Nath J (2025) Awarded as DBT-CTEP Travel Grant for participating in Plant Biology Europe 2025 held in Budapest, Hungary. May 06.

Joshi R (2025) Appointed Ambassador ISTEM, Bangalore. May 15.

Kumari K (2025) Awarded as DBT-CTEP Travel Grant for participating in SIVB 2025 In Vitro Biology Meeting to be held in Norfolk, Virginia, USA. May 06

Bali S (2025) Received the Best Oral Presentation Award at "National Conference on Nurturing Young Minds for Scientific innovations-2025 (NYMSI)" held at Central University of Himachal Pradesh, Shahpur, May 15-16.

Chawla A (2025) Received State Level Recognition for excellent contributions in Conservation of Biodiversity for the year 2024-25; felicitated on the occasion of International Day for Biological Diversity in a programme organized by HP State Biodiversity Board, Shimla at Himachal Pradesh University Shimla, May 22.

Joshi R (2025) External examiner for PhD thesis evaluation Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj. May 30.

Gusain S (2025) Awarded as DBT-CTEP Travel Grant for participating in SIVB 2025 In Vitro Biology Meeting to be held in Norfolk, Virginia, USA. June 07.

Kumari K (2025) Secured third place award in the Bob V. Conger Plant Biotechnology Student Oral Competition Award at SIVB 2025 In Vitro Biology Meeting to be held in Norfolk, Virginia, USA. June 09.

Joshi R (2025) Nominated External examiner for PhD thesis evaluation Guru Gobind Singh Indraprastha University June 17.

Kumari P (2025) Received Certificate of Recognition for online presentation on Wild Edible Flowers of Indian Himalayan Region, Their Traditional Uses and Potential Health Benefits: A Way Forward for Food and Nutritional Security in "32nd European Nutrition and Dietetics Conference" held during Zurich, Switzerland, July 07-08.

Joshi R (2025) Nominated External reviewer CRC press book. August 25.

Joshi R (2025) Nominated Evaluator of DBT project proposals August 31 and March 15.

Joshi R (2025) Enlisted in top 2% global scientist list by Stanford University and Elsevier. September.

Manisha and Kumar A (2025) Received Best Oral Presentation Award "Non-Invasive Monitoring of Tea Leaf Diseases through Hyperspectral Remote Sensing and Machine Learning". National Symposium on Sustainable Development and Conservation of Himalayan Bioresources through a Multidisciplinary approach, CSIR-IHBT, Palampur. September 02-03.

Meenakshi, Kashyap A, Kumar A and Shukla DP (2025) Received Best Poster Award "Changing Forest Landscapes of Kangra (2019–2025): Integrating FRAGSTATS Metrics with GEE and Geospatial AI for Climate–Ecology Insights". National Symposium on Sustainable Development and Conservation of Himalayan Bioresources through a Multidisciplinary Approach, CSIR-IHBT, Palampur, Himachal Pradesh, India, September 02-03.

Kharwal N, Thakur BK, Guleria B and Pal PK (2025) Received oral presentation entitled "Seaweed (Kappaphycus alvarezii) extract improves growth and secondary metabolites in Stevia rebaudiana by modulating biochemical activities under well-watered and water-deficient conditions" won first prize in the National symposium on sustainable development and conservation of Himalayan bioresources through a multidisciplinary approach. Organized by CSIR-IHBT, Palampur. September 02–03.

Kashyap A, Meenakshi and Kumar A (2025) Received Best Poster Award "Advanced UAV and ML/DL Approaches for Monitoring Morphological Traits and Yield Estimation of Aromatic Crops". National Symposium on Sustainable Development and Conservation of Himalayan Bioresources through a Multidisciplinary Approach, CSIR-IHBT, Palampur, Himachal Pradesh. September 02-03.

Bathla M and Acharya A (2025) Received Best Oral Presentation Award "Himalayan Plant Derived Carbon Dots as Copper Chelators for Restoring Lipid Homeostasis in Neurodegenerative Disease Models" National Symposium on "Sustainable Development and Conservation of Himalayan Bioresource Through a Multidisciplinary Approach" CSIR-Institute of Himalayan Bioresource and Technology (IHBT), Palampur, Himachal Pradesh, India. September 02-03.

Sharma P (2025) Received Best Poster award in the National Symposium on "Sustainable development and conservation of Himalayan bioresources through a multidisciplinary approach" at CSIR-IHBT, September 02-03.

Harish (2025) Awarded best poster award in the National Symposium on Sustainable Development and Conservation of Himalayan Bioresources through a multidisciplinary approach" under a specific theme on the topic "UV Radiations influencing the photosynthetic performance in Juniperus polycarpos, a high altitude tree species occurring in the cold desert region of western Himalaya" at CSIR-IHBT, Palampur (H.P.), India, September 02–03.

Kumari K (2025) Awarded as best Memes award in National Symposium on "Sustainable development and conservation of Himalayan bioresources through a multidisciplinary approach". September 03.

Kumari K (2025) Awarded as best Flash Talk award in National Symposium on "Sustainable development and conservation of Himalayan bioresources through a multidisciplinary approach". September 03.

Nandini and Acharya A (2025) Won best poster presentation by RSC "Vitamin-nanoparticle Conjugate Impedes Protein Aggregation Induced Neuronal Cell Death" 2nd International Conference on Molecules to Materials: Chemistry for sustainable future M2ChemSF 2025, Department of Chemistry, NIT Hamirpur, Himachal Pradesh, India. September 04-06.

Singh D (2025) Received SPSR Excellence Award 2025 (Excellence in Pharmaceutical Research

Award) by the Society of Pharmaceutical Sciences and Research (SPSR), India. September 07.

Joshi R (2025) Nominated External examiner for master's thesis evaluation of Indian Agricultural Researc Institute, New Delhi. September 13.

Joshi R (2025) Nominated External examiner for PhD thesis evaluation UPES, Dehradun October 14.

Saini TC and Acharya A (2025) Won Anusandhan National Research Foundation International Travel Support (ANRF-ITS) fellowship (ITS/2025/003960) "Functional Polyphenol–Quantum Dots Nanosystem Mitigate Amyloidogenic Cross-Seeding and Restore Neurophysiological Homeostasis in Alzheimer's Disease" 17th International Conference on Nanomaterials – Research & Application to be held in Brno, Czech Republic TANGER Ltd., Czech Republic, European Eunion. October 15-17.

Joshi R (2025) Received ASCI Certified Master trainer "Plant Tissue Culture Technician". October 27.

Chawla A (2025) Received Distinguished Alumnus Award 2025 by Guru Nanak Dev University, Amritsar, November 10.

Joshi R (2025) Received ASCI Certified Master trainer "Bamboo cultivator". October 27.

Singh D (2025) Received Distinguished Alumnus Award from the Guru Nanak Dev University Amritsar Alumni Association. November 10.

Kumar A, Thakur S, Gupta CK, Rajan P, Mohapatra GN, B Rakesh and Rakesh Kumar (2025) Awarded the best poster award in the Sixth International Agronomy Congress on "Re-envisioning Agronomy for Smart Agri-food Systems and Environmental Stewardship" held at CSIR-NPL New Delhi, India. November 24–26.

Joshi R (2025) Nominated External examiner for PhD thesis evaluation Banasthali Vidyapith, Rajasthan. December 06.

Pandey B, Rialch A, Acharya A, Gorakh Mal, Singh B and Sharma R (2025) Received First Prize in Poster Presentation "In-vitro efficacy of copper-oxide andzinc oxide nanoparticles incombination with albendazole against Haemonchus contortus" 34th National Congress of Veterinary Parasitology and National Symposium (NVCP-2025) On Parasitology in the Digital Era: Innovations for one health and farmers' prosperity College of Veterinary and Animal Sciences, Udgir, Maharashtra, Animal and Fishery Sciences University, Nagpur. December 17-19.

Suparna Mondal (2026) Completed "Hands-0n workshop on gene editing in plants: From CRISPR design to analysing edited lines" organized by Regional Centre for Biotechnology, Faridabad. January 06-10

Kumar R, Ranout AS and Nadda G (2026) Unlocking the acricidal potential of the Himalyan plant Roylea cinerea (D. Don) against the Tetranychus urticae Koch. 2026, MCM DAV College Kangra (HP). Awarded with best poster award. January 21-23.

Sharma S (2026) Received 3rd Best poster award on topic Microbial Diversity of Edible Flowers from the Western Himalayas: Implications for Food Safety and Pathogen Risk. In National Conference and IPS Mid-Eastern Zonal meet on PATHOGENS, MICROBES AND PLANT DEFENSE: Bridging Research and Applications (PMPD-2026) at ICAR-NBAIM, Mau, January 28-29.

Joshi R (2026) Nominated Editor, Plant Physiology Reports February 13.

Joshi R (2026) Nominated External examiner for PhD thesis evaluation Deen Dayal Upadhyaya Gorakhpur University, Gorakhpur. February 10.

Kumar D (2026) Nominated Member of scientific panel for Scientific Panel on Genetically modified organisms (GMOs) and Foods (SP-04), FSSAI-India Member of scientific panel for Scientific Panel on Genetically modified organisms (GMOs) and Foods (SP-04), FSSAI-India. February 11.

Kumar D (2026) Nominated Member of the Research Advisory Committee (RAC) of Chitkara University, Himachal Pradesh, India. February 12.

Kumar D (2026) Nominated Rapporteur scientific panel for Scientific Panel on Genetically modified organisms (GMOs) and Foods (SP-04), FSSAI-India. February 16.

Puri S and Sharma U (2026) Dr. Shivani Puri Got Young Ethnopharamcology Award/P K Debnath Memorial Award. Chemometric-Guided Isolation of New Oleanane-Type Triterpenoid Saponins from Achyranthes bidentata Seeds: Biochemometric-Driven Scientific Validation of their Biological Effects. 13th International congress of Society of Ethnopharmacology and International conference on Translational Research in Ethnopharmacology-Integrating Traditional Medicine in Modern Healthcare (SFEC-ICTRE 2026). NIPER Mohali, India. February 26-28.

Sharma M and Sharma U (2026) Dr. Mehak Sharma Got Best Oral Presentation Award. Unlocking the Phytochemical Wealth of

Nardostachys jatamansi: A Study of Its Medicinally Significant Compounds. National Conference on Translational Opportunities in Natural Products Research (ToNPR-2026). CSIR-IICT Hyderabad, India. March 05-06.

Bhargava B (2026) Received the Prestigious Lotus Puraskar Award (2026) from the Indian Society of Ornamental Horticulture (ISOH) on the occasion of the National Conference on "Floriculture and Landscaping @2047 Viksit Bharat". March 23-25.

Acharya A (2026) Awarded Fellow of Royal Society of Biology (FRSB).

Acharya A (2026) Awarded Fellow of Bose Science Society (FBSS).

Acharya A (2026) Awarded Editorial Board Member, Discover Applied Sciences.

Acharya A (2026) Awarded Associate Editor, Frontiers in Medical Technology.

Acharya A (2026) Awarded Associate Editor, Frontiers in Nanotechnology.

Kumari P (2026) Received Outstanding Woman Researcher Award in Floriculture and Landscaping by Venus International Foundation, Chennai, India.

Nath J (2026) Selected as assistant professor (Adhoc) in Delhi University.

MEMBERSHIP OF PROFESSIONAL BODIES/ ORGANISATIONS

Dr Amit Kumar nominated as a Life Member of Society of Plant research, Vgetos: An international Journal of Plant Research and Biotechnology Springer.

Dr Jeremy Dkhar accepted as member of the Japanese Society for Plant Physiology (JSPP, Membership No. 16709).

Dr Sandopu Sravan Kumar nominated as a Life Member of Society of Biological Chemists (SBC, Membership No.: 3570), Mysore, India.

Dr Sandopu Sravan Kumar nominated as a Life Member of Association of Food Science and Technology India (AFST(I), Membership No.: AFST/LM/6-2018/HQR/2050), Mysore, India.

Dr Sandopu Sravan Kumar nominated as a Life Member of The Indian Botanical Society (IBS, Membership No.: 243/2024), Uttar Pradesh, India.

Dr Vijai K. Agnihotri (2025) Member of Asian Council of Science Editors: Membership No: 242616306 (2025).

Dr Vijai K. Agnihotri (2025) Metabolomics Association of North America: Membership No: 838 (2025-2027).

Dr Poonam Kumari (2025) Life membership of The Indian Academy of Horticultural Sciences, New Delhi and Society for Horticultural Research and Development, Ghaziabad, Uttar Pradesh, India.

POSTER PRESENTED

Joshi S and Joshi R (2025) Surviving and thriving: sensing and signaling mechanism in alpine Himalayan medicinal plant *Nardostachys jatamansi*. In: 2025 World Congress on *In Vitro* Biology". Norfolk, Virginia, USA, organized by Society of *In Vitro* Biology. June 07-10.

Gusain S and Joshi R (2025) Molecular dynamics underlying elicitor-induced fortification to drought stress reveal crosstalk between calcium ions and nitric oxide signalling. In: 2025 World Congress on *In Vitro* Biology" at Norfolk, Virginia, USA organized by Society of In Vitro Biology. June 07-10.

Kumari K and Joshi R (2025) Integrating artificial intelligence and multi-omics for precision organogenesis, embryogenesis and secondary metabolite production in *Ferula assa-foetida* L. In: 2025 World Congress on *In Vitro* Biology" at Norfolk, Virginia, USA organized by Society of In Vitro Biology. June 07-10.

Himanshu, Chauhan M and Kumar A (2025) Activity-guided identification, cloning, heterologous expression, and characterization of a highly thermostable mitochondrial superoxide dismutase from Lantana camara. "National Symposium on Sustainable Development and Conservation of Himalayan Bioresources through a Multidisciplinary Approach", CSIR Institute of Himalayan Bioresource Technology, Palampur. September 02-03.

Kandpal Y and Dkhar J (2025) Low continuous temperature promotes embryo growth, while alternating temperature accelerates seed germination in Kala Jeera (*Bunium persicum*). National Symposium on Sustainable Development and Conservation of Himalayan Bioresources through a Multidisciplinary Approach. September 02-03.

Maina SS and Kumar SS (2025) Intensification of bioactive metabolites extraction and antioxidnat activities from Western Himalayan medicinal plant viz Urtica spp. using sonication methods. National Symposium on Sustainable Development and Conservation of Himalayan Bioresources Through Multidisciplinary Approach. September 02-03.

Sharma R and Agnihotri VK (2025) *In Vitro* Antidiabetic Evaluation of Volatile Organic Compounds from the Roots of *Rosa damascena* Mill. Cultivated in the High-Altitude North-Western Himalaya. National Symposium on Sustainable Development and Conservation

of Himalayan Bioresources through a Multidisciplinary Approach, CSIR-IHBT Palampur, H.P., India p. 61. September 02-03.

Dev K and Agnihotri VK (2025) Comparative chemical profiling of *Pinus roxburgii* Sarg. essential oils from the bioresource of the Western Himalayas. National Symposium on Sustainable Development and Conservation of Himalayan Bioresources through a Multidisciplinary Approach, CSIR-IHBT Palampur, H.P., India, p. 64. September 02-03.

Ranout AS, Kumar R, Kaur R, Anmol, Sharma U and Nadda G (2025) Eco-Friendly Management of Aphis craccivora using indigenous Tolypocladium inflatum: A Biotechnological Approach. CSIR-IHBT, Palampur (HP). September 02-03.

Kharwal N, Thakur BK, Guleria B and Pal PK (2025) Seaweed (*Kappaphycus alvarezii*) extract improves growth and secondary metabolites in *Stevia rebaudiana* by modulating biochemical activities under well-watered and water-deficient conditions. National symposium on sustainable development and conservation of Himalayan bioresources through a multidisciplinary approach. Organized by CSIR-IHBT, Palampur. September 02–03.

Mitakshi, Kharwal N, Shivani, Katoch A, Thakur BK, Singh RK and Pal PK (2025) Dynamics of sugar, starch, and phenolic compounds in Monk Fruit (*Siraitia grosvenorii*) root across dormancy to sprouting in the western Himalayan Region. National symposium on sustainable development and conservation of Himalayan bioresources through a multidisciplinary approach. Organized by CSIR-IHBT, Palampur. September 02–03.

Thakur A, Shailja, Yadav JP, Sharma A and Pal PK (2025) Seaweed (*Solieria chordalis*) extract improved the yield of *Valeriana jatamansi* under well-watered and water-deficient conditions. National symposium on sustainable development and conservation of Himalayan bioresources through a multidisciplinary approach. Organized by CSIR-IHBT, Palampur. September 02–03.

Kumari K, Devi K, Kachra A, Singh S, Sharma RK, Yadav SK, and Joshi R (2025) Integrative multi-omics and AI-driven approaches elucidate molecular signaling and secondary metabolite dynamics during *in vitro* organogenesis of *Ferula assa-foetida* L. In: National symposium on sustainable development and conservation of himalayan bioresources through a multidisciplinary approach at CSIR-IHBT, Palampur. September 02-03.

Gupta T, Devi K, Pandey SS, and Joshi R (2025) Optimization of Somatic Embryogenesis and Agrobacterium-Mediated transformation in Tea (*Camellia sinensis*) cv. Him Sphurti. In: National symposium on sustainable development and conservation of himalayan bioresources through a multidisciplinary approach CSIR-IHBT, Palampur. September 02-03.

Kumar A, Thakur S, Gupta CK, Rajan P, Mohapatra GN, Rakesh V and Kumar R (2025) Smart Sensor based Growth Assessment of Rice (*Oryza sativa* L.) Varieties Grown in Acidic Soils of the Western Himalayas". In: Sixth International Agronomy Congress on "Re-envisioning Agronomy for Smart Agri-food Systems and Environmental Stewardship" held at CSIR-NPL, New Delhi, India. November 24–26.

Thakur S, Kumar A, Gupta CK, Rajan P, Mohapatra GN, Rakesh V and Kumar R (2025) Spatial Variability and Precision Nutrient Management in Apple (*Malus domestica* Borkh.) varieties grown in the Western Himalayas. In: Sixth International Agronomy Congress on "Re-envisioning Agronomy for Smart Agri-food Systems and Environmental Stewardship" held at CSIR-NPL New Delhi. India. November 24–26.

Kumar R, Ranout AS and Nadda G (2026) Unlocking the acricidal potential of the Himalyan plant *Roylea cinerea* (D. Don) against the *Tetranychus urticae* Koch. 2026, MCM DAV College Kangra (HP). Awarded with best poster award. January 21-23.

Kumari K, Devi K, Kachra A, Yadav SK, and Joshi R (2026) Multi-omics dissection of in vitro seed germination and UV-C elicitation reveals transcriptional reprogramming of growth and secondary metabolite biosynthesis in *Ferula assa-foetida*. In: 47th Annual Meeting of Plant Tissue Culture Association (India) Symposium & Industry Conclave on Plant Tissue Culture for Boosting Biomanufacturing, Nutritional Security, and Climate Resilience. Organized by BRIC-National Institute of Plant Genome Research, New Delhi in association with Plant Tissue Culture Association (India). 17-February 20.

Joshi S and Joshi R (2026) Ca^{2+}-mediated stress signalling underpins cold and freezing tolerance in the alpine medicinal herb *Nardostachys jatamansi*. In: 47th Annual Meeting of Plant Tissue Culture Association (India) Symposium & Industry Conclave on Plant Tissue Culture for Boosting Biomanufacturing, Nutritional Security, and Climate Resilience. Organized by BRIC-National Institute of Plant Genome Research, New Delhi in association with Plant Tissue Culture Association (India). February 17-20.

Nath J and Joshi R (2026) Deciphering developmental plasticity and stress adaptation in *Picrorhiza kurrooa* Royle through integrated molecular and metabolic insights. In: 47th Annual Meeting of Plant Tissue Culture Association (India) Symposium & Industry Conclave on Plant Tissue Culture for Boosting Biomanufacturing, Nutritional Security, and Climate Resilience. Organized by BRIC-National Institute of Plant Genome Research, New Delhi in association with Plant Tissue Culture Association (India). February 17-20.

Gusain S and Joshi R (2026) Deciphering drought induced carbon and energy reprogramming and its impact on growth and corm development in *Crocus sativus* L. In: 47th Annual Meeting of Plant Tissue Culture Association (India) Symposium & Industry Conclave on Plant Tissue Culture for Boosting Biomanufacturing, Nutritional Security, and Climate Resilience. Organized by BRIC-National Institute of Plant Genome Research, New Delhi in association with Plant Tissue Culture Association (India). February 17-20.

Sharma M and Sharma U (2026) Exploring the phytochemical depth and biological versatility of *Nardostachys jatamansi*. 13th International congress of Society of Ethnopharmacology and International conference on Translational Research in Ethnopharmacology-Integrating Traditional Medicine in Modern Healthcare (SFEC-ICTRE 2026). NIPER Mohali, India. February 26-28.

Bora PS and Sharma U (2026) Leveraging UPLC-Q-TOF-MS-based Biochemometric Workflow for the Isolation and Characterization of Low-Abundance Bioactive Isosteroidal Alkaloids from *Fritillaria cirrhosa* D.Don. 13th International Congress of the Society of Ethnopharmacology and International Conference on Translational Research in Ethnopharmacology-Integrating Traditional Medicine in Modern Healthcare (SFEC-ICTRE 2026). NIPER Mohali, India. February 26-28, 2026.

Singh CP, Bharitkar YP and Sharma U (2026) Phytochemical Investigation and their Chemical Transformation of *Dysoxylum binectariferum*, *Parthenium hysterophorus*, and Aconitum heterophyllum. 13th International congress of Society of Ethnopharmacology and International conference on Translational Research in Ethnopharmacology-Integrating Traditional Medicine in Modern Healthcare (SFEC-ICTRE 2026). NIPER Mohali, India. February 26-28.

Bhardwaj A and Sharma U (2026) Establishing Quality Benchmarks for *Trillium govanianum* Wall ex D.Don, a High-Altitude Medicinal Plant. 13th International congress of Society of Ethnopharmacology and International conference on Translational Research in Ethnopharmacology-Integrating Traditional Medicine in Modern Healthcare (SFEC-ICTRE 2026). NIPER Mohali, India. February 26-28.

Bhardwaj A and Sharma U (2026) Phytochemical Foundations of Quality Assessment in *Trillium govanianum* Wall ex D. Don. National Conference on Translational Opportunities in Natural Products Research (ToNPR-2026). CSIR-IICT Hyderabad, India. March 05-06.

Chauhan P, Samkaria S and Kumari P (2026) Comprehensive Nutritional, Biochemical, and Phenolic Profiling of Rose (*Rosa hybrida* L.) Hips: Implications for Functional Food Development. In: 9th AMIFOST-2026 International conference on "Bio-Convergence & Next-Gen Food Systems: Towards Sustainable Nutrition and Global Food Resilience, Amity University Uttar Pradesh, page no. 208-209. March 17-18.

ABSTRACT PRESENTED

Samkaria S, Sharma S, Chauhan P and Kumari P (2026) Comparative evaluation of drying techniques on bioactive compounds, nutritional quality, and anti-nutrients of Kachnar (*Bauhinia variegata* L.) flowers. Book of Abstracts, 4th Indian Horticulture Summit-cum-International Conference-2026, Jhansi, Uttar Pradesh, page no. 92. January 28-30.

Chauhan P, Samkaria S and Kumari P (2026) Comprehensive Nutritional, Biochemical, and Phenolic Profiling of Rose (*Rosa hybrida* L.) Hips: Implications for Functional Food Development. In: 9th AMIFOST-2026 International conference on "Bio-Convergence & Next-Gen Food Systems: Towards Sustainable Nutrition and Global Food Resilience, Amity University Uttar Pradesh, page no. 208-209, March 17-18.

Sharma S, Harman and Kumari P (2026) Microbial Diversity of Edible Flowers from the Western Himalayas: Implications for Food Safety and Pathogen Risk. In Abstract of National Conference and IPS Mid-Eastern Zonal meet on PATHOGENS, MICROBES AND PLANT DEFENSE: Bridging Research and Applications (PMPD-2026) at ICAR-NBAIM, Mau, Page no. 25-26, January 28-29.

PARTICIPATION IN EXIBITION

Dr Sandopu Sravan Kumar (2025) Exhibited the R&D activities and Products of CSIR-IHBT on Industrial Green Chemistry World (IGCE-2025) organized by Green ChemisTree Foundation and Department of Chemicasl & Petrochemicals as Co-ordaniser at The Westin Mumbai Garden City, Mumbai, India. October 6-8.

STAFF

STAFF

Director:
Dr. Sudesh Kumar Yadav

Chief Scientist:
Dr.(Mrs.) Aparna Maitra Pati
Dr. Vipin Hallan
Dr. Ram Kumar Sharma
Dr. Sanjay Kumar Uniyal
Dr. Amit Kumar
Dr. Rakesh Kumar
Dr. Sanatsujat Singh
Dr. Shashi Bhushan

Senior Principal Scientist:
Dr. Pralay Das
Dr. Dharam Singh
Dr. Vijai Kant Agnihotri
Dr. Ravi Shankar
Dr. Probir Kumar Pal
Dr. Mahesh Gupta
Dr. Rituraj Purohit
Er. Mohit Sharma
Dr. Amit Chawla
Dr. Y.S. Padwad
Dr. Gireesh Nadda
Dr. Dinesh Kumar
Dr. Damanpreet Singh

Principal Scientist:
Dr. Upendra Sharma
Dr. Pamita Bhandari
Dr. Amitabha Acharya
Dr. Vikram Patial
Dr. Vishal Acharya
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Dr. Narender Vijay Tirpude
Dr. Vivek Dogra
Dr. Gaurav Zinta
Dr. Rajesh Kumar Singh
Dr. Vidyashankar Srivatsan
Dr. Arun Kumar

Senior Scientist:
Dr. Ankit Saneja
Dr. Poonam Kumari
Dr. Vandana Jaiswal
Dr. Satbeer Singh
Dr. Ramesh
Dr. Vikas Kumar
Dr. Sarita Devi
Er. Amit Kumari

Scientist:
Dr. Ashok Kumar Pathera
Dr. Amit Kumar
Dr. Vishal Sharma
Dr. Sandopu Sravan Kumar
Dr. Prashant Kumar
Ms. Priya Chaudhary
Dr.Vivek Dhiman
Dr. Jyoti
Dr. Kumari Nisha
Dr. Prasanth A
Dr. Parthasarathy S
Dr. Kodape Anup Ramdas

Senior Technical Officer (3):
Dr. Kiran Devi
Sh. Vikrant Gautam
Dr. Avnesh Kumari
Sh. J. S. Bisht
Dr. Kiran Singh Saini
Sh. Shiv Kumar
Dr. Rajneesh
Sh. Rakesh Verma
Sh. Anil Kumar
Dr. Anish Kaachra

Senior Technical Officer (2):
Sh. Ramjeelal Meena
Sh. Vivesh Sood
Sh. Mahesh S.
Sh. Bijan Bihari Garnayak
Sh. Jasbeer Singh
Sh. Mukesh Gautam
Sh. Om Prakash
Sh. Ashok Gehlot
Sh. Kunjan Saxena
Dr. Vipul Gupta, Senior Medical Officer (2)
Mrs. Vijaylata Pathania
Sh. Pabitra Gain
Sh. Aman Kumar

Senior Technical Officer (1):
Sh. Mohit Kumar Swarankar
Dr. Arvind Kumar Verma
Mrs. Meenakshi
Sh. Anil Chaudhary
Sh. Vikrant Awasthi
Sh. Pawan Kumar

Technical Officer:
Dr. Rimpy Diman
Sh. Virat Abhishek
Sh. Saurabh Sharma

Technical Assistant:
Sh. Rajeev Kumar Koundal
Sh. Vikas Soni
Ms. Ishani Gautam
Ms. Anjali Chandel
Sh. Ravindra Kumar
Dr. Alka Rani

Senior Technician (1):
Sh. Sanjay Kumar
Sh. Avinash Chander Rana
Sh. Arvind Kant
Sh. Sandeep Sood
Sh. Ranjeet Singh
Sh. Ajay Kumar
Sh. Surjeet Singh
Mrs. Jasveer Kaur
Sh. Vikas Kumar

Technician (2):
Sh. Sanjeev
Sh. Sanjeet Kumar
Sh. Monu Kumar
Sh. Ishwar Dass

Technician (1):
Ms. Sarita Devi
Sh. Kamlesh Dutt

Lab Assistant:
Mrs. Anupama Saini
Sh. Shamsher Singh
Sh. Uttam Chand
Sh. Balak Ram
Sh. Kuldip Singh
Sh. Balwant Raj
Sh. Girja Nand
Sh. Deepak Sood

Controller of Administration:
Sh. Shankar Das Rishi

Controller of Finance & Accounts:
Sh. Sunil Kumar

Store and Purchase Officer:
Sh. Sanjay Rawat

Hindi Officer:
Sh. Sanjay Kumar

Private Secretary:
Sh. Didar Singh

Section Officer (Gen.):
Sh. Prajwal Rai
Sh. Ranjeet Kumar Gupta
Ms. Saroj

Section Officer (F&A):
Sh. Mahabir Singh (relieved on 22.07.2025)
Ms. Priyanka Meena

Section Officer (S&P):
Sh. Ravinder Singh (VRS on 09.01.2026)
Sh. Sohan Singh

Assistant Section Officer (G.):
Mrs. Santosh Kumari
Sh. Baldev
Sh. Kiran Kumar
Mrs. Pooja Awasthi
Sh. Ankit Rohilla
Mrs. Jyoti

Assistant Section Officer (F&A):
Mrs. Aruna Kumari
Sh. Mukul Sharma
Sh. Saurabh Sharma

Assistant Section Officer (S&P):
Sh. Rajeev Sood
Ms. Deepika

Sr. Stenographer:
Sh. Boni Kumar

Jr. Stenographer:
Sh. Sanchit Thakur
Sh. Mayank Khatri (resigned on 22.10.2025)
Sh. Ritik Sharma (resigned on 17.10.2025)

Senior Secretariat Assistant (G.):
Sh. Praveen Kumar

Senior Secretariat Assistant (S&P):
Sh. Rajinder Singh

Junior Secretariat Assistant (G.) :
Sh. Shubham Barsola
Sh. Nikhil Awasthi
Ms. Deepika
Sh. Shivam Mohanpuria (transferred on 30.01.2026)
Sh. Ashwani Kumar Chauhan
Sh. Abhishek Thakur
Ms. Pramila Kumari
Sh. Rakesh Kumar
Sh. Rakesh
Sh. Amit Chahal
Sh. Jasbinder

Junior Secretariat Assistant (F&A):
Ms. Priyanka Chauhan
Sh. Harsh Kotnala

Junior Secretariat Assistant (S&P):
Sh. Pransh Katoch
Sh. Mital Rana

Coupon Clerk (Canteen):
Sh. Anand Sharma

Cook:
Sh. Karan Singh

Driver:
Sh. Partap Chand
Sh. Lakhwinder Singh
Sh. Nitesh Bhardwaj

Bearer (Canteen):
Sh. Bipan Kumar

Tea & Coffee Maker:
Sh. Bipan Gurung

MTS:
Sh. Thaman Bahadur

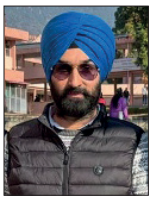
Joined CSIR-IHBT between 01.04.2025-31.03.2026

S.N.	Name	Designation	Date of Joining
1.	Sh. Sanchit Thakur	Jr. Steno.	01.04.2025
2.	Ms. Saroj	SO (G)	08.04.2025
3.	Ms. Priyanka Meena	SO (F&A)	09.04.2025
4.	Dr. Priya Chaudhary,	Sct.	11.04.2025
5.	Ms. Sarita Devi,	Tech. (1)	01.05.2025
6.	Ms. Ishani Gautam	TA	02.05.2025
7.	Sh. Kamlesh Dutt,	Tech (2)	29.04.2025
8.	Ms. Anjali Chandel	TA	22.05.2025
9.	Sh. Ravindra Kumar	TA	07.07.2025
10.	Dr. Alka Rani	TA	14.07.2025
11.	Sh. Shubham Barsola	JSA (G)	18.07.2025
12.	Sh. Nikhil Awasthi	JSA (G)	21.07.2025
13.	Ms. Priyanka Chauhan	JSA (F&A)	21.07.2025
14.	Ms. Deepika	JSA (G)	21.07.2025
15.	Sh. Abhishek Thakur	JSA (G)	28.07.2025
16	Sh. Ashwani Kumar Chauhan	JSA (G)	28.07.2025
17	Sh. Harsh Kotnala	JSA (F&A)	31.07.2025
18	Sh. Pransh Katoch	JSA (S&P)	01.08.2025
19	Ms. Pramila Kumari	JSA (G)	21.08.2025
20.	Sh. Rakesh Kumar	JSA (G)	22.08.2025
21.	Sh. Rakesh	JSA (G)	03.09.2025
22.	Sh. Jasbinder	JSA (G)	08.09.2025
24	Sh. Amit Chahal	JSA (G)	08.09.2025
25.	Sh. Mital Rana	JSA (S&P)	06.10.2025
26	Dr. Vivek Dhiman	Sct.	18.02.2026
27.	Dr. Jyoti	Sct.	05.03.2026
28.	Dr. Kumari Nisha	Sct.	09.03.2026
29.	Dr. Prasantha A	Sct.	11.03.2026
30.	Dr. Parthasarathy S	Sct.	20.03.2026
31.	Dr. Kodape Anup Ramdas	Sct.	30.03.2026

Staff Superannuated

Smt. Rujala Devi
MTS, 30.06.2025

Voluntarily Retirement



Sh. Ravinder Singh
SO (S&P), 09.01.2026

Transferred to other CSIR Labs/Institutes:

1. Sh. Shivam Mohanpuria, CSIR-IHBT to CSIR-NAL, Bangalore: 30.01.2026
2. Sh. Ranjeet Kumar Gupta, CSIR-IHBT to CSIR NBRI, Lucknow: 30.03.2026

Staff Resigned:

1. Sh. Ritik Sharma, Jr. Steno. 17.10.2025
2. Sh. Mayank Khatri, Jr. Steno. 22.10.2025

INSPIRE Faculty
Dr. Poonam Jyoti

RAMANUJAN Fellow
Dr. Satish Singh

Young Scientist
Ms. Tanvi Sharma

Senior Research Associate (Pool Scheme)
Dr. Vipasha Verma

Women Scientist
Dr. Vidya Rajendran
Ms. Nitisha Sendri
Ms. Neha Kumari

NPDF & PDF
Dr. Narender Kumar
Dr. Kapil Deswal
Dr. Dipankar Bera
Dr. Payal Kapoor

ISWP
Ms. Abhisha Roy
Mr. Sourav Kanungo
Mr. Mathewos Geneto Abiche

BioCARe Women Scientist
Dr. Monika Rana
Dr. Aparna Misra
Dr. Nisha Bhardwaj

Research Associate
Dr. Ashish Gupta
Dr. Shagun Bali
Dr. Mohammed Saba Rahim
Mr. Shinde Bhagatsing Devidas
Dr. Avriti Ranjan
Dr. Sheetal
Dr. Hrishikesh Mahato
Dr. Priyanka Sharma

Project Research Scientist (PRS-I)
Mr. Navneet Thakur
Mr. Paramdeep Kumar

Principal Project Associate
Dr. Megha Katoch

Research Associate-I
Dr. Hanny Chauhan

Senior Project Associate
Mr. Deekshith H. N.
Dr. Payal Kapoor
Mr. Manish Kumar
Mr. Prateek Singh Bora
Mr. Sachin Ashok Thorat
Dr. Sapna Thakur
Dr. Rajveer Singh

Senior-PAT
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Dr. Sumeet Parkash Kaundal
Mr. Nitesh Kaushal
Dr. Kavita Rana
Mr. Anmol
Mr. Karthik R
Mr. Lokesh Thakur
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Ms. Suman Gusain
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Mr. Nabab Khan
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Ms. Himanshi Gangwar
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Ms. Shivani
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Mr. Shiv Kumar Saini
Ms. Sahiba Chahal
Mr. Vivek Kumar
Mr. Gaurav Aggarwal
Mr. Sarthi
Ms. Neha
Mr. Rahul Singh
Ms. Ekjot Kaur
Ms. Shagun Sanjivv Dogra
Ms. Neha Bhardwaj
Mr. Vinesh Sharma
Mr. Aman Thakur
Mr. Raman Kumar
Ms. Pooja Sharma
Ms. Mamta Masand
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Mr. Suresh Kumar
Ms. Shweta Sharma
Ms. Shikha Sharma
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Ms. Meenakshi Rawat
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Ms. Anjali Nisha
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Ms. Nandini
Ms. Palak Sharma
Ms. Kamini Thakur

JRF

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Mr. Garvit Singh
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Mr. Rajesh Kumar
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Ms. Bharti
Ms. Reeta Devi
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Ms. Arooshi Sharma
Ms. Sanjna Kumari
Ms. Amanpreet Kaur
Ms. Sakshi Verma
Ms. Anchal Thakur
Ms. Anjali Sharma

Project Scientist

Dr. Arvind Anand

Project Coordinator-II

Ms. Babita Kaundal

Project Associate-II

Ms. Neha
Ms. Sampa Das
Mr. Athrinandan S. Hegde
Mr. Ravi Raj

Mr. Manoj S. Aroor
Ms. Kamlesh
Mr. Sourabh Kumar
Ms. Nishtha Vashishta
Ms. Himanshi Gupta
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Ms. Mehak Sharma
Ms. Ragini Bhardwaj
Ms. Tamanna Bhalla
Ms. Pallavi Sharma
Ms. Isha Thakur
Mr. Naveen Katoch
Ms. Neha Rana

Project Associate PAT-II

Mr. Abhishek Goel
Ms. Mrinali Sood
Ms. Nilofer
Mr. Kalit Sharma
Mr. Rahul Kumar
Ms. Aditi Guleria
Mr. Babit Kumar Thakur
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Ms. Meenakshi Sharma
Ms. Neha Thakur
Mr. Aman Kumar

Project Associate-I

Mr. Ravi Kumar
Mr. Akash
Mr. Pardeep Kumar
Ms. Anjali Thakur
Mr. Sagar Gupta
Mr. Banish Guleria
Ms. Surbhi Sharma
Mr. Ayush Paul
Ms. Shivani
Mr. Veerbhan Kesarwani
Ms. Tanvi
Ms. Diksha Sharma
Mr. Rahul Bodh
Ms. Diksha Thakur
Ms. Shivani Sharma
Ms. Garima Kumari
Ms. Sangeeta Kumari
Ms. Deepika Sharma
Mr. Akhil Rana
Mr. Chaudhari Aniket Anant
Mr. Mukul Rana
Ms. Priya
Ms. Anmol Sharma
Ms. Krishma Devi
Ms. Taniya Sharma
Mr. Ajay Kumar
Ms. Priyanka Raj
Ms. Shalini Jariyal
Mr. Sunil Kumar
Mr. Mohar Singh
Ms. Swati
Ms. Romika Thakur
Mr. Ankush Garla
Ms. Anjali Kumari
Mr. Hari Sharan
Ms. Neerja Kharwal
Ms. Shailja
Mr. Sachin Vashisth
Mr. Rishabh Bhardwaj
Ms. Tamanna Sharma
Ms. Saizal Jamwal
Mr. Chanchal Bhatt
Mr. Ritesh Sharma
Ms. Shambhvi
Mr. Akhilesh Kumar Sharma
Ms. Monalisa Mathan
Ms. Diksha Sood
Mr. Naveen
Mr. Rajneesh Kumar
Ms. Aditi Sharma
Mr. Bhupender Singh
Mr. Abhishek Kumar
Ms. Rajni Devi
Ms. Ajeta Katoch
Mr. Kapil Dev
Mr. Jatin
Ms. Savita Chaudhary
Mr. Shourabh Rav
Mr. Amit
Mr. Punit Kumar
Mr. Shashi Kumar
Ms. Ananya Sood
Mr. Sakshi Dogra
Mr. Shubham

Ms. Akanksha Sharma
Ms. Kritika Sharma
Ms. Bindu Rawat
Ms. Parul
Ms. Reetika Sharma
Mr. Aadarsh Shrivastav
Ms. Diksha Dhiman
Ms. Anmol Katoch
Ms. Mitakshi
Ms. Ronika
Mr. Ashish Kumar
Ms. Paridhi Shrivas
Mr. Himanshu
Ms. Sunanda Jassal
Mr. Mohit
Mr. Yogesh Kandpal
Mr. Rahul Kumar
Ms. Sumedha Thakur
Mr. Prajwal Jakhmola
Dr. Kajal
Ms. Arushi Sharma
Ms. S. Vaishnavi
Mr. Shubham Verma
Ms. Neha
Ms. Vanshika Thakur
Ms. Tanvi Gupta
Ms. Ritika Rana
Ms. Teotia Nidhi
Mr. Keshav Kumar
Ms. Garima Thakur
Ms. Sonia Sharma
Ms. Ankita Sharma
Mr. Rohit Singh Negi
Ms. Ayushi Walia
Ms. Sunidhi Sharma
Ms. Kanika Chauhan
Dr. Swati Walia
Ms. Lakshita Dhiman

Project Associate PAT-I

Ms. Aditi Anand
Mr. Sahil Guleria
Ms. Neha Pathak
Mr. Jatin Kumar
Mr. Ravi Kumar
Ms. Pallavi Phian
Ms. Gaytri Hetta
Mr. Rishabh Kaundal
Ms. Akshita Awasthi
Ms. Smriti Gupta
Mr. Abhinandan
Ms. Tsering Dolma
Ms. Anchal Sharma
Mr. Akshat Sood
Ms. Priyanka Bhardwaj
Ms. Ankita
Ms. Sakshi
Ms. Shalini
Mr. Sarvpreet Singh
Ms. Sweety Rana
Ms. Aanchal Sharma
Ms. Dimpal Thakur
Ms. Simran Kamal
Ms. Shakshi
Ms. Anika Samyal
Mr. Gourav Kashyap
Ms. Sneha
Mr. Nitin Kumar
Mr. Ritik Sharma
Ms. Dimple Kumari
Ms. Ashna Acharya
Ms. Ayushi Kukreti
Mr Priyanshu Sharma
Ms. Aakriti Sood
Ms. Mamta Dhiman
Ms. Sakshi Choudhary
Ms. Kanika
Mr. Vishal Kumar
Mr. Abhishek Kumar
Ms. Nitika Parmar
Mr. Karan Saini
Ms. Niharika Gurung
Ms. Jyotsna Pathania
Ms. Shagun Pathania
Mr. Gourav
Mr. Manthan Sood
Ms. Manisha Choudhary
Ms. Parul
Mr. Hari Shankar Gadri
Mr. Harsh Kumar
Ms. Puneet Kaur
Ms. Diksha Kalia
Mr. Sumanta Mohapatra
Ms. Dixit Chaudhary
Ms. Anjalika Dhiman
Mr. Himanshu Saini
Mr. Arvind Sharma
Mr. Abhinav Rathi
Ms. Shaina
Ms. Isha Chaudhary
Ms. Anshumali
Ms. Priyanka
Mr. Ankur Kapil
Ms. Payal Chauhan
Mr. Aakash
Ms. Akanksha Parashar
Ms. Mahima Chauhan
Mr. Shubham Thakur
Mr. Gowher Rashid Lone
Mr. Ayush Thakur
Ms. Ananya Singh

Ms. Kiran Dhiman
Mr. Sahil Bhakal
Ms. Shivani Puri
Ms. Prakriti
Mr. Udesh Dhiman
Mr. Shubhnam
Ms. Preetika Verma
Ms. Shikha Kumari
Ms. Shourya Gautam
Ms. Trisha Dogra
Mr. Sahil Sharma
Ms. Foola Devi
Ms. Shailja
Ms. Diksha Kumari
Ms. Anchal Thakur
Ms. Nisha Devi
Mr. Banish Guleria
Ms. Shagun Sanjivv Dogra
Mr. Krishna Gill
Ms. Nenakshi Thakur

Project-JRF
Mr. Amit Kumar
Ms. Aastha
Mr. Navneet Thakur

Project Assistant
Mr. Randhir Singh
Ms. Chhering Youdon
Ms. Deepti
Mr. Sahil Kumar
Mr. Neeraj Barwal
Ms. Iva Sharma
Ms. Nidhi Negi
Mr. Shagun Sharma
Mr. Aditya
Ms. Diksha Kharwal
Mr. Shubham Jamwal
Mr. Sahil Awasthi

Project Assistant-II (PA-II)
Mr. Sarthi
Ms. Harman
Mr. Amnish Singh
Mr. Atul Dhiman
Ms. Bandna Kumari
Mr. Shankar
Mr. Sahil Sharma
Mr. Akshit Sood
Ms. Shivani Sharma
Mr. Amit
Mr. Rohit
Ms. Shagun Chambyal
Ms. Ronika

Project Assistant-I (PA-I)
Mr. Jagdeep Singh
Mr. Kishan Kharka

Field Assistant
Mr. Arvind Sharma
Ms. Anchal Thakur

Field worker
Mr. Abhishek Bhatt
Mr. Kalyan Yadav
Mr. Rakesh Choudhary
Mr. Nitin Kumar
Mr. Vivek Gaurav

Scientific Administrative Assistant
Mr. Anchit Kumar
Mr. Sandeep Kumar

Student Intern
Ms. Preetika Tanwar
Ms. R Harippriya
Ms. Aishwarya
Ms. Pratima Singh
Ms. Samriti Sharma
Ms. Tanuja
Ms. Isha Saklani

Consultant (Retired Employee)
Sh. Oman Singh
Sh. Ramesh Kumar

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पर्यावरण अनुकूल नवीनतम तकनीकें अपनाएं

सीएसआईआर-आईएचबीटी ने मनाया अंतरराष्ट्रीय चाय दिवस

अंतरराष्ट्रीय चाय दिवस पर मौजूद सीएसआईआर-आईएचबीटी पालमपुर के कर्मचारी।

अनंत ज्ञान, पालमपुर

सीएसआईआर-हिमालयी जैवसंसाधन प्रौद्योगिकी संस्थान (सीएसआईआर-आईएचबीटी) पालमपुर ने बुधवार को चाय थीम पर अंतरराष्ट्रीय चाय दिवस मनाया। इसमें आजीविका, स्थिरता और स्वास्थ्य में चाय के योगदान पर प्रकाश डाला गया। पूर्व विधानसभा

हिमालय जैव संपदा संस्थान पालमपुर ने चाय दिवस मनाया

पालमपुर। एसआईआर-हिमालय जैवसंपदा प्रौद्योगिकी संस्थान, पालमपुर ने अंतरराष्ट्रीय चाय दिवस मनाया। विषय था बेहतर जीवन के लिए चाय। यह आजीविका, स्थिरता और स्वास्थ्य में चाय के योगदान को उजागर करता है। मुख्य अतिथि बीबीएल बुटेल, पूर्व स्पीकर हिमाचल प्रदेश विधानसभा और प्रसिद्ध चाय उत्पादक जिनका के साथ जैव-संसाधनों के स लंबे समय से जुड़ाव रहा है, ने की अर्थव्यवस्था में चाय की और जी.आई (भौगोलिक

कार्यों और कांगड़ा चाय उद्योग को पुनर्जीवित करने में इसकी भूमिका की प्रशंसा की। चाय ब्रांड हिमालयन के मालिक राजीव सूद पालमपुर स्थित भारतीय चाय बोर्ड के फैक्टरी सलाहकार हेमराज अग्रवाल ने चाय की विभिन्न किस्मों, उनके स्वादों और एक बेहतरीन चाय बनाने के लिए

हमारी प्राचीन कला है हस्तशिल्प : गिरिराज सिंह

केंद्रीय मंत्री ने पालमपुर में किया उर्वरक उत्पादन इकाई का उद्घाटन

ऑपरेशन सिंदूर पर दी बोले केंद्रीय मंत्री

वैश्विक स्तर पर ऑपरेशन सिंदूर के लिए सांसदों के प्रतिनिधिमंडलों के विभिन्न देशों के दौरे पर केंद्रीय मंत्री गिरिराज सिंह ने कहा कि प्रतिनिधिमंडल भारत के बिंदुओं को सामने रख रहे हैं, पाकिस्तान द्वारा किया गया यह कायरतापूर्ण हमला हमें और मजबूत बना देगा। इसी तरह का एक प्रतिनिधिमंडल 1994 में अटल बिहारी वाजपेयी के नेतृत्व में इसी उद्देश्य से गया था। अगर पाकिस्तान इसे समझने में असमर्थ है, और नियत है, तो वह फिर उस समझने में है। केंद्रीय मंत्री गिरिराज सिंह ने सीएसआईआर- आईएचबीटी में एक किसान एवं अतिथि रजरटोरम केंद्र का भी शुभारंभ किया। इसकी स्थापना द्वारा नवाचार और रजरटोरम को बढ़ावा देने की दिशा में एक महत्वपूर्ण कदम है। केंद्रीय मंत्री ने वैज्ञानिकों से आग्रह किया कि वे ऐसी तकनीकों का विकास करें, जो किसानों के लिए आसान हों, लागत कम करें और उत्पादकता बढ़ाएं। इस कार्यक्रम में हिमाचल प्रदेश के कृषि मंत्री चंद्र कुमार, सांसद कंगना रनौत, सीएसआईआर-आईएचबीटी के निदेशक डॉ. सुदेश कुमार यादव ने अपने स्वागत संबोधन में संस्थान में की जा रही जैव-संसाधन आधारित गतिविधियों का विस्तार से परिचय दिया। साथ उन्होंने हाल ही में स्थापित इस फ्लोरीकल्चर यूनिट, मेडिसिनल एंड एरोमैटिक प्लांट्स के कार्यकर्मों और उनके वैज्ञानिक महत्व पर प्रकाश डाला। उन्होंने बताया कि संस्थान किसान समूहों का गठन कर उन्हें उद्यमिता और तकनीकी प्रशिक्षण दे रहा है, ताकि वे अपने उत्पादों को बाजार तक पहुंचा सकें। इस कार्यक्रम में बड़ी संख्या में किसान, महिला स्वयं सहायता समूह और स्थानीय उद्यमी शामिल हुए।

CSIR-IHBT Palampur celebrates national technology day

The Savera Times Network

Shimla: The CSIR-Institute of Himalayan Bioresource Technology (CSIR-IHBT), Palampur, Himachal Pradesh, celebrated National Technology Day with a special event on 15th May, emphasizing India's strides toward Acceleration," highlighted the country's commitment to advancing technology and promoting research for global solutions. Dr. Sudesh Kumar Yadav, Director of CSIR-IHBT, extended a warm welcome to the distinguished guests and attendees. In his address, Dr. Yadav highlighted the transformative power of and Phytopharmaceutical Missions, which have empowered local farmers with modern cultivation and processing techniques. These initiatives have opened new avenues for economic growth in the region and beyond.

The Chief Guest, Ms. Suchita Singh, founder of Vijya Wellness and Biosciences

सौगात — गिरिराज ने व्याड़ा में किया बायोफर्टिलाइजर उत्पादन इकाई का उद्घाटन

अब पंचरुखी में बनेगी जैविक खाद

अजय पाल, अनंत ज्ञान

पालमपुर। केंद्रीय वस्त्र मंत्री गिरिराज सिंह ने सीएसआईआर-हिमालय जैवसंपदा प्रौद्योगिकी संस्थान पालमपुर में अपने दो दिवसीय दौरे के तहत पंचरुखी ब्लॉक के व्याड़ा गांव में बायोफर्टिलाइजर उत्पादन इकाई,

मंत्री ने शनिवार को सीएसआईआरआईएचबीटी पालमपुर का दौरा किया था।

निदेशक ने मंत्री को संस्थान में किए जा रहे कार्यों से अवगत कराया, जो कि विकसित भारत के लक्ष्य को केंद्र में रखते हुए ग्रामीण लोगों की आजीविका में सुधार ला

किसान जैविक खेती अपनाएं : गिरिराज

केंद्रीय मंत्री ने पालमपुर में बायोफर्टिलाइजर उत्पादन इकाई का किया उद्घाटन

संवाद न्यूज एजेंसी

पालमपुर (कांगड़ा)। केंद्रीय कपड़ा मंत्री गिरिराज सिंह सीएसआईआर-हिमालय जैवसंपदा प्रौद्योगिकी संस्थान पालमपुर में दो दिवसीय दौरे के तहत बियाड़ा गांव में बायोफर्टिलाइजर उत्पादन इकाई, बीओबी ऑर्गेनिक्स का उद्घाटन किया।

तुर्किये नहीं, हिमाचल के सेब को प्राथमिकता देंगे देशवासी

संवाद सहयोगी, जागरण ० पालमपुर : केंद्रीय वस्त्र मंत्री गिरिराज सिंह ने कहा है कि देशवासी तुर्किये नहीं, बल्कि हिमाचल प्रदेश के सेब को प्राथमिकता देंगे। तुर्किये ने पाकिस्तान का साथ दिया है। अब देशवासियों ने तुर्किये का सेब न खरीदने का सही निर्णय लिया है। केंद्र से सर्वदलीय प्रतिनिधिमंडल विदेश दौरे पर गया है जो भारत की बात रखेगा। यह बात केंद्रीय मंत्री ने सीएसआईआर-आईएचबीटी पालमपुर के दो दिवसीय दौरे के दौरान रविवार को पंचरुखी के समीप व्याड़ा गांव में बायोफर्टिलाइजर उत्पादन इकाई व बीओबी आर्गेनिक्स का उद्घाटन करने के बाद कही। इसे संस्थान के तकनीकी सहयोग से स्थापित किया है।

केंद्रीय मंत्री गिरिराज सिंह ने व्याड़ा में बायोफर्टिलाइजर उत्पादन इकाई व बीओबी आर्गेनिक्स का किया उद्घाटन

का उपयोग करने के लिए प्रेरित किया। कहा, फ्लोरीकल्चर एक अच्छा विकल्प है, जो न केवल जैव आर्थिकी को बढ़ावा देने की क्षमता रखता है बल्कि पर्यटन को भी प्रोत्साहित करेगा। जैविक खेती को अपनाने की बात भी गिरिराज सिंह ने कही। इसके बाद उन्होंने सीएसआईआर-आईएचबीटी में किसान एवं उद्योग स्टार्टअप बैठक में भाग लिया। उन्होंने संस्थान की प्रयोगशालाओं का दौरा किया। अंट्रेटा में मिट्टी के बर्तन बनाने वाले संस्थान का

Minister unveils biochar unit, stresses on sustainable tech

RAVINDER SOOD

PALAMPUR, MAY 25

Minister of Textiles Giriraj Singh visited the CSIR-Institute of Himalayan Bioresource Technology (IHBT) in Palampur, Himachal Pradesh. He was warmly received by the institute's Director, Dr Sudesh Kumar Yadav, and staff members.

During the visit, Dr Yadav briefed the minister about the institute's cutting-edge research and technology development efforts, particularly under the CSIR-Aroma, Floriculture and Phytopharmaceutical Missions, which are positively impacting rural livelihoods and aligning with the vision of Viksit Bharat.

The Director of NIFT, Kangra, also attended the programme and emphasised the growing importance of creativity and design thinking in contemporary times.

The minister appreciated CSIR-IHBT's efforts in strengthening the region's bio-economy and acknowledged the institute's role in translating scientific innovations into grassroots applications. He stressed the importance of developing environmentally sustainable and user-friendly

Textile Minister Giriraj Singh inaugurates a bio-fertiliser unit.

technologies that are widely accessible. He extended his best wishes for the institute's future endeavours.

Prior to this, Giriraj Singh planted a tree sapling as a part of "Ek Ped Maa Kae Naam" initiative and visited various facilities of the institute. He also inaugurated the biochar and compost booster production unit in the institute.

On the occasion, the institute signed a technology transfer agreement with Komal Innovation and Wellness Initiatives, Nagrota Bagwan, Kangra. Also a memorandum of understanding for collaborative research on fibre and natural colours was signed with NIFT, Kangra. An agreement with Vijya Wellness and Biosciences LLP, Dera Mandi, Neemar Delhi on advanced technical textile solutions was also signed.

As a part of the programme, the minister launched beverages and food products prepared by startups, and distributed planting material of aromatic marigold chrysanthemum to farmer clusters.

पालमपुर : हिमालय जैवसंपदा प्रौद्योगिकी संस्थान पालमपुर में विश्व पर्यावरण दिवस पर आयोजित कार्यक्रम के प्रतिभागी सामूहिक चित्र में। (भृगु)

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विकसित भारत का सपना विज्ञान और प्रौद्योगिकी से होगा संभव : डा. पाल

संवाद सहयोगी, जागरण ० पालमपुर : विकसित भारत का सपना विज्ञान और प्रौद्योगिकी से ही संभव होगा। यह बात भारत सरकार में नीति आयोग सदस्य डा. वीपी पाल ने बुधवार को हिमालय जैवसंपदा प्रौद्योगिकी संस्थान पालमपुर के 43वें स्थापना दिवस समारोह में कही। उन्होंने महिला स्वास्थ्य व कुपोषण के मुद्दों पर भी चर्चा की। कहा कि आत्मनिर्भर भारत के निर्माण के लिए सभी को एक साथ चलना होगा। कोविड वैक्सीन तैयार कर भारत ने विश्व में कीर्तिमान स्थापित किया है। भारतीय कृषि अनुसंधान परिषद के पूर्व महानिदेशक एवं राष्ट्रीय प्राध्यापक डा. टीआर शर्मा ने स्थापना दिवस पर व्याख्यान दिया। उन्होंने धान की "प्लास्ट" रोग प्रतिरोधक किस्मों के प्रजनन की सामाजिक, खाद्य सुरक्षा, पारिस्थितिकी और आर्थिक दृष्टि से महत्ता को रेखांकित किया। डा. महेश कुमार दधीच, सीईओ, एनएमपीबी ने ऑनलाइन संबोधित करते हुए हिमालय में औषधीय पादपों को विविधता, हर्बल क्षेत्र की भूमिका तथा दुर्लभ व संकटग्रस्त पादपों के संरक्षण एवं प्रबंधन की आवश्यकता पर बल दिया।

सीएसआईआर-हिमालय जैवसंपदा प्रौद्योगिकी संस्थान पालमपुर में बुधवार को 43वें स्थापना दिवस कार्यक्रम में मौजूद मुख्यतिथि व अन्य ० जागरण

कार्यक्रम के विशिष्ट अतिथि आईआइएसईआर मोहाली के निदेशक डा. एके त्रिपाठी ने कहा कि विज्ञान ने सामाजिक विकास में विशेष भूमिका निभाई है। उन्होंने सीएसआईआर आर्थिकी को बढ़ावा देने में संस्थान का सामर्थ्य तथा नए अवसरों के बारे में विस्तार से बताया। हर्बल स्टेकहोल्डर मीट की स्मारिका का भी इस अवसर पर विमोचन हुआ। समारोह में सीएसआईआर-आईएचबीटी 'वार्षिक रिपोर्ट-2024-25', 'इकनॉमिक इम्पेक्ट ऑफ सीएसआईआर-आईएचबीटी टेक्नोलॉजीस, पोटेंनसिएल क्रॉप फॉर हर्बल सेक्टर एवं लो चिलिंग एपल वैराइटीज पर पुस्तक व ब्रॉशर का विमोचन किया गया। सीएसआईआर मिशन जैव सम्पदा, संरक्षण और संभावनाएं' पर एक वीडियो और ब्रॉशर भी विमोचित किए गए। कार्यक्रम में मॉक फूट के जर्मप्लाज्म रिसोर्स सेंटर और गुलाब के प्रदर्शन प्लॉट्स का अवलोकन किया गया। इस अवसर पर आनलाइन संबोधित करते हुए अरोमा मिशन के माध्यम से हिमालय में औषधीय पादपों की विविधता, हर्बल क्षेत्र की भूमिका तथा दुर्लभ व संकटग्रस्त पादपों के संरक्षण एवं प्रबंधन की आवश्यकता पर बल दिया।

इससे पहले सीएसआईआर आईएचबीटी के निदेशक डा. सुदेश कुमार यादव ने अतिथियों का स्वागत करते हुए संस्थान की गतिविधियों पर प्रकाश डाला। उन्होंने फ्लोरीकल्चर, अरोमा और मिलेट मिशन जैसी पहलों और उनके सामाजिक अनुकूल प्रभावों की जानकारी दी।

विज्ञान-प्रौद्योगिकी से साकार होगा विकसित भारत का सपना

आईएचबीटी पालमपुर के स्थापना दिवस पर बोले नीति आयोग के सदस्य डाक्टर वीपी पॉल

कार्यालय संवाददाता-पालमपुर

सीएसआईआर-हिमालय जैवसंपदा प्रौद्योगिकी संस्थान पालमपुर ने अपना 43वां स्थापना दिवस मनाया। समारोह में नीति आयोग के सदस्य के डा. वीपी पॉल ने बतौर मुख्यातिथि शिरकत की। डा. पॉल कहा कि विकसित भारत 2047 का सपना विज्ञान और प्रौद्योगिकी के माध्यम से ही संभव है।

उन्होंने महिला स्वास्थ्य व कुपोषण के मुद्दों पर भी चर्चा की और कहा कि आत्मनिर्भर भारत के निर्माण के लिए सभी को एक साथ चलना होगा। डा. टीआर शर्मा, राष्ट्रीय प्रोफेसर और पूर्व उपमहानिदेशक, भाकृअनुप, ने

उन्होंने चावल की 'ब्लास्ट' रोग प्रतिरोधक किस्मों के प्रजनन की सामाजिक, खाद्य सुरक्षा, पारिस्थितिकी और आर्थिक दृष्टि से महत्ता को रेखांकित किया। डा. महेश कुमार दधीच, सीईओ, एनएमपीबी ने ऑनलाइन संबोधित करते हुए हिमालय में औषधीय पादपों को विविधता, हर्बल क्षेत्र की भूमिका तथा दुर्लभ व संकटग्रस्त पादपों के संरक्षण एवं प्रबंधन की आवश्यकता पर बल

के निदेशक डा. एके त्रिपाठी, जो कि प्रोग्राम के विशिष्ट अतिथि थे, ने कहा कि विज्ञान ने सामाजिक विकास में विशेष भूमिका निभाई है। उन्होंने सीएसआईआर अरोमा मिशन के द्वारा सामाजिक सशक्तिकरण पर प्रकाश डाला। सीएसआईआर-आईएचबीटी के निदेशक डा. सुदेश कुमार यादव ने फ्लोरीकल्चर, अरोमा और मिलेट मिशन जैसी पहलों और उनके सामाजिक अनुकूल प्रभावों की

विज्ञान एवं प्रौद्योगिकी के माध्यम से ही विकसित भारत 2047 का सपना संभव : डॉ. वीपी पॉल

हिमाचल दस्तक ■ पालमपुर

सीएसआईआर हिमालय जैव संपदा प्रौद्योगिकी संस्थान पालमपुर ने मनाया 43वां स्थापना दिवस

सीएसआईआर-हिमालय जैवसंपदा प्रौद्योगिकी संस्थान, पालमपुर ने बुधवार को अपना 43वां स्थापना दिवस मनाया। समारोह के मुख्यअतिथि डॉ. वीपी पॉल, सदस्य, नीति आयोग, भारत सरकार अपने संबोधन में सीएसआईआर-आईएचबीटी के स्थापना दिवस की बधाई देते हुए कहा कि संस्थान ने अपने स्थापना के समय से ही विकसित भारत 2047 के सपने को साकार करने की दिशा में महत्वपूर्ण योगदान दिया है। उन्होंने कहा कि संस्थान ने हिमालयी जैवसंपदा के संरक्षण, सतत उपयोग और ग्रामीण आजीविका के सशक्तिकरण के लिए जो कार्य किए हैं, वे अत्यंत सराहनीय हैं। उन्होंने कहा कि आज जब देश आत्मनिर्भरता की ओर बढ़ रहा है, तब संस्थान जैसे संस्थानों की भूमिका और भी महत्वपूर्ण हो जाती है। उन्होंने वैज्ञानिकों से आग्रह किया कि वे अपने शोध को केवल प्रयोगशाला तक सीमित न रखें, बल्कि उसे किसानों और उद्योगों तक पहुंचाने का प्रयास करें। उन्होंने कहा कि विज्ञान तभी सार्थक है जब उसका लाभ समाज के अंतिम व्यक्ति तक पहुंचे। डॉ. पॉल ने कहा कि हिमालय क्षेत्र में उगने वाले औषधीय और सुगंधित पौधों में अपार संभावनाएं हैं, जिनका वैज्ञानिक तरीके से दोहन किया जाना चाहिए। उन्होंने संस्थान द्वारा विकसित तकनीकों और उत्पादों की सराहना की और कहा कि इन्हें बड़े पैमाने पर उद्योगों के साथ साझा किया जाना चाहिए। उन्होंने युवा वैज्ञानिकों को प्रोत्साहित करते हुए कहा कि वे नवाचार और उद्यमिता की भावना को अपनाएं।

इस अवसर पर संस्थान के निदेशक डॉ. सुदेश कुमार यादव ने संस्थान की उपलब्धियों और भविष्य की योजनाओं पर प्रकाश डाला। उन्होंने बताया कि संस्थान ने पिछले वर्षों में कई नई तकनीकें विकसित की हैं, जिनमें हर्बल खेती, जैविक खेती और मूल्य संवर्धन से जुड़ी तकनीकें प्रमुख हैं। उन्होंने कहा कि संस्थान ने अब तक हजारों किसानों और उद्यमियों को प्रशिक्षण दिया है और कई स्टार्टअप्स को तकनीकी सहयोग प्रदान किया है। उन्होंने कहा कि संस्थान का लक्ष्य आने वाले वर्षों में ग्रामीण आजीविका को और मजबूत करना है।

इस अवसर पर संस्थान के वैज्ञानिकों, कर्मचारियों और विद्यार्थियों ने बड़ी संख्या में भाग लिया। कार्यक्रम के दौरान उत्कृष्ट कार्य करने वाले कर्मचारियों को सम्मानित भी किया गया। अंत में संस्थान के वरिष्ठ वैज्ञानिक डॉ. राकेश कुमार ने सभी अतिथियों और प्रतिभागियों का धन्यवाद ज्ञापित किया।

विकसित भारत-2047 का सपना विज्ञान और प्रौद्योगिकी से ही संभव

■ सी.एस.आई.आर.-आई.एच.बी.टी. के स्थापना दिवस पर बोले नीति आयोग के सदस्य

पालमपुर, 2 जुलाई (भृप्): सी.एस.आई.आर.-हिमालय जैवसंपदा प्रौद्योगिकी संस्थान पालमपुर में 43वें स्थापना दिवस पर आयोजित समारोह में मुख्यातिथि डॉ. वीके सारस्वत, सदस्य, नीति आयोग, भारत सरकार ने कहा कि विज्ञान और प्रौद्योगिकी से ही विकसित भारत 2047 का सपना संभव है। वर्ष 2014 में इस क्षेत्र की मार्केट महत्ता को रेखांकित किया। डा. सी.एस.आई.आर.-आई.एच.बी.टी. वार्षिक रिपोर्ट-2024-

पालमपुर: हिमालय जैव संपदा प्रौद्योगिकी संस्थान पालमपुर में 43वें स्थापना दिवस समारोह के दौरान प्रतिभागी। (भृप्)

बायोटेक प्रा.लि., सोलन (हि.प्र.) के साथ तकनीकी हस्तांतरण समझौतों पर भी हस्ताक्षर हुए। संस्थान द्वारा आयोजित 2 दिवसीय " हर्बल स्टेकहोल्डर मीट का उद्घाटन हुआ, जिसमें 3 सत्र और विशेषज्ञों के व्याख्यान शामिल हैं। हर्बल स्टेकहोल्डर मीट की स्मारिका का भी विमोचन किया गया।

समारोह में 'सी.एस.आई.आर.-आई.एच.बी.टी " वार्षिक रिपोर्ट-2024-

पालमपुर में हर्बल खेती पर सजे कार्यक्रम का समापन

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सीएसआईआर-हिमालय जैवसंपदा प्रौद्योगिकी संस्थान दो दिवसीय हर्बल सैक्टर स्टेकहोल्डर मीट-मीट में कुल तीन सत्र आयोजित किए गए। पहले सत्र का विषय था 'हर्बल खेती में चुनौतियां और सतत स्रोत'। जिसमें डा. डीआर नाग ने उद्घाटन भाषण दिया और औषधीय संसाधनों पर प्रकाश डाला। दूसरे सत्र में 'हर्बल उत्पादों की गुणवत्ता नियंत्रण और वैज्ञानिक प्रमाणन' पर चर्चा हुई।

सीएसआईआर. आईएचबीटी, पालमपुर में हर्बल सैक्टर स्टेक होल्डर मीट-2025 सम्पन्न

हर्बल क्षेत्र सतत विकास का एक महत्वपूर्ण स्रोत, जो विकसित भारत को साकार करने में महत्वपूर्ण योगदान करता है प्रदान

सवेरा न्यूज/जसवंत कठियाल

पालमपुर, 3 जुलाई : सीएसआईआर. आईएचबीटी, पालमपुर में गत दिवस शुरू हुई दो दिवसीय हर्बल सैक्टर स्टेक होल्डर मीट-2025 वीरवार को सम्पन्न हुई। कार्यक्रम में देशभर से 200 से अधिक प्रतिभागियों ने हिस्सा लिया, जिनमें वैज्ञानिक, किसान, नीति निर्धारक, उद्योगपति, शोधकर्ता, चिकित्सा क्षेत्र के और एफपीओ के ट में कुल तीन गए। पहले सत्र ती में चुनौतियां में डॉ. डीआर. ण दिया और प्रकाश डाला।

नियंत्रण और वैज्ञानिक प्रमाणन पर चर्चा हुई। इसकी अध्यक्षता फार्माकोपिया कमीशन फॉर इंडियन मेडिसन एंड होम्योपैथी, गाजियाबाद के निदेशक डा. रमन मोहन सिंह ने की और मुख्य वक्ता के रूप में डा. सीके. कटियार, सलाहकार (आर एंड डी हेल्थकेयर, इमामी लिमिटेड) ने

तीसरा सत्र हर्बल क्षेत्र में सहयोग को बढ़ावा देने पर केंद्रित था, जिसमें प्रमुख व्याख्याता डा. विजय चौधरी, प्राचार्य, राजीव गांधी आयुर्वेदिक कॉलेज एवं अस्पताल, पपरोला (हि.प्र.) ने दिया। उन्होंने हर्बल चिकित्सा की प्रमाणिकता और सहयोग की आवश्यकता पर बल दिया। प्रमुख व्याख्यानों के अतिरिक्त, के भविष्य विषय पर एक पैनल चर्चा भी आयोजित की गई। प्रतिभागियों द्वारा उठाए गए मुद्दों और प्रश्नों के उत्तर विशेषज्ञों द्वारा दिए गए। प्रतिभागियों ने संस्थान की प्रयोगशालाओं का भ्रमण कर वहां हो रहे शोध को प्रत्यक्ष रूप से देखा और सराहा। उन्होंने इस उपयोगी और समय रूप से लाभकारी कार्यक्रम के आयोजन के लिए संस्थान की सराहना की। बैठक में यह निष्कर्ष निकला कि हर्बल क्षेत्र सतत विकास का एक महत्वपूर्ण स्रोत है, जो देश की समृद्ध जैव विविधता और पारंपरिक ज्ञान का लाभ उठाकर ग्रामीण आजीविका स्वास्थ्य सुरक्षा और वैश्विक व्यापार को बढ़ावा देता है और

लाहुल में तैयार हुआ हींग व बीज

जलधारा ठाकुर ■ जांगरुप

मनाली : लाहुल घाटी के सलगांव के किसान तोग चंद ठाकुर ने हींग व इसका बीज तैयार किया है। हींग का बीज तैयार करने वाले यह देश के पहले किसान बने हैं। सीएसआईआर आईएचबीटी पालमपुर ने तोग चंद ठाकुर को सम्मानित किया है। हींग के पौधे के लिए हिमाचल जैसे ही लाहुल घाटी की ठंडी व शुष्क जलवायु बेहतर पाई गई है।

सीएसआईआर आईएचबीटी पालमपुर के वैज्ञानिकों के मुताबिक भारत में हींग की खेती एक महत्वाकांक्षी परियोजना है, जिससे किसानों को आर्थिक रूप से लाभ हो सकता है। भारत में पैदा हींग के बीज अन्य पहाड़ी क्षेत्रों में हींग की खेती के लिए न्यादा उपयुक्त हैं क्योंकि इनकी उत्पति देश को जलवायु के अनुरूप हुई है।

लाहुल स्पीति के किसान तोग चंद ठाकुर के खेत में तैयार हुए हींग के बीज का निरीक्षण करते सीएसआइआर पालमपुर के निदेशक सुदेश कुमार यादव व उनकी टीम ■ जांगरुप

- किसान तोग चंद ठाकुर को सीएसआइआर आइएचबीटी पालमपुर ने किया सम्मानित
- हींग के पौधे के लिए हिमाचल की लाहुल घाटी की ठंडी व शुष्क जलवायु को पाया गया बेहतर

हींग एक अत्यंत उपयोगी औषधीय मसाला है। तोग चंद ठाकुर देश के पहले किसान बन गए हैं जिन्होंने सीएसआइआर आइएचबीटी की ओर से विकसित हींग के पौधों को सफलतापूर्वक उगाया और उससे बीज भी तैयार किया। हमारी टीम ने खेतों का निरीक्षण कर उनकी मेहनत, तकनीकी समझ और समर्पण की सराहना की। यह उपलब्धि देश के लिए महत्वपूर्ण है। तोग चंद ठाकुर की इस सफलता देश को हींग उत्पादन में आत्मनिर्भर बनाने की दिशा में बड़ा कदम साबित हो सकती है।

-सुदेश कुमार यादव, निदेशक, सीएसआईआर हिमालय जैवसंपदा प्रौद्योगिकी संस्थान पालमपुर।

सीएसआईआर-आईएचबीटी में राष्ट्रीय खेल दिवस समारोह संपन्न

खेल प्रतियोगिताओं में भाग लेते संस्थान के प्रतिभागी कर्मी)

सवेरा न्यूज/जसवंत कठियाल पालमपुर, : सीएसआईआर - आईएचबीटी हिमालय जैवसंपदा प्रौद्योगिकी संस्थान, पालमपुर में तीन दिवसीय राष्ट्रीय खेल दिवस समारोह रविवार को संपन्न हुआ। गौरतलब है कि यह आयोजन 29 अगस्त को संस्थान के निदेशक, डॉ. सुदेश कुमार यादव द्वारा ध्वज फहराकर किया गया था। इसके पश्चात खेल दिवस समारोह के शुभारंभ के अवसर पर संस्थान के वैज्ञानिकों, तकनीकी कर्मचारियों और विद्यार्थियों के लिए 100 मीटर दौड़, लंबी कूद, रस्साकशी, शॉट पुट, कैरम, शतरंज, क्रिकेट, फुटबॉल और एथलेटिक्स जैसे खेलों के मैत्रीपूर्ण मुकाबले आयोजित किए गए। इन प्रतियोगिताओं में संस्थान के लगभग 150 कर्मचारियों ने उत्साहपूर्वक भाग लिया। समारोह के मुख्य अतिथि डॉ. सुरेश कुमार यादव ने विजेता टीमों को ट्रॉफी व प्रमाणपत्र देकर सम्मानित किया। इस अवसर पर संस्थान के निदेशक, डॉ. सुदेश कुमार यादव ने सभी खिलाड़ियों को बधाई देते हुए कहा कि खेल केवल शारीरिक स्वास्थ्य ही नहीं, बल्कि टीम भावना, अनुशासन और नेतृत्व क्षमता को भी विकसित करते हैं। उन्होंने कहा कि संस्थान में नियमित रूप से खेल गतिविधियों का आयोजन होना चाहिए, ताकि कार्य के दबाव के बीच कर्मचारियों को तनाव से राहत मिल सके और वे अधिक ऊर्जा के साथ अपने दायित्वों का निर्वहन कर सकें। उन्होंने कहा कि खेल दिवस समारोह जैसे आयोजन टीम वर्क, आपसी सहयोग और सामूहिक उपलब्धि की भावना को मजबूत करते हैं, जो संस्थान के वैज्ञानिक कार्यों के लिए भी अत्यंत आवश्यक है।

अजय पाल, अमित शर्मा, पालमपुर। सीएसआईआर-हिमालय जैवसंपदा प्रौद्योगिकी संस्थान पालमपुर में तीन दिवसीय राष्ट्रीय खेल दिवस समारोह रविवार को संपन्न हुआ। यह आयोजन 29 अगस्त को संस्थान के निदेशक, डॉ. सुदेश कुमार यादव द्वारा ध्वज फहराकर किया गया था। इसके पश्चात खेल दिवस समारोह के शुभारंभ के अवसर पर संस्थान के वैज्ञानिकों, तकनीकी कर्मचारियों और विद्यार्थियों के लिए 100 मीटर दौड़, लंबी कूद, रस्साकशी, शॉट पुट, कैरम, शतरंज, क्रिकेट, फुटबॉल और एथलेटिक्स जैसे खेलों के मैत्रीपूर्ण मुकाबले आयोजित किए गए। इन प्रतियोगिताओं में संस्थान के लगभग 150 कर्मचारियों ने उत्साहपूर्वक भाग लिया। समारोह के मुख्य अतिथि डॉ. सुरेश कुमार यादव ने विजेता टीमों को ट्रॉफी व प्रमाणपत्र देकर सम्मानित किया। इस अवसर पर संस्थान के निदेशक, डॉ. सुदेश कुमार यादव ने सभी खिलाड़ियों को बधाई देते हुए कहा कि खेल केवल शारीरिक स्वास्थ्य ही नहीं, बल्कि टीम भावना, अनुशासन और नेतृत्व क्षमता को भी विकसित करते हैं। उन्होंने कहा कि संस्थान में नियमित रूप से खेल गतिविधियों का आयोजन होना चाहिए, ताकि कार्य के दबाव के बीच कर्मचारियों को तनाव से राहत मिल सके और वे अधिक ऊर्जा के साथ अपने दायित्वों का निर्वहन कर सकें। उन्होंने कहा कि खेल दिवस समारोह जैसे आयोजन टीम वर्क, आपसी सहयोग और सामूहिक उपलब्धि की भावना को मजबूत करते हैं, जो संस्थान के वैज्ञानिक कार्यों के लिए भी अत्यंत आवश्यक है।

3 दिवसीय राष्ट्रीय खेल दिवस समारोह संपन्न

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सीएसआईआर में जैव संसाधनों के संरक्षण पर दिया गया बल

दो दिवसीय राष्ट्रीय संगोष्ठी का समापन, 100 प्रतिभागियों ने लिया हिस्सा

संवाद सहयोगी, जागरण ■ पालमपुर: वैज्ञानिक व औद्योगिक अनुसंधान परिषद (सीएसआईआर)-हिमालय जैवसंपदा प्रौद्योगिकी संस्थान (आईएचबीटी) पालमपुर में आयोजित दो दिवसीय राष्ट्रीय संगोष्ठी का समापन हुआ। यह संगोष्ठी हिमालयी जैवसंसाधनों के संतत विकास और संरक्षण के लिए बहु-विषयक दृष्टिकोण पर केंद्रित थी और इसे डा. सर्वपल्ली राधाकृष्णन की जयंती के अवसर पर आयोजित किया गया। इस कार्यक्रम में देशभर से 100 से अधिक प्रतिभागियों ने भाग लिया। संगोष्ठी के उद्घाटन सत्र में सीएसआईआर आईएचबीटी के निदेशक डा. सुदेश कुमार यादव ने सभी अतिथियों और प्रतिभागियों का स्वागत किया। उन्होंने संस्थान की पिछली गतिविधियों के बारे में जानकारी दी और हिमालयी संसाधनों के संरक्षण तथा जैव आधारित में इसके योगदान पर प्रकाश डाला। एनआईटी हमीरपुर के डा. राकेश सहगल ने इस आयोजन की सराहना करते हुए कहा कि वैज्ञानिक दृष्टिकोण और परंपरा ज्ञान को जोड़ना आज आवश्यकता है, जिन पर हमें अधिक ध्यान देना चाहिए।

जवाहरलाल नेहरू विश्वविद्यालय नई दिल्ली से आए डा. पीके जोशी ने जैव संसाधनों की मैपिंग और विश्लेषण के लिए सेंसर-आधारित इमेजिंग तकनीकों पर विचार प्रस्तुत किए। इसके बाद विशेषज्ञों और छात्रों ने चार सत्रों में प्रस्तुतियां दीं। पहले सत्र में आइआइएचबी पालमपुर के भेषज के डा. शैली कालरा ने आण्विक चारणकार्ड और जैव परिसीमनों तक की भूमिका पर मुख्य व्याख्यान दिया। दूसरे सत्र में एनआरसीबीआर फरीदाबाद के डा. वीके उपाध्याय ने जैव विश्लेषणों के माध्यम से संसाधनों के संरक्षण तथा जैव आधिकों में इसके

प्रति किलो के दर पर किया जाता है। भारत में हींग की खपत सालाना 1500 टन है। भारत में

सीएसआईआर आईएचबीटी में दो दिवसीय, हिमालयी जैवसंसाधनों के संतत विकास और संरक्षण हेतु बहु-विषयक दृष्टिकोण पर राष्ट्रीय संगोष्ठी सम्पन्न

संगोष्ठी में भाग लेते प्रतिभागी व संस्थान का स्टाफ, वैज्ञानिक व अन्य।

सवेरा न्यूज/जसवंत कठियाल पालमपुर,3 सितंबर : सीएसआईआर-हिमालय जैवसंपदा प्रौद्योगिकी संस्थान, (आईएचबीटी) पालमपुर में आयोजित दो दिवसीय, हिमालयी जैवसंसाधनों के संतत विकास और संरक्षण हेतु बहु-विषयक दृष्टिकोण पर राष्ट्रीय संगोष्ठी का समापन हो गया। डॉ. सर्वपल्ली राधाकृष्णन की जयंती के उपलक्ष्य में आयोजित इस संगोष्ठी में देश के विभिन्न संस्थानों के वैज्ञानिकों, शोधार्थियों और उद्योग प्रतिनिधियों ने भाग लिया। संगोष्ठी के दौरान आयोजित विभिन्न प्रविधियों तकनीकों फोटोग्राफी, वीडियोग्राफी, प्रस्तुतियां, पोस्टर और मीनाक्षी के विजेताओं को भी किया सम्मानित

और उनके पारिस्थितिकी तंत्र की एन.आई.पी.ई. आर, पंजाब ने भूमिका पर मुख्य व्याख्यान दिया। ऑनलाइन माध्यम से सभा को दूसरे सत्र में एन.ए.पी.एच.आर.सी. संबोधित किया और उत्तराखंड के डा. वी. के. पुरोहित ने फाइटोफार्मास्युटिकल्स तथा उच्च हिमालयी औषधीय पौधों और प्राकृतिक उत्पादों पर प्रकाश उनके लाभ-पर प्रकाश डाला। डाला। इसके अतिरिक्त, छात्रों द्वारा मूल

पंजाब केसरी
THU, 18 SEPTEMBER 2025
EDITION: KANGRA KESARI, PAGE NO. 2

एक सप्ताह में बांटे 1.66 लाख पौधे

संवाद सहयोगी, जागरण ■ पालमपुर

हिमालय जैवसंपदा प्रौद्योगिकी संस्थान (सीएसआईआर आईएचबीटी) पालमपुर ने सीएसआईआर फ्लोरीकल्चर मिशन के तहत प्रदेश में पुष्प खेती को नई दिशा देने की पहल की है। पिछले सप्ताह संस्थान ने सोलन, मंडी, बिलासपुर, शिमला और हमीरपुर के किसानों को 1.66 लाख से अधिक कार्नेशन के पौधे उपलब्ध कराए। ये पौध 1.5 हेक्टेयर भूमि पर रोपे जाएंगे और इससे 130 से अधिक किसान लाभान्वित होंगे। इससे ग्रामीण किसानों को अतिरिक्त आय के साथ ग्रामीण क्षेत्रों में टिकाऊ आजीविका के नए अवसर मिलेंगे।

कार्नेशन पुष्प से लहलहाएगी हिमाचल की वादियां

सोलन, मंडी, बिलासपुर, शिमला और हमीरपुर जिलों के किसानों को 1.66 लाख से अधिक कार्नेशन की पौध उपलब्ध कराई

पालमपुर, 17 सितम्बर (भृप्): हिमाचल की वादियां रंग-बिरंगे कार्नेशन पुष्प से लहलहाएंगी। इस दिशा में बड़ी पहल की गई है। इस कवायद का शुभारंभ सी.एस.आई.आर.-हिमालय जैवसंपदा प्रौद्योगिकी संस्थान पालमपुर।

सी.एस.आई.आर. हिमालय जैवसंपदा प्रौद्योगिकी संस्थान पालमपुर ने भी, एस. आई. आर. फ्लोरीकल्चर मिशन के अंतर्गत प्रदेश में पुष्प खेती को नई दिशा देने की एक महत्वपूर्ण पहल की है। संस्थान ने सोलन, मंडी, बिलासपुर, शिमला और हमीरपुर जिलों के किसानों को 1.66 लाख से अधिक कार्नेशन की पौध उपलब्ध कराई।

पालमपुर: सी.एस.आई.आर.-हिमालय जैव संपदा प्रौद्योगिकी संस्थान पालमपुर द्वारा तैयार की गई उच्च गुणवत्ता कार्नेशन पुष्प की पौध। (भृप्)

अधिक समय तक रहता है तरोताजा

कार्नेशन एक महत्वपूर्ण पुष्प आधारित व्यावसायिक पुष्प है। यह कैरियोफाइलेसी कुल का सदस्य है। इसका उत्पत्तिस्थल भूमध्य सागरीय क्षेत्र (दक्षिण यूरोप) है। वर्तमान में यह उपरी स्तर दक्षिण प्रांत मन्त्र राज्य है। इसको विभिन्न व्यापार के नाम से जाना जाता है। इसके पुष्प की सुगन्ध, विभिन्न रंग, लम्बा तना एवं अधिक दिनों तक पौधों पर रहने के कारण इसकी मुख्य फूल की विशेषताएं में से एक सुगन्ध है। इसका कट फ्लावर सुगन्धदार बनाने, घर की सजावट, गाड़ियों की सजावट इत्यादि में किया जाता है। इसकी व्यावसायिक खेती ग्रीनहाउस

हिमाचल प्रदेश में कार्नेशन की खेती और अधिक बढ़ेगी

संस्थान के निदेशक डा. सुदेश कुमार यादव ने कहा कि इस पहल से किसानों के सामने सस्ते दरों सस्ता तैयार कुशलताओं और संसाधन पौध सम्बंधी की उपलब्धता जो दूर किया है। उन्होंने विश्वास व्यक्त किया कि निरंतर सहयोग से हिमाचल प्रदेश में कार्नेशन की खेती का क्षेत्र और भी बढ़ेगा। कार्नेशन पौध प्राप्त करने वाले किसानों को संस्थान के वैज्ञानिकों द्वारा समय-समय पर तकनीकी मार्गदर्शन भी दिया जाएगा, ताकि वे उच्च गुणवत्ता वाले फूलों का उत्पादन कर सकें।

कृषि

हिमाचल में पुष्प खेती को नई उड़ान: सी.एस.आई.आर.-आई.एच.बी.टी. ने 130 से अधिक किसानों को दी 1.66 लाख कारनेशन पौध

सवेरा न्यूज/जसवंत कठियाल

पालमपुर, 17 सितम्बर : हिमालय जैवसंपदा प्रौद्योगिकी संस्थान (सी.एस.आई.आर.-आई.एच.बी.टी.), पालमपुर ने प्रदेश में पुष्प खेती को प्रोत्साहित करने की दिशा में एक महत्वपूर्ण पहल उठाया है। सी.एस.आई.आर. फ्लोरीकल्चर मिशन के अंतर्गत संस्थान ने सोलन, मंडी, बिलासपुर, शिमला और हमीरपुर जिलों के किसानों को 1.66 लाख से अधिक कार्नेशन की पौध उपलब्ध कराई।

किसानों को पौध वितरित करते संस्थान के अधिकारी व अन्य

रही हैं। उन्होंने विश्वास व्यक्त किया कि निरंतर सहयोग से हिमाचल प्रदेश में कार्नेशन की खेती का क्षेत्र और भी बढ़ेगा। कार्नेशन पौध प्राप्त करने वाले किसानों ने इस पहल को लेकर गहरी संतुष्टि जताई है। उनका मानना है कि यह उच्च मांग वाले बाजारों में पुष्प खेती को एक नई दिशा देगा, जिससे किसानों की आय में वृद्धि होगी और

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शोध को हिंदी में लोगों तक पहुंचाएं विज्ञानी : डा. सुदेश

संवाद सहयोगी, जागरण ■ पालमपुर

सीएसआईआर-आईएचबीटी पालमपुर में नौ से 23 सितंबर तक आयोजित हिंदी पखवाड़े का मंगलवार को समापन हुआ। जवाहर लाल नेहरू विश्वविद्यालय नई दिल्ली के प्राध्यापक डा. कृष्ण मोहन पांडेय ने वेदों में वर्णित कई औषधियों के उपयोग के बारे में जानकारी दी। संस्थान के निदेशक डा. सुदेश कुमार यादव ने विज्ञान के क्षेत्र में अनुसंधान एवं उपलब्धियों को जन-जन तक पहुंचाने में हिंदी का महत्व बताया।

उन्होंने विज्ञानियों का आह्वान किया कि वे अपने शोध को लोगों तक हिंदी में पहुंचाएं। उन्होंने हिंदी पखवाड़ा के अंतर्गत आयोजित प्रतियोगिताओं के विजेताओं को पुरस्कार दिए। इस दौरान संस्थान की हिंदी पत्रिका हिमसंपदा साइंटिस्टी का विमोचन

सीएसआईआर-आईएचबीटी, पालमपुर में हिंदी पखवाड़े का सफल आयोजन

समारोह में उपस्थित संस्थान के अधिकारी, कर्मचारी ।

सवेरा न्यूज/जसवंत कठियाल पालमपुर, : सीएसआईआर-हिमालय जैवसंपदा प्रौद्योगिकी संस्थान (आईएचबीटी), पालमपुर में 9 से 23 सितम्बर 2025 तक हिंदी पखवाड़े का आयोजन हर्षोल्लास से संपन्न हुआ। समापन समारोह के अवसर पर विशेष रूप से आमंत्रित वक्ता, जवाहरलाल नेहरू विश्वविद्यालय, नई दिल्ली के प्रोफेसर डॉ. कृष्ण मोहन पाण्डेय ने ह्वेदों में विज्ञानग्रह विषय पर एक अत्यंत रोचक एवं जानकारीपूर्ण संभाषण दिया। उन्होंने अपने उद्बोधन में वेदों में उल्लिखित विभिन्न औषधियों एवं उनके वैज्ञानिक प्रयोगों की चर्चा की, जिससे श्रोताओं को भारत की प्राचीन वैज्ञानिक परंपरा की गहराई का अनुभव हुआ। समारोह की अध्यक्षता कर रहे संस्थान के निदेशक डॉ. सुदेश कुमार यादव ने विज्ञान सप्तेपण में हिंदी भाषा की भूमिका को रेखांकित करते हुए कहा कि वैज्ञानिक शोध और तकनीकी उपलब्धियों को जनसामान्य तक पहुँचाने के लिए मातृभाषा में कार्य करना अत्यंत आवश्यक है। हिंदी पखवाड़े के सफल आयोजन ने संस्थान में कार्यरत वैज्ञानिकों, कर्मचारियों एवं विद्यार्थियों को हिंदी भाषा के वैज्ञानिक प्रयोग और अभिव्यक्ति की दिशा में प्रेरित किया।

सीएसआईआर-आईएचबीटी जैम्मू की जलवायु को बताया अनुकूल

सुगंधित फसलों की पैदावार से महकेगी जम्मू के किसानों-बागवानों की आर्थिकी

संवाद न्यूज एजेंसी

पालमपुर (कांगड़ा)। जम्मू क्षेत्र के लोग भी अब सुगंधित फसलों से अपनी आर्थिकी मजबूत कर सकेंगे। इन फसलों के लिए अनुकूल जलवायु होने के कारण यहां पर ये फसलें किसानों को काफी लाभ दे सकती हैं, जबकि कॉट-पत्तों से दूर व रोग प्रतिरोधक क्षमता रखने वाली ये फसलें काफी मात्रा में होंगी।

काफी कम खर्च वाली और अधिक मुनाफे वाली इन फसलों को लेकर वैज्ञानिक एवं औद्योगिक अनुसंधान परिषद पालमपुर सहयोग कर रही है। इसी के चलते सीएसआईआर में किसानों को सुगंधित फसलों के लिए प्रशिक्षित किया जा रहा है।

अपनी आर्थिकी के लिए जम्मू क्षेत्र के किसान पारंपरिक रूप से गेहूं, मक्का, हल्दी, तिल और बाजरा

सीएसआईआर पालमपुर में जम्मू के किसान और अन्य। फोटो: सीएसआईआर

लिए उगाते हैं, लेकिन इन्हें बंदरों, मोरों और जंगली सूअरों के की ओर से नुकसान के साथ-साथ वर्षा पर निर्भर कृषि जैसी प्रमुख चुनौतियों का सामना करना पड़ता है। इससे उनकी फसल उत्पादकता और आय पर प्रतिकूल प्रभाव पड़ता है।

सीएसआईआर में किसानों को

गया। संस्थान के मुख्य वैज्ञानिक एवं प्रशिक्षण समन्वयक डॉ. राकेश कुमार ने जम्मू क्षेत्र के लिए उपयुक्त प्रमुख सुगंध फसलों का विस्तृत विवरण प्रस्तुत किया।

उन्होंने बताया कि यह फसलें कीटों और रोगों के प्रति अधिक प्रतिरोधी हैं। अधिक मूल्य देने वाली

सीएसआईआर उत्तर-पश्चिमी हिमालय में सुगंध और उच्च मूल्य वाली फसलों की खेती को बढ़ावा देने के लिए प्रतिबद्ध है। जम्मू क्षेत्र में इन फसलों के लिए अच्छी जलवायु होने से किसान अच्छा मुनाफा कमा सकते हैं।

- डॉ. सुदेश कुमार यादव, निदेशक, सीएसआईआर पालमपुर

इन फसलों के लिए जम्मू क्षेत्र की जलवायु और मिट्टी के लिए उपयुक्त हैं। इनकी बाजार में भ उच्च मांग है। डॉ. सनत सुजात सिं ने संस्थान की ओर से विकसित इ फसलों की उच्च उत्पादक किस्मों के

किसानों के लिए सगंध और उच्च मूल्ययुक्त फसलों पर सजी कार्यशाला

कार्यालय संवाददाता-पालमपुर

सी.एस.आई.आर हिमालय जैवसंपदा प्रौद्योगिकी संस्थान, पालमपुर द्वारा जम्मू क्षेत्र के किसानों के लिए सगंध और उच्च मूल्ययुक्त फसलों पर दो दिवसीय प्रशिक्षण एवं जागरूकता कार्यक्रम

जम्मू क्षेत्र के किसान पारंपरिक रूप

सीएसआईआर आईएचबीटी पालमपुर में राष्ट्रीय कार्यशाल 'संवाद से संचार, सबके लिए विज्ञान' का शुभारंभ

सीएसआईआर आईएचबीटी में आयोजित कार्यशाला में भाग लेते संस्थान व वैज्ञानिक, स्टाफ व अन्य प्रतिभागी

कार्यक्रम | सीएसआईआर-आईएचबीटी पालमपुर में राष्ट्रीय कार्यशाला 'संवाद से संचार सबके लिए विज्ञान' का शुभारंभ

देश-दुनिया में वैज्ञानिकों की भूमिका अहम

कार्यालय संवाददाता-पालमपुर

राष्ट्रीय विज्ञान संचार एवं नीति अनुसंधान संस्थान (सीएसआईआर-निस्पर), नई दिल्ली के तत्वावधान में सीएसआईआर - हिमालय जैवसंपदा प्रौद्योगिकी संस्थान (सीएसआईआर-आईएचबीटी), पालमपुर के सहयोग से सीएसआईआर-आईएचबीटी, पालमपुर में दो दिवसीय राष्ट्रीय कार्यशाला 'संवाद से संचार सबके लिए विज्ञान' का शुभारंभ हुआ। यह कार्यक्रम विज्ञान प्रसार और जैवसंपदा संरक्षण के लिए नई तकनीकों को एक साथ लाता है। सीएसआईआर-निस्पर के

सीएसआईआर हिमालय जैवसंपदा प्रौद्योगिकी पालमपुर टीम ने किया त्रिपुरा का दौरा

अनंत ज्ञान, पालमपुर

सीएसआईआर हिमालय जैवसंपदा प्रौद्योगिकी पालमपुर टीम ने त्रिपुरा का दौरा किया। इस दौरे का उद्देश्य सीएसआईआर- अरोमा मिशन चरण-2 के अंतर्गत चल रही अनुसंधान एवं विस्तार गतिविधियों की समीक्षा करना तथा त्रिपुरा राज्य के विभिन्न विभागों और सैद्धांतिक संस्थानों के साथ सहयोग की संभावनाओं पर विचार करना था।

टीम ने त्रिपुरा विश्वविद्यालय तथा एनजी ट्रेसटेट्यूट फॉर रूरल टेक्नोलॉजी (एनआईआरटी), पश्चिम त्रिपुरा के अधिकारियों एवं संकाय सदस्यों के साथ संवाद किया। टीम ने हितधारकों को सीएसआईआर- आईएचबीटी द्वारा विकसित विभिन्न किसानोन्मुखी प्रौद्योगिकियों की जानकारी दी और राज्य विभागों, विश्वविद्यालयों एवं उद्यमी स्तर की संस्थाओं की कार्यान्वयन पर चर्चा की। इस दौरान संगठित फसलों की उन्नत कृषि तकनीकों एवं प्रसंस्करण विधियों पर प्रशिक्षण-सह-जागरूकता कार्यक्रमों का भी आयोजन किया गया।

त्रिपुरा विधि तथा एनजीआईआरटी, पश्चिम त्रिपुरा के संकाय सदस्यों के साथ संवाद किया।

इन कार्यक्रमों में 60 से अधिक किसानों, राज्य अधिकारियों, शोधार्थियों तथा त्रिपुरा विश्वविद्यालय के वैज्ञानिकों ने उत्साहपूर्वक भाग लिया, जिससे परिलक्षित हुई। डॉ. सुदेश कुमार यादव, निदेशक, सीएसआईआर-आईएचबीटी पालमपुर ने कहा कि त्रिपुरा की आई उष्णकटिबंधीय मिट्टी संगठित फसलों के लिए जलवायु, अधिक वर्षा एवं उपजाऊ किया कि सिट्रोनेला, लेमनग्रास, पामारोसा, पैचौली एवं तुलसी जैसी फसलें त्रिपुरा की कृषि-जलवायु परिस्थितियों के लिए उपयुक्त हैं और ग्रामीण आर्थिकी को सशक्त बनाने में महत्वपूर्ण भूमिका निभा सकती हैं।

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टीबी रोगियों को वितरित की पोषण किट

सीएसआईआर-आईएचबीटी पालमपुर ने शुरू किया विशेष पोषण अनुपूरण कार्यक्रम

टीबी उन्मूलन के लिए शुरू आई- पोषण के तहत सहायता राशि प्राप्त करते लाभार्थी।

कार्यालय संवाददाता — पालमपुर

सीएसआईआर हिमालय जैवसंपदा प्रौद्योगिकी संस्थान की टीम ने त्रिपुरा का दौरा किया। इस दौरे का उद्देश्य सीएसआईआर अरोमा मिशन चरण-III के अंतर्गत चल रही अनुसंधान एवं विस्तार गतिविधियों की समीक्षा करना तथा त्रिपुरा राज्य के विभिन्न विभागों और सैद्धांतिक संस्थानों के साथ सहयोग की संभावनाओं पर विचार करना था। इस दौरान सीएसआईआर-आईएचबीटी टीम ने त्रिपुरा विश्वविद्यालय तथा एनजी ट्रेसटेट फार रूरल टेक्नोलॉजी त्रिपुरा के अधिकारियों एवं संकाय सदस्यों के साथ संवाद किया। टीम ने हितधारकों को सीएसआईआर-आईएचबीटी द्वारा विकसित विभिन्न किसानोन्मुखी प्रौद्योगिकियों की जानकारी दी तथा राज्य विभागों, विश्वविद्यालयों एवं उद्यमी स्तर की संस्थाओं को सहभागिता से अभिसरण मॉडल के माध्यम से इन प्रौद्योगिकियों के त्रिपुरा में कार्यान्वयन पर चर्चा की। इस दौरान संगठित फसलों की उन्नत कृषि तकनीकों एवं प्रसंस्करण विधियों पर प्रशिक्षण, सह-जागरूकता कार्यक्रमों का भी आयोजन किया गया। कार्यक्रमों में 60 से अधिक किसानों, राज्य अधिकारियों, शोधार्थियों तथा त्रिपुरा विश्वविद्यालय के वैज्ञानिकों ने उत्साहपूर्वक भाग लिया, जिससे क्षेत्र में संगठित एवं औषधीय पौधों को वैकल्पिक आय सृजन फसलों के रूप में अपनाने की बढ़ती रुचि परिलक्षित हुई। डा. सुदेश कुमार यादव निदेशक सीएसआईआर-आईएचबीटी पालमपुर ने कहा कि त्रिपुरा की आई उष्णकटिबंधीय मिट्टी संगठित फसलों के लिए अत्यंत अनुकूल है। संगठित पौधों को बढ़ावा देने हेतु त्रिपुरा विश्वविद्यालय के साथ एक समझौता ज्ञापन पर हस्ताक्षर किए हैं। इस सहयोग के माध्यम से उपयुक्त संगठित फसलों के साथ उन्नत खेती एवं प्रसंस्करण तकनीकों को अपनाकर किसानों की आय में वृद्धि करने का लक्ष्य है। उन्होंने यह भी उल्लेख किया कि सिट्रोनेला, लेमनग्रास, पामारोसा, पैचौली व तुलसी जैसी फसलें त्रिपुरा की कृषि-जलवायु परिस्थितियों के लिए अत्यंत उपयुक्त हैं और ग्रामीण अर्थव्यवस्था को सशक्त बनाने में महत्वपूर्ण भूमिका निभा सकती हैं।

कामयाबी सीएसआईआर हिमालय जैवसंपदा प्रौद्योगिकी संस्थान पालमपुर के सहयोग से उगेंगी सगंधित फसलें

खेती में हिमाचल की तकनीक अपनाएगा त्रिपुरा

- त्रिपुरा विश्वविद्यालय के साथ करार, किसानों की आय बढ़ाने का लक्ष्य

जमीन कनेक्शन

अरुणाचल प्रदेश के जीरो गांव में सीएसआईआर-आईएचबीटी ने दिया वाणिज्यिक फूलों के कटाई उपरांत प्रबंधन पर प्रशिक्षण

सवेरा न्यूज/जसवंत कठियाल

पालमपुर, 8 जनवरी : सीएसआईआर-इंस्टीट्यूट ऑफ हिमालयन बायो-रिसोर्स टेक्नोलॉजी (आईएचबीटी),पालमपुर की एक टीम ने 6 -7 जनवरी, 2026 के दौरान अरुणाचल प्रदेश का दौरा कर 7 जनवरी, 2026 को जीरो गांव में आयोजित एक दिवसीय प्रशिक्षण कार्यक्रम में भाग लिया। यह प्रशिक्षण का सीएसआइआर आइएचबीटी ने उत्पादों का किया प्रदर्शन

सीएसआइआर हिमालयन जैव संसाधन प्रौद्योगिकी संस्थान द्वारा आईडा के वित्तपोषण तिगत के कुरुवाड़ा गांव में आयोजित कार्यक्रम में इकट्ठी हुई महिलाएं ● सौ. लेखक

प्रधान वैज्ञानिक डॉ. भव्या भार्गव ने वाणिज्यिक फूलों की खेती के लिए फसल पोषण ण रणनीतियों एस, Mushrooms, and Medicinal

एमआईडीएच बेंजामिन पर्टिन, पीएमयू के मुरलीधर मुरारी तथा जिला बागवानी अधिकारी जीरो हिबू दते ने भी संबोधित किया। उप-विभागीय

से भी भेंट की और सीएसआईआर फ्लोरीकल्चर की गतिविधियों से अवगत करा इस अवसर पर सीएसआई

urce Technology (CSIR-IHBT), , from February 2–4, 2026, to er the project "Inter-Institutional ble Bioresources of Mizoram", t of India. During their visit, the es, distributing low-chill apple es suited to Mizoram's climate. ne on apple cultivation, shiitake . The event drew more than 25 ecting strong community interest

nphasized that the project, run in collaboration with the Mizoram Science, College of Horticulture, Thenzawl (CAU Imphal), is already showing positive l introducing suitable cultivars along with modern cultivation and processing gthen the rural economy. Dr. Rakesh Kumar, Chief Scientist and Principal using scientifically validated planting material, adopting improved agronomic specially in rainfed and marginal areas. Dr. Sudesh Kumar Yadav, Director of tion with the Mizoram Science, Technology and Innovation Council (MISTIC) , is already showing positive results in improving farmers' livelihoods. He noted cultivation and processing technologies can significantly boost income and scientist and Principal Investigator of the project, highlighted the importance of

सीएसआईआर-आईएचबीटी का टीबी उन्मूलन की दिशा में बड़ा कदम

मिजोरम में आईएचबीटी टीम ने लो-चिलिंग सेब, शिटाके मशरूम व औषधीय पौधे वितरित किए

आईएचबीटी पालमपुर की टीम ने आइजोल में किसानों के साथ संवाद किया

भास्कर न्यूज धर्मशाला

एसआईआर-हिमालय जैवसंपदा प्रौद्योगिकी संस्थान (आईएचबीटी) लमपुर की वैज्ञानिक टीम ने 2 से 4 रवरी 2026 के दौरान मिजोरम के इजोल जिले का दौरा कर किसानों साथ सीधा संवाद किया और कल्पित आय स्रोतों वाली फसलों खेती को प्रोत्साहित किया। यह रा भारत सरकार के जैवप्रौद्योगिकी भाग (डीबीटी) द्वारा वित्तपोषित योजेना के अंतर्गत चल रही शोध ं प्रसार गतिविधियों की निगरानी लिए किया गया।

टीम ने डर्टलांग और सिहफिर वों में किसानों से बातचीत की और हे अन्ना व डोरसेट गोल्डन किस्म

मिजोरम में पौधे वितरण कार्यक्रम के दौरान मौजूद आईएचबीटी टीम।

किए। इसके साथ ही सेब, शिटाके मशरूम तथा सुगंधित एवं औषधीय पौधों पर ट्रेनिंग-कम-जागरूकता कार्यक्रम आयोजित किया गया, जिसमें 25 से अधिक आदिवासी किसान, राज्य अधिकारियों, विद्वानों और वैज्ञानिकों ने भाग लिया। सीएसआईआर–आईएचबीटी के बताया कि यह परियोजना चार वर्षों से सफलतापूर्वक चल रही है। उन्होंने कहा कि मिजोरम की जलवायु और उपजाऊ मिट्टी बागवानी फसलों, मशरूम और औषधीय पौधों के लिए अनुकूल है। सही किस्मों के चयन, बेहतर खेती पद्धति और प्रसंस्करण तकनीक अपनाने से किसानों की

पर्यटकों के लिए आज से खुलेगा पालमपुर का ट्यूलिप गार्डन

पिछले साल के मुकाबले इस बार एक लाख से अधिक लोगों के आने की उम्मीद, छह किस्मों के 50,000 फूलों से बाग गुलजार

Officials at the CSIR–Institute of Himalayan Bio-resource Technology's Tulip Garden in Palampur.

ट्यूलिप गार्डन को निहारते कैमरे में कैद हुए पर्यटक। संवाद

गुड न्यूज पर्यटकों को देखने को मिलेगी साइंटिफिक फूलों की खेती की झलक, अलग-अलग 50,000 ट्यूलिप वत्व लगाए

Tulip Garden opens to public in Palampur

RAVINDER SOOD

PALAMPUR, FEBRUARY 10

Tulip Garden, developed by the CSIR-Institute of Himalayan Bio-resource Technology (CSIR-IHBT), Palampur, was formally opened to the public on Monday by Sub-Divisional Magistrate Dr OP Yadav.

Spread across the scenic premises of CSIR-IHBT, the garden showcases 50,000 tulip bulbs of six varieties, carefully cultivated under mid-Himalayan agro-climatic conditions. The colourful bloom is a testimony to the institute's scientific expertise in bulbous ornamental crop research and floriculture technologies tailored for hill regions.

Addressing the gathering on the occasion, Dr Sudesh Kumar Yadav, Director, CSIR-IHBT, said the ini-

Palampur SDM Dr OP Yadav opens the Tulip Garden for public.

reach. He described the initiative as a living laboratory that demonstrated the potential of ornamental horticulture as a sustainable livelihood option for farmers in

plied 22,000 tulip bulbs to the New Delhi Municipal Council (NDMC) for public landscape displays in the national capital. This collaboration underscores the rising demand for high-quality, indigenously produced planting material and reflects the institute's growing role in strengthening India's ornamental horticulture sector.

In addition, the institute supplied 3,000 tulip bulbs to the Himachal Pradesh State Forest Department for the development of a tulip garden at Saurabh Van Vihar, Palampur, further extending the benefits of scientific floriculture to public green spaces in the state.

The Tulip Garden will remain open to visitors during the blooming season, offering residents, tourists, students, and nature lovers a unique opportunity to witness world-class floriculture nurtured through Indian scientific research.

ing scientific tourism and environmental awareness. The popularity of the initiative continues to grow, as over one lakh visitors from across India visited the gar-

सीएसआईआर आईएचबीटी में ट्यूलिप गार्डन का उद्घाटन, पर्यटकों के लिए खुला रहेगा गार्डन

ीएआईआर आईएचबीटी पालमपुर में मनाया अंतर्राष्ट्रीय महिला दिवस

International Women's Day celebrations underway at CSIR-IHBT in Palampur on Friday.

CSIR celebrates Women's Day, felicitates entrepreneurs, staff

OUR CORRESPONDENT

PALAMPUR, MARCH 14

The CSIR-Institute of Himalayan Bioresource Technology celebrated International Women's Day on its premises on Friday. Dr Sudesh Kumar Yadav, Director, CSIR-IHBT, in his welcome address, highlighted the importance of the day and the role of women in science, society, sports and other fields. He emphasised equal opportunities for women and their safety.

Dr Jatinder Kaur Arora, adviser, Northern Region Science and Technology Cluster; PI-RAHI, Punjab State Council for Science and Technology, was the chief guest on the occasion. She spoke about the role of women in a changing world and highlighted various initiatives being led by them.

Advocate Adarsh Sood and Nitika Bhandari were the guests of honour. Sood talked about various legal initiatives and deliberated in detail on the POSH Act while Bhandari highlighted the social movement and societal issues relating to women.

Inspiring women entrepreneurs and female administrative staff of the institute were felicitated during the programme. A workshop on 'Strengthening of innerself' for the female staff and students of the institute was also organised. An exhibition of creative artefacts prepared by them was also put up on display.

सवेरा न्यूज/जसवंत कठियाल

पालमपुर,14 मार्च : सीएसआईआर-हिमालय वसंपदा प्रौद्योगिकी संस्थान (आईएचबीटी) मपुर में शुक्रवार देर सायं अंतर्राष्ट्रीय महिला स बड़े उत्साह के साथ मनाया गया। कार्यक्रम उद्देश्य महिलाओं की समानता, स्वतंत्रता और के अधिकारों के प्रति जागरूकता बढ़ाना था। र्यक्रम की शुरूआत निदेशक डॉ. सुदेश कुमार व के स्वागत भाषण से हुई।

उन्होंने अंतर्राष्ट्रीय महिला दिवस के महत्व पर ाश डालते हुए विज्ञान, समाज और खेल सहित भिन्न क्षेत्रों में महिलाओं की बढ़ती भूमिका को ांकित किया। इस अवसर पर नॉर्दर्न रीजन साइंस टेक्नोलॉजी क्लस्टर पीआई-राही की ाहकार तथा पंजाब राज्य विज्ञान एवं प्रौद्योगिकी षद की पूर्व कार्यकारी निदेशक डॉ. जतिंदर कौर अरोड़ा मुख्यातिथि के रूप में उपस्थित रहीं। कार्यक्रम में अधिवक्ता आदर्श सूद और नीतिका भंडारी सम्मानित अतिथि के रूप में शामिल हुए। अधिवक्ता आदर्श सूद ने महिलाओं से जुड़े विभिन्न कानूनों, विशेषकर पीओएसएच अधिनियम के बारे में जानकारी दी, जबकि नीतिका भंडारी ने महिलाओं से जुड़े सामाजिक आंदोलनों और अधिकारों पर अपने विचार साझा किए। इस अवसर पर प्रेरणादायक महिला उद्यमियों और संस्थान के प्रशासनिक महिला कार्मिकों को सम्मानित किया गया।

साथ ही महिला कर्मचारियों और छात्राओं के लिए ब्रेस्ट्रेथिनिंग ऑफ इनर सेल्फ्रह विषय प कार्यशाला का आयोजन किया गया। कार्यक्रम के दौरान महिला कर्मचारियों और छात्राओं द्वारा तैया की गई कलाकृतियों की प्रदर्शनी भी लगाई गई।

वार्षिक प्रतिवेदन 2025-26 Annual Report

VISION

To be a global leader on technologies for boosting bioeconomy through sustainable utilization of Himalayan bioresources

MISSION

To discover, innovate, develop and disseminate the processes, products and technologies from Himalayan bioresources for society, industry, environment and academia

REACH OUT TO US ON:

Director
CSIR-Institute of Himalayan Bioresource Technology
Post Box No. 6
Palampur (H.P.) 176061
INDIA
Tel: +91-1894-230411, Fax: +91-1894-230433
E-mail: director@ihbt.res.in

@CSIR_IHBT
@csir_ihbt
CSIR IHBT
ihbt.res.in