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वार्षिक प्रतिवेदन
Annual Report
2024-25

Agri-tech to sweet treat

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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।

संस्थान गान हेतु क्यूआर कोड को स्कैन करें

क्यूआर रीडर ऐप डाउनलोड करें

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With Best Compliments from
Dr. Sudesh Kumar Yadav
Director

सीएसआईआर–हिमालय जैवसंपदा प्रौद्योगिकी संस्थान
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परिकल्पना: जैवार्थिकी के उन्नयन हेतु प्रौद्योगिकीय उद्भवता एवं विकास में हिमालयी जैवसंपदा के संपोषणीय उपयोग द्वारा विश्व स्तर पर अग्रणी होना।

उद्देश्य: 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

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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
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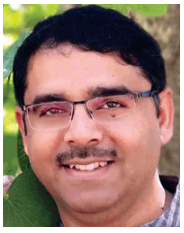

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(01.04.2024 - 31.12.2024)

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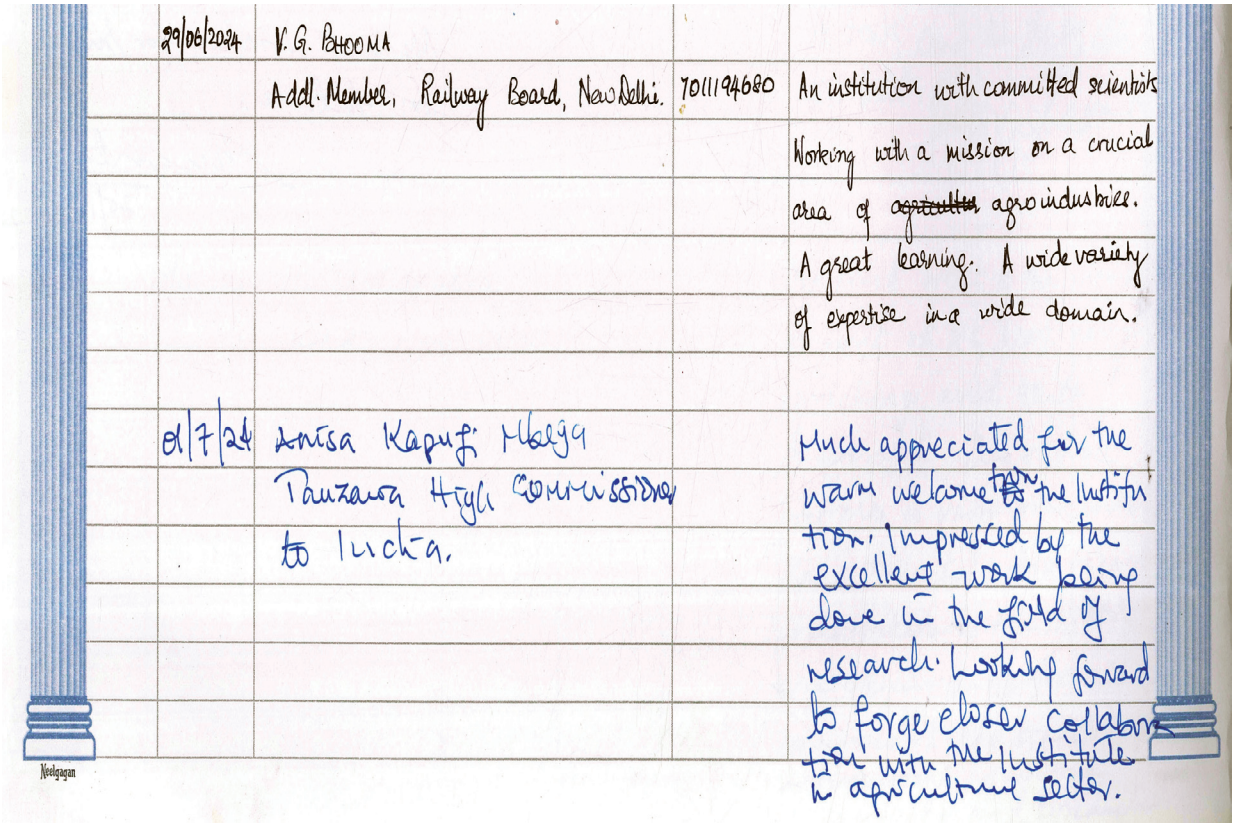
CSIR-Institute of Himalayan Bioresource Technology
Palampur - 176061 (H.P.)
(01.01.2025 to Till Date)

IMPRESSIONS



29/06/2024	V. G. BHOOMA Addl. Member, Railway Board, New Delhi.	7011194680	An institution with committed scientists working with a mission on a crucial area of ~~agriculture~~ agro industries. A great learning. A wide variety of expertise in a wide domain.
01/7/24	Anisa Kapuji Mbeya Tanzania High Commissioner to Lucknow.		Much appreciated for the warm welcome ~~to~~ the Institution. Impressed by the excellent work being done in the field of research. Looking forward to forge closer collaboration with the Institute in agricultural sector.

निदेशकीय प्रतिवेदन

मुझे वर्ष 2024–25 के लिए सीएसआईआर–हिमालय जैवसंपदा प्रौद्योगिकी संस्थान (सीएसआईआर–आईएचबीटी) का वार्षिक प्रतिवेदन प्रस्तुत करते हुए अत्यन्त हर्ष हो रहा है। इस अवधि के दौरान चल रहे कार्यक्रमों एवं आरंभ की गई नई पहलों का संक्षिप्त विवरण इसमें प्रस्तुत किया गया है। सीएसआईआर–आईएचबीटी देश में वैज्ञानिक एवं प्रौद्योगिक प्रगति पथ में महत्वपूर्ण भूमिका निभा रहा है और इस क्षेत्र में कुछ उल्लेखनीय उपलब्धियां इस प्रकार हैं।

सीएसआईआर अरोमा मिशन (चरण–III) के दूसरे वर्ष के दौरान, सीएसआईआर–आईएचबीटी के द्वारा 13 राज्यों और 2 केंद्र शासित प्रदेशों में 505 हेक्टेयर अतिरिक्त क्षेत्र बढ़ाया गया। लगभग 12.85 टन सगंध तेल का उत्पादन किया गया, जिसके परिणामस्वरूप 7.35 करोड़ की आय हुई। आगामी फसल हेतु किसानों में वितरण के लिए लगभग 12 लाख रोपण सामग्री और एक टन बीज तैयार किया गया। किसानों के खेतों में चार प्रक्षेत्र आसवन इकाईयां स्थापित की गईं (हिमाचल प्रदेश के कांगड़ा और मंडी जिलों में एक–एक और मेघालय के पश्चिमी जैंतिया पहाड़ियों में दो)। इस अवधि के दौरान 4,160 किसान सगंध फसलों की खेती, उनके प्रसंस्करण और मूल्यवर्धन में भागीदार बने। बीस प्रशिक्षण कार्यक्रम आयोजित किए गए, जिनमें 368 नए किसानों को सगंध फसलों की खेती और प्रसंस्करण पहलुओं पर प्रशिक्षण दिया गया। संस्थान द्वारा किसानों को खेती के लिए सुगंधित पौधों की नई किस्मों, लैवेंडर (हिम आरोही) और कैमोमाइल (हिम कांति) को आईसीएआर–पीजीआरसी के साथ पंजीकृत और विमोचित किया गया।

इसी प्रकार सीएसआईआर फ्लोरीकल्चर मिशन (चरण–II) के अंतर्गत, सीएसआईआर–आईएचबीटी ने पुष्प फसलों की खेती के क्षेत्र को 170 हेक्टेयर तक बढ़ाया। इस मिशन कार्यक्रम के दूसरे वर्ष के दौरान किसानों को पुष्प फसलों की लगभग 52.19 लाख रोपण सामग्री वितरित की गई। संस्थान ने फूलों के निर्जलीकरण सहित खेती की तकनीकों और मूल्यवर्धन पर केंद्रित 49 प्रशिक्षण और जागरूकता कार्यक्रम आयोजित किए, जिनसे किसानों और छात्रों सहित 1,721 प्रतिभागी लाभान्वित हुए। इसके अतिरिक्त, हरित पहल को बढ़ावा देने के लिए हिमाचल प्रदेश और हरियाणा में 50 स्कूल उद्यान तथा सार्वजनिक क्षेत्र के कार्यालयों में 10 वर्टिकल उद्यान विकसित किए गए।

सीएसआईआर–आईएचबीटी ने सीएसआईआर–फाइटो–फार्मास्युटिकल मिशन के अंतर्गत औषधीय पौधों जैसे *इनुला रेसमोसा, पिक्रोराइजा कुरोआ* और *फेरुला एसाफोएटिडा* की खेती को भी बढ़ावा दिया। इनके अलावा, *वेलेरियाना जटामांसी, स्टीविया, बैकोपा* और *ओसीमम* जैसे अन्य औषधीय पौधों की पांच लाख रोपण सामग्री किसानों को वितरित की गई। काली हल्दी (*करकुमा कैसिया*) और क्लेरी सेज (*साल्विया स्केलेरिया*) जैसे औषधीय और सगंध पौधों की कृषि तकनीक भी संस्थान द्वारा विकसित की गई।

इस वर्ष, हमने *स्टीविया रेबोडियाना* (रेबोडियोसाइड–ए से भरपूर किस्म) की उच्च गुणवत्ता वाली, हैप्लोटाइप–समाधानित गुणसूत्र–स्तरीय जीनोम असेंबली विकसित की है, जो स्टीविओल ग्लाइकोसाइड (एसजी) जैवसंश्लेषण के जटिल आनुवंशिक विनियमन में अंतर्दृष्टि प्रदान करती है। मोनोप्लॉइड जीनोम 1.34 जीबी तक फैला है, जिसका N50 110 एमबी है और इसमें 55,551 अनुमानित प्रोटीन–कोडिंग जीन, ~80% दोहरावदार सामग्री और 2.33 जीबी चरणबद्ध हैप्लोटाइप (ए और बी) शामिल हैं, जिसमें 639,000 से अधिक वेरिएंट शामिल हैं। संपूर्ण जीनोम दोहराव विश्लेषण ने प्रमुख UGT और CYP जीन कुलों के अग्रानुक्रम दोहराव का खुलासा किया। यह जीनोमिक संसाधन *स्टीविया रेबोडियाना* में प्राकृतिक स्वीटनर उत्पादन को बढ़ाने के लिए जीनोम संपादन और सटीक प्रजनन करने की विधि को आसान करता है।

इस वर्ष, हमने भारतीय हिमालयी क्षेत्र में गैर–स्वच्छ कचरा भराव क्षेत्र का पहला व्यापक मेटाजीनोमिक विश्लेषण किया है, जिसमें प्लास्टिक, जेनोबायोटिक्स को नष्ट करने और भारी धातुओं का प्रतिरोध करने की मजबूत मेटाबोलाइट क्षमता वाले विविध सूक्ष्मजीव समूहों का पता चला है। अलग–अलग भौतिक–रासायनिक प्रोफाइल के बावजूद, मनाली और मंडी दोनों साइटों में कार्यात्मक बाहुल्य दिखा, जो सतत बायोरेमेडिएशन रणनीतियों के लिए मूल्यवान अंतर्दृष्टि प्रदान करता है।

अजैविक तनावों के अंतर्गत पौधों के विकास और प्रतिक्रियाओं को नियंत्रित करने वाले आणविक प्रक्रिया को उजागर करने के लिए, *नार्डोस्टैचिस जटामांसी, पिक्रोराइजा कुरोआ, बैम्बुसा बाल्कोआ* और *क्रोकस सेटाइवस* जैसी प्रजातियों में प्रतिलेखन कारकों और तनाव–उत्तरदायी जीनों का अध्ययन किया गया, ताकि

चुनौतीपूर्ण स्थितियों में उनके बेहतर अनुकूलन और फसल के लचीलेपन में सुधार हो सके। इसके अलावा, पत्ती कोशिका निलंबन संवर्धन का उपयोग करके *वेलेरियाना जटामांसी* में एंडोफाइट–आधारित कवक एलिसिटर की पहचान करने के प्रयास किए गए, जिनमें वैलेपोट्रिएट्स और सेस्क्यूटरपेनोइड्स के उत्पादन को बढ़ाने की क्षमता है। *पी. कुरोआ* में किए गए *इन–विट्रो* सेल कल्चर अध्ययनों ने भी औषधीय रूप से महत्वपूर्ण पिक्रोसाइड्स के संचय में महत्वपूर्ण सुधार दिखाया। औद्योगिक रूप से महत्वपूर्ण फाइटोकेमिकल्स के निष्कर्षण के लिए एक स्थायी प्रणाली विकसित करने के पिछले कार्य के क्रम में, हींग की विशिष्ट सुगंध के अग्रगामी, वाष्पशील डाइसल्फाइड यौगिकों के उत्पादन के लिए *फेरुला एसाफोएटिडा* सेल कल्चर के उपयोग पर इस वर्ष एक प्रक्रिया पेटेंट दायर किया गया है।

आईएचबीटी में HiCHiCoB की जैवसूचना टीम ने PTFSpot विकसित किया है, जो एक ट्रांसफॉर्मर–आधारित गहन शिक्षण मॉडल है, जो विविध पादप जीनोम में ट्रांसक्रिप्शन फैक्टर बाइंडिंग क्षेत्रों (TFBRs) का सटीक पूर्वानुमान करता है। प्रजातियों या TF कुल से स्वतंत्र TF-DNA अंतःक्रिया पैटर्न सीखकर, PTFSpot मौजूदा उपकरणों से आगे निकल जाता है और पूर्व TF जानकारी के बिना उच्च सटीकता वाले TFBR एनोटेशन को सक्षम बनाता है। टीम ने MDbDMRP भी विकसित किया, जो एक मशीन–लर्निंग मॉडल है जो दवा–एमआईआरएनए संबंधों की भविष्यवाणी करने के लिए आणविक विवरणकों का उपयोग करता है। संरचनात्मक जैव सूचना विज्ञान समूह ने γ–साइक्लोडेक्सट्रिन का उपयोग करके पिपेरिन एनकैप्सुलेशन का मूल्यांकन करने के लिए आणविक गतिशीलता और DFT गणनाओं का उपयोग किया। ऑक्टाकिस (6-O-सल्फो)-γ-CD ने उच्चतम स्थिरता और बाइंडिंग एफिनिटी का प्रदर्शन किया, जो HP-γ-CD से बेहतर प्रदर्शन करता है, जो कि बढ़ी हुई गैर–सहसंयोजक अंतःक्रियाओं के कारण है, जो पिपेरिन घुलनशीलता और जैव उपलब्धता में सुधार करने के लिए एक बेहतर उपाय प्रदान करता है।

लिग्नोसेल्यूलोसिक कृषि अपशिष्टों के अपघटन के लिए एंजाइमेटिक जैवप्रक्रिया के विकास की दिशा में एक प्रयास में, प्रोसेसिव एंडोग्लूकेनेज का एक उत्परिवर्ती संस्करण बनाया गया, जिसने 60 डिग्री सेल्सियस से अधिक उच्च तापमान पर दो गुना सक्रियता और स्थिरता बढ़ा दी है। थर्मोफिलिक माइक्रोबियल एंजाइमों के उत्पादन के अलावा, भारतीय पश्चिमी हिमालय के विविध माइक्रोबियल संसाधनों को कार्यात्मक खाद्य पदार्थों के विकास एवं सूक्ष्मजीवों की पहचान के लिए चिह्नित किया गया है।

नैनोबायोलॉजी समूह ने न्यूरोडीजेनेरेटिव रोगों (NDs) से संबंधित हानिकारक प्रोटीन समुच्चयों को प्रभावी ढंग से लक्षित और नष्ट करने के लिए जैवसक्रिय संयुग्मित ग्लूकोसामाइन–गोल्ड नैनोकणों (Gln@CA-AuNP) को विकसित किया है। यह देखा गया कि विकसित एनपी ने सल्फेटेड ग्लाइकोसामिनोग्लाइकन (एसजीएजी) उत्पादन को महत्वपूर्ण रूप से बढ़ाया और एक्स्ट्रासेलुलर मैट्रिक्स (ईसीएम) उत्पादन को बढ़ाया। इसके अलावा, Gln@CA-AuNP ने न्यूरोनल सिनैप्स की सुरक्षा में महत्वपूर्ण भूमिका निभाई, *सी. एलिगेंस* में प्रोटीन एग्रीगेट जमाव को प्रभावी ढंग से कम किया और NDs में संभावित उपचारों का मार्ग प्रशस्त किया।

ट्रिलियम गोवेनियानम वॉल. एक्स डी. डॉन, *फ्रिटिलारिया सिरोसा* डी. डॉन और *अचिरांथेस बिडेन्टाटा* ब्लूम से सात नए बायोएक्टिव मेटाबोलाइट्स का विलगन और लक्षणचित्रण किया गया। *स्वर्शिया पर्पुरासेंस, स्वर्शिया कार्डेटा* और *थैलिक्ट्रम फॉलियोलोसम* से बायोएक्टिव यौगिकों को विलगित किया गया है और उन्हें मधुमेहरोधी और कीटनाशक गतिविधियों के लिए लक्षणचित्रित किया गया। *टैजेटस इरेक्टा* में ल्यूटिन के शुद्धिकरण के लिए एक हरित निष्कर्षण प्रक्रिया विकसित की गई है। लक्षित हिमालयी औषधीय पौधों की गुणवत्ता सुनिश्चित करने के लिए पाँच हरित विश्लेषणात्मक विधियाँ विकसित की गई हैं।

इस वर्ष, सेड्रस देवदार तेल से संभावित रूप से जैवसक्रिय बेंजोसुबेरिन–प्रतिस्थापित क्विनोलिनोन, संयुग्मित एंजाइम और ट्रायजोलो–एजेपाइन अणुओं को संश्लेषित करने के लिए तीन नवीन उत्प्रेरक पद्धतियां विकसित की गईं। 5–एचएमएफ और फरफुरल उत्पादन के लिए दो नए ग्राम–स्केल प्रोटोकॉल विभिन्न नवीकरणीय फीडस्टॉक से सीधे विकसित किए गए थे, जिनमें कपास, अपशिष्ट कागज, तेल रहित लेमनग्रास अपशिष्ट, मकई के भुट्टे, चावल के भूसे और गन्ने की खोई शामिल हैं। CO स्थिरीकरण अभिक्रियाओं के लिए CO प्रणेता के रूप में ऑक्सालिक एसिड का उपयोग करते हुए तीन नई पद्धतियां विकसित की गईं और N-युक्त हेट्रोसाइकल्स के संश्लेषण के लिए नौ C-H सक्रियण (फोटोकैटेलिटिक/थर्मल) आधारित उत्प्रेरक पद्धतियां विकसित की गई हैं।

सीएसआईआर–सीएलपी थीम के अंतर्गत इन–हाउस प्रीकर्सर के रूप में संबंधित साइक्लोहेक्सन–1, 3–डायऑन का उपयोग करके 4–प्रतिस्थापित रिसोरसिनॉल यौगिकों के संश्लेषण के लिए एक नया ग्राम–किलोग्राम स्केल प्रोटोकॉल स्थापित किया गया है। इसके अतिरिक्त, सीएसआईआर–एएनबी थीम के अंतर्गत एफटीटी परियोजना निहित, हिमालयी औषधीय

पौधों से प्राप्त पांच प्रमाणित संदर्भ सामग्रियों (सीआरएम) के लिए ग्राम–स्तरीय शुद्धिकरण प्रक्रियाएं विकसित की गई हैं, जिनमें शुद्धता मूल्यों का सफल लक्षण–निर्धारण किया गया है। साथ ही, सीएसआईआर–सीएलआरआई के साथ साझेदारी में, सीएसआईआर–सीएलपी थीम के अंतर्गत एक मिशन मोड परियोजना के हिस्से के रूप में, चमड़ा टैनिंग प्रक्रिया को बढ़ाने के उद्देश्य से चाय की पत्तियों से टैनिन युक्त पदार्थ निकालने के लिए एक प्रयोगशाला–स्तरीय प्रक्रिया विकसित की गई है।

मेंथा पिपेरिटा से शुद्ध प्राकृतिक मेंथॉल क्रिस्टल निकालने की एकल–चरण विधि के लिए एक पेटेंट दायर किया गया है। इसके अतिरिक्त, प्राकृतिक पारगम्य/पॉकेट परफ्यूम तकनीक मैसर्स पहाड़ीक्राफ्ट को सौंप दी गई है। साथ ही संस्थान ने हिमाचल प्रदेश से भौगोलिक संकेत (जीआई) के साथ प्रमाणित दो सामग्रियों के साथ एक प्रीमियम ऑर्थोडॉक्स फ्लेवर वाली चाय का लाइसेंस प्राप्त किया है।

हाल ही में हिमालय की समृद्ध जैव विविधता का पता लगाने और उसका दस्तावेजीकरण करने के प्रयास में, सीएसआईआर–आईएचबीटी के टैक्सोनॉमिस्टों ने अरुणाचल प्रदेश के दिबांग घाटी से महत्वपूर्ण वनस्पतिक खोजें की हैं। इनमें दो नई प्रजातियाँ शामिल हैं, *क्रेमेनथोडियम डिबांगी* विक. कुमार और राहुल कुमार (कुल एस्टेरेसी) और *हेमिपिलिया हिमालायेंसिस* विक. कुमार और अग्रवाला (कुल ऑर्किडेसी), जिन्हें भारतीय हिमालयी क्षेत्र से खोजा गया है। इसके अतिरिक्त, *क्रेमैंथोडियम ओब्लांसीलिगुलैटम* लॉन्ग वांग, सी. रेन और क्यू. ई. यांग (एस्टेरेसी) और ने *ओशीआ बाईकाइलोसा* एक्स. एच. जिन (ऑर्किडेसी) को पहली बार भारत से रिकॉर्ड किया गया है। पश्चिमी हिमालय में ज्ञात पौधों की विविधता का विस्तार करते हुए, *कैलन्थे ट्रूलीफोर्मिस* किंग और पेंटल. और *नेओशीआ लोंगिकाउलिस* (किंग और पेंटल.) स्ज्लाच, नामक दो ऑर्किड्स को भी पहली बार हिमाचल प्रदेश में दर्ज किया गया है। इन खोजों से न केवल इस क्षेत्र की पुष्प विविधता समृद्ध होती है बल्कि यह भी संकेत मिलता है कि हिमालय की अज्ञात वनस्पति संपदा की खोज हेतु क्षेत्र आधारित अनुसंधान बहुत आवश्यक है। *एरेमुरस हिमलाईकस, पॉलीगोनैटम सिरिहिफोलियम, अर्नेबिया यूक्रोमा, एलियम कैरोलियानम* और *ए. जैक्मोंटी* पर पारिस्थितिकी अध्ययन, उच्च तुंगता वाले 67 स्थानों और 1 संरक्षण स्थल में किए गए। उच्च तुंगता जीवविज्ञान केन्द्र, लाहौल और स्पीति, हिमाचल प्रदेश में 15 औषधीय पौधों का बीज बैंक भंडार भी तैयार किया गया है। लाहौल घाटी में कम लागत युक्त चार शुष्क शौचालय स्थापित किए गए हैं, जो उच्च तुंगता वाले हिमालयी क्षेत्रों के लिए स्वच्छ, उपयोगकर्ता के अनुकूल और सतत स्वच्छता समाधान प्रदान करते हैं। लोक वनस्पति संबंधी सर्वेक्षणों ने मुख्य रूप से त्सम्पा (जौ) और चुरपे (सूखे पनीर) से बने पारंपरिक व्यंजनों (n=10) का दस्तावेजीकरण किया, जिन्हें स्पीति घाटी के निवासियों के लिए अत्यधिक महत्व का माना गया। सीएसआईआर–टीकेडीएल के संबंध में, सोवा रिग्पा (ट्रांस–हिमालयन सिस्टम ऑफ मेडिसिन) डेटाबेस में 1000 पूर्व कला सूचनाओं के साथ लगभग ~2000 नए रिकॉर्ड जोड़े गए। लद्दाख की नुब्रा घाटी में पौधों से प्राप्त उत्पादों के निर्माण में *सैलिक्स* का महत्व सामने आया, जिसका उपयोग 16 घरेलू उपकरण बनाने में किया गया।

हमारे सुदूर संवेदन (रिमोट सेंसिंग) समूह द्वारा 10 हिमालयी औषधीय पौधों की प्रजातियों के 1,237 संकेतो के साथ एक अद्वितीय और अपनी तरह का पहला वर्णक्रमीय संग्रह किया है, जिससे एआई–आधारित पहचान/वर्गीकरण मॉडल विकसित हुआ। साथ ही मिश्रित उपोष्णकटिबंधीय हिमालयी वनों में बायोमास और कार्बन स्टॉक का अनुमान लगाने के लिए सेंटिनल 2A सूचकांक की भी पहचान की, जो पर्यावरण प्रबंधन और कार्बन संतुलन के लिए आवश्यक आधारभूत डेटा प्रदान करता है।

सीएसआईआर–आईएचबीटी ने स्वदेशी रूप से विकसित ट्यूलिप बल्बों की आपूर्ति के लिए एनडीएमसी के साथ एक समझौता ज्ञापन किया और इस वर्ष एनडीएमसी को 15000 बल्ब प्रदान किए गए जो दिल्ली में खिले। 26 फरवरी 2025 को विज्ञान एवं प्रौद्योगिकी मंत्री तथा सीएसआईआर के उपाध्यक्ष, डॉ. जितेंद्र सिंह द्वारा जरबेरा की तीन किस्में, हिम कुमुद (गुलाबी), हिम प्रभा (पीला) और हिम अरुणा (लाल) लोकार्पित की गईं, जो पुष्प–कृषि नवाचार में एक महत्वपूर्ण उपलब्धि सिद्ध होगी।

सीएसआईआर–आईएचबीटी ने कई नई सुविधाएँ विकसित की हैं, जिनका उद्घाटन डॉ. जितेंद्र सिंह ने किया। सीएसआईआर–फ्लोरीकल्चर मिशन के अंतर्गत, सीएसआईआर–आईएचबीटी में ट्यूलिप गार्डन 26 फरवरी, 2025 को लोकार्पित किया गया, जिसमें सात ट्यूलिप किस्मों का एक जीवंत संग्रह प्रदर्शित किया गया, जिसमें इस सीजन के दौरान कुल 50,000 बल्ब लगाए गए। इस पहल का उद्देश्य पुष्प–कृषि अनुसंधान को बढ़ाना, पारिस्थितिकी–पर्यटन को बढ़ावा देना और मध्य–हिमालयी क्षेत्र में ट्यूलिप की खेती की व्यावसायिक व्यवहार्यता का पता लगाना था। स्वायत्त ग्रीनहाउस एक अत्याधुनिक सुविधा है जो न्यूनतम मानवीय हस्तक्षेप के साथ पौधों की वृद्धि को अनुकूलित करने के लिए उन्नत स्वचालन प्रौद्योगिकियों को एकीकृत करती है, जिससे पुष्प–कृषि में उत्पादकता, संसाधन दक्षता और स्थिरता

सुनिश्चित होती है, का उद्घाटन किया गया। बल्ब उत्पादन और फसलोपरांत प्रबंधन की दक्षता बढ़ाने के लिए एक अत्याधुनिक सजावटी बल्ब प्रसंस्करण सुविधा का भी उद्घाटन किया गया। देश में हींग की खेती को बढ़ावा देने के लिए हींग के बीज उत्पादन केंद्र का उद्घाटन 26 फरवरी, 2025 को डॉ. जितेंद्र सिंह द्वारा किया गया ताकि हींग के बीज उत्पादन को चिरस्थायी उपाय से स्वदेशी बनाया जा सके। इस प्रयास को सुचारू बनाने के लिए, हींग गुणवत्ता पौध सामग्री उत्पादन सुविधा का उद्घाटन भी किया गया, जिसे हींग की गुणवत्ता वाली पौध सामग्री की वर्ष भर की आवश्यकता को पूरा करने के लिए विकसित किया गया है।

इस वर्ष मार्च में, डॉ. एन. कलैसेलवी, महानिदेशक सीएसआईआर एवं सचिव डीएसआईआर, भारत सरकार ने पंजाब के गढ़शंकर में एग्रीनेचुरल्स स्टीविया फार्म का दौरा किया, जिसे सीएसआईआर–आईएचबीटी स्टीविया कृषि प्रौद्योगिकी का उपयोग करके विकसित किया गया है जिसमें ड्रोन प्रौद्योगिकी, विशेष रूप से ड्रोन आधारित मानचित्रण और छिड़काव का उपयोग करके स्टीविया पौधशाला और फार्म प्रबंधन के पहलुओं पर ध्यान केंद्रित किया गया है। सीएसआईआर–आईएचबीटी के वैज्ञानिकों ने किसानों के समक्ष इस तकनीक का सफलतापूर्वक प्रदर्शन किया। डॉ. एन. कलैसेल्वी ने 15 मार्च 2025 को हिमाचल प्रदेश के ऊना जिले में मैसर्स आर जे सेंट्स स्टीविया प्रसंस्करण संयंत्र का उद्घाटन भी किया। यह सीएसआईआर–आईएचबीटी, पालमपुर द्वारा विकसित और मैसर्स आर जे सेंट्स को हस्तांतरित एक नवीन हरित प्रक्रिया प्रौद्योगिकी है, जो देश में स्टीविया प्रसंस्करण में क्रांति लाने के लिए प्रतिबद्ध है। स्टीविया प्रौद्योगिकी को अधिक बढ़ावा देने के लिए, सीएसआईआर–आईएचबीटी ने स्टीविया की एक उन्नत किस्म 'हिम स्टीविया उत्कृष्ट' जारी की और किसानों को खेती के लिए स्टीविया के बीज भी वितरित किए। स्टीविया आधारित उत्पादों (रुद्र शक्ति हर्ब्स प्राइवेट लिमिटेड, हमीरपुर, हिमाचल प्रदेश) का शुभारंभ भी किया गया।

वर्ष 2024–25 के दौरान, उद्यमशीलता और सामाजिक उन्नति को बढ़ावा देने के लिए अनुसंधान, शैक्षणिक, समाज और उद्योग के बीच संबंधों को बढ़ावा देने पर अधिक ध्यान केंद्रित किया गया। हमारे वैज्ञानिकों ने 210 शोध लेख सफलतापूर्वक प्रकाशित किए, जिनमें से 51 का इम्पैक्ट फैक्टर 5 से अधिक और 11 का 10 से अधिक है। संस्थान ने अपनी प्रौद्योगिकियों को प्रदर्शित करने के लिए विभिन्न राष्ट्रीय और अंतर्राष्ट्रीय व्यापार मेलों और प्रदर्शनियों में सक्रिय रूप से भाग लिया।

संस्थान ने 27 प्रौद्योगिकी हस्तांतरण समझौते, स्टार्टअप्स के साथ 14 समझौते, इनक्यूबेट्स के साथ 02, एक आवश्यकता–आधारित समझौता, 134 सामग्री हस्तांतरण समझौते तथा 41 समझौता ज्ञापन किए गए। अफ्रीका में टिशू कल्चर, हाइड्रोपोनिक एवं एरोपोनिक विधि से पौधे उगाने, हिमालयी उच्च मूल्य वाले पुष्प उत्पादन और सुगंधित फसलों की आधुनिक विधियों के माध्यम से उद्योगों के विकास के लिए एम्पावरिंग फार्मर्स फाउंडेशन (ईएफएफ), तंजानिया के साथ एक अंतर्राष्ट्रीय समझौता भी किया गया।

इस वर्ष, विभिन्न कार्यक्रमों के माध्यम से सामाजिक वैज्ञानिक उत्तरदायित्व (एसएसआर) गतिविधियों के अंतर्गत 11467 छात्र और शिक्षकों तक पंहुच बनाई गई, इसमें सीएसआईआर–जिज्ञासा कार्यक्रम में भाग लेने वाले स्कूलों के 9804 और 11 राज्यों और केंद्र शासित प्रदेशों के विश्वविद्यालयों, संस्थानों और कॉलेजों के 1663 छात्र और संकाय सदस्य शामिल हैं। इसके अतिरिक्त, विभिन्न कौशल विकास कार्यक्रमों (एसडीपी) के अंतर्गत, 320 व्यक्तियों ने प्रशिक्षण प्राप्त किया, जिसमें विभिन्न राज्यों और केंद्र शासित प्रदेशों के 189 शोध प्रशिक्षु शामिल थे। इसके अलावा, हमने एसडीपी के लिए विभिन्न शैक्षणिक संस्थानों और हितधारकों के साथ साझेदारी स्थापित की है। उल्लेखनीय है, कि हमने इस वर्ष एमएसएमई–प्रायोजित उद्यमिता कौशल विकास कार्यक्रम (ई–एसडीपी) का भी सफलतापूर्वक संचालन किया।

मुझे अपने स्टाफ से मिल रहे निरंतर सहयोग के लिए हार्दिक आभार व्यक्त करते हुए अत्यन्त हर्ष हो रहा है। इस सहयोग के फलस्वरूप हमें अपने प्रयासों को नए लक्ष्यों पर केंद्रित करने में न केवल सहायता मिली है, अपितु मानवता की बेहतरी के लिए विज्ञान का उपयोग करने की हमारी प्रतिबद्धता को बल भी मिला है। संस्थान के नव पहलयुक्त प्रयासों को साकार करने एवं इस प्रतिवेदन के संकलन में उनके अमूल्य सहयोग और परिश्रम के लिए वैज्ञानिक समुदाय और संस्थान के कर्मचारियों के प्रति मैं अपनी हार्दिक कृतज्ञता व्यक्त करता हूँ।

जय हिंद!

(सुदेश कुमार यादव)

FROM THE DIRECTOR'S DESK

I am delighted to share the annual report of CSIR-Institute of Himalayan Bioresource Technology (CSIR-IHBT) for the year 2024-25. This report offers an overview of our ongoing programs as well as details on the new initiatives launched during this period. CSIR-IHBT has been instrumental in fostering scientific and technological progress in the country, and we highlight some of our notable achievements in this realm.

During the second year of the CSIR Aroma Mission (Phase-III), CSIR-IHBT covered an additional area of 505 ha in 13 states and two union territories. About 12.85 tons of essential oil was produced resulting in a revenue generation of 7.35 crores. Around 12 lakh planting materials and 01 ton of seeds were generated for distribution to the farmers for upcoming seasons. Four field distillation units were installed at farmers' fields (two in the Kangra and Mandi districts of Himachal Pradesh and two in the West Jaintia Hills of Meghalaya). During this period 4,160 farmers were involved in cultivating, processing and value addition of aromatic crops. Twenty training programs were conducted in which 368 new farmers were trained on cultivation and processing aspects of aromatic crop. New varieties of aromatic plants, one each of lavender (Him Aarohi) and chamomile (Him Kanti) were registered with ICAR-PGRC and released by the institute for cultivation by the farmers.

On similar lines, under the CSIR Floriculture Mission (Phase-II), CSIR-IHBT further extended the cultivation of floriculture crops to 170 ha. During the second year of the Mission program about 52.19 lakh planting material of floriculture crops were distributed to the farmers. The institute conducted 49 training and awareness programs focused on cultivation techniques and value addition, including flower dehydration, benefitting 1,721 participants comprising farmers and students. Additionally, 50 school gardens in Himachal Pradesh and Haryana and 10 vertical gardens in public sector offices were developed to promote green initiatives.

CSIR-IHBT also promoted the cultivation of medicinal plants viz., *Inula racemosa*, *Picrorhiza kurroa* and *Ferula assa-foetida* under CSIR Phytopharmaceutical Mission. Apart from these, 05 lakh planting materials of other medicinal plants such as *Valeriana jatamansi*, *Stevia*, *Bacopa* and *Ocimum* were distributed to the farmers. Agrotechnologies for medicinal and aromatic plants such as black turmeric (*Curcuma caesia*) and clary sage (*Salvia sclarea*) were also developed by the institute.

This year, we have developed a high-quality, haplotype-resolved chromosome-level genome assembly of *Stevia rebaudiana* (cultivar enriched in Rebaudioside-A), offering insights into the complex genetic regulation of steviol glycoside (SG) biosynthesis. The monoploid genome spans 1.34 Gb with an N50 of 110 Mb and includes 55,551 predicted protein-coding genes, ~80% repetitive content, and 2.33 Gb of phased haplotypes (A and B) containing over 6,39,000 variants. Whole-genome duplication analysis revealed tandem duplications of key UGT and CYP gene families. This genomic resource provides a valuable platform for genome editing and precision breeding to enhance natural sweetener production in *S. rebaudiana*.

This year, we have conducted the first comprehensive metagenomic analysis of non-sanitary landfills in the Indian Himalayan Region, revealing diverse microbial communities with strong metabolic potential for degrading plastics, xenobiotics, and resisting heavy metals. Despite differing physicochemical profiles, both Manali and Mandi sites showed functional redundancy, offering valuable insights for sustainable bioremediation strategies.

In order to uncover the molecular mechanisms that regulate plant development and responses under abiotic stresses, the transcription factors and stress-responsive genes in species like *Nardostachys jatamansi*,

Picrorhiza kurroa, *Bambusa balcooa* and *Crocus sativus* were studied for their better adaption in challenging conditions and improved crop resilience. Further, efforts were made to identify endophyte-based fungal elicitors in *Valeriana jatamansi* using leaf cell suspension cultures that have the potential to enhance the production of valepotriates and sesquiterpenoids. Elicitation *in vitro* cell culture studies performed in *P. kurroa* also showed significant improvement in the accumulation of pharmaceutically important picrosides. In continuation to the previous work on developing a sustainable system for extraction of industrially important phytochemicals, a process patent has been filed this year on using *Ferula assa-foetida* cell culture for the production of volatile disulfide compounds, a precursor for the characteristic aroma of heeng.

The Bioinformatics group of HiCHiCoB at IHBT developed PTFSpot, a transformer-based deep learning model that accurately predicts transcription factor binding regions (TFBRs) across diverse plant genomes. By learning TF-DNA interaction patterns independent of species or TF family, PTFSpot surpasses existing tools and enables high-accuracy TFBR annotation without prior TF information. The team also developed MDbDMRP, a machine-learning model utilizing molecular descriptors to predict drug-miRNA associations. The structural bioinformatics group employed molecular dynamics and DFT calculations to evaluate piperine encapsulation using γ-cyclodextrins. Octakis(6-O-sulfo)-γ-CD demonstrated the highest stability and binding affinity, outperforming HP-γ-CD, due to enhanced non-covalent interactions, offering a superior strategy to improve piperine solubility and bioavailability.

In an effort towards the development of enzymatic bioprocess for the degradation of lignocellulosic agro-wastes, a mutant version of processive endoglucanase was created, which has increased two-fold activity and stability at high temperatures beyond 60°C. Besides the production of microbial enzymes, the diverse microbial resources of Western Indian Himalaya are characterized for the identification of microorganisms for the development of functional foods.

The Nanobiology group developed bioactive conjugated glucosamine-gold nanoparticles (Gln@CA-AuNP) to effectively target and dismantle harmful protein aggregates related to neurodegenerative diseases (NDs). It was observed that the developed NP significantly boosted sulfated glycosaminoglycan (sGAG) production and enhanced extracellular matrix (ECM) generation. Furthermore, Gln@CA-AuNP played an important role in safeguarding neuronal synapses, effectively reducing protein aggregate deposition in *C. elegans* and paving the way for potential treatments in NDs.

Seven new bioactive metabolites have been isolated and characterized from *Trillium govanianum* Wall. ex D. Don, *Fritillaria cirrhosa* D. Don and *Achyranthes bidentata* Blume. The bioactive compounds from *Swertia purpurascens*, *Swertia cordata,* and *Thalictrum foliolosum* have been isolated and characterized for anti-diabetic and insecticidal activities. A green extraction process has been developed for the purification of lutein in *Tagetes erecta*. Five green analytical methods have been developed to ensure the quality of targeted Himalayan medicinal plants.

This year, three novel catalytic methodologies were developed to synthesize potentially bioactive benzosuberene-substituted quinolinones, conjugated enzymes, and triazolo-azepine molecules from *Cedrus deodara* oil. Two novel gram-scale protocols for 5-HMF and furfural production were developed directly from various renewable feedstock's, including cotton, waste papers, de-oiled lemongrass waste, corn cobs, rice straw, and sugarcane bagasse. Three new methodologies were developed using oxalic acid as CO precursor for CO fixation reactions and 09 C-H activation (photocatalytic/thermal) based catalytic methodologies have been developed for the synthesis of *N*-containing heterocycles.

A novel gram-kilogram scale protocol has been established for synthesizing 4-substituted resorcinol compounds using corresponding cyclohexan-1, 3-diones as in-house precursors under the CSIR-CLP theme. Additionally, within the FTT project under the CSIR-ANB theme, gram-scale purification processes have been developed for 05 certified reference materials (CRMs) derived from Himalayan medicinal

plants, with successful characterization and assignment of purity values. Moreover, a lab-scale process has been developed for extracting tannin-rich substances from tea leaves, aimed at enhancing the leather tanning process, in partnership with CSIR-CLRI, as part of a mission mode project under the CSIR-CLP theme.

A patent has been filed for a single-step method to extract pure natural menthol crystals from *Mentha piperita*. Additionally, the natural travel/pocket perfumes technology has been handed over to M/s Pahadicraft. Furthermore, the institute has licensed a premium orthodox flavored tea with 02 ingredients certified with Geographical Indication (GI) from Himachal Pradesh.

In a recent effort to explore and document the rich biodiversity of the Himalayas, CSIR-IHBT taxonomists have reported notable botanical findings from Dibang Valley in Arunachal Pradesh. Among these are two new species, viz. *Cremanthodium dibangii* Vik. Kumar & Rahul Kumar (family Asteraceae) and *Hemipilia himalayensis* Vik. Kumar & Agrawala (family Orchidaceae), which have been discovered in the Indian Himalayan region. In addition to this *Cremanthodium oblanciligulatum* Long Wang, C. Ren & Q. E. Yang (Asteraceae) and *Neottia bicallosa* X. H. Jin (Orchidaceae) have been recorded for the first time from India. Expanding the known orchid diversity in the western Himalayas, *Calanthe trulliformis* King & Pantl. and *Neottia longicaulis* (King & Pantl.) Szlach has also been documented for the first time in Himachal Pradesh. These discoveries not only enrich the floristic records of the region but also highlight the significance of continued field-based research in uncovering the unexplored plant wealth of the Indian Himalayas. Ecological studies on *Eremurus himalaicus*, *Polygonatum cirrhifolium*, *Arnebia euchroma*, *Allium carolinianum*, and *A. jacquemontii* were conducted in high-altitude areas at 67 sites and 01 conservation site. A seed bank repository of 15 medicinal plants has also been prepared at CeHAB, Lahaul & Spiti (HP). Four low-cost dry toilets have been installed in the Lahaul Valley, providing a hygienic, user-friendly, and sustainable sanitation solution for high-altitude Himalayan regions. The ethnobotanical surveys documented traditional recipes (n=10) primarily made from tsampa (barley) and churpe (dried cheese), which were noted to be of high significance for the inhabitants of Spiti Valley. With regard to the CSIR-TKDL, ~2000 new records along with 1000 prior art information were added to the *Sowa Rigpa* (Trans-Himalayan System of Medicine) database. In the Nubra Valley of Ladakh, the importance of *Salix* for making plant-derived products was revealed and it was used for making 16 household tools.

A unique and first-of-its-kind spectral repository with 1,237 signatures of 10 Himalayan medicinal plant species was created by our remote sensing group, leading to the development of an AI-based identification/ classification model. They also identified Sentinel 2A indices for estimating biomass and carbon stock in mixed subtropical Himalayan forests, providing essential baseline data for environmental management and carbon balance.

CSIR-IHBT signed a Memorandum of Understanding with NDMC for the supply of indigenously developed tulip bulbs, and 15000 bulbs were provided to NDMC this year that bloomed at Delhi. Three varieties of gerbera, Him Kumud (pink), Him Prabha (yellow) and Him Aruna (red), were released by Dr. Jitendra Singh, Hon'ble Minister of Science & Technology and Vice-President of CSIR, on February 26th, 2025, marking a significant milestone in floricultural innovation.

CSIR-IHBT developed an array of new facilities, which were inaugurated by Dr. Jitendra Singh. Under CSIR Floriculture Mission, the tulip garden at CSIR-IHBT was inaugurated on February 26th, 2025, showcasing a vibrant collection of seven tulip varieties with a total of 50,000 bulbs planted during the season. This initiative was aimed to enhance floricultural research, promote eco-tourism, and explore the commercial viability of tulip cultivation in the mid-Himalayan region. Inauguration of Autonomous Greenhouse Facility, a state-of-the-art facility that integrates advanced automation technologies to optimize plant growth with minimal human intervention, ensuring enhanced productivity, resource efficiency, and sustainability in floriculture. A state-of-the-art Ornamental Bulb Processing Facility was also inaugurated to enhance the efficiency of bulb production and post-

harvest management. In order to boost heeng cultivation in the country, the inauguration of Heeng Seed Production Centre was done by Dr. Jitendra Singh on February 26th, 2025 to indigenize seed production of heeng in a sustainable manner. To streamline this endeavor, the inauguration of the Heeng Quality Plant Material Production Facility was also done, which has been developed to meet the round-the-year requirement for heeng's quality plant material.

This year, in March, Dr. N. Kalaiselvi, Director General CSIR & Secretary DSIR, Govt. of India, visited the AgriNaturals Stevia Farm at Garhshankar, Punjab, which has been developed using CSIR-IHBT stevia cultivation technology and focused on aspects of stevia nursery and farm management utilizing drone technology, particularly drone based mapping and spraying. The scientist of CSIR-IHBT successfully demonstrated the technology to the farmers. Dr. N. Kalaiselvi also inaugurated the M/s RJ Saints Stevia Processing Plant in the Una district of Himachal Pradesh on March 15th, 2025. It is an innovative green process technology developed by CSIR-IHBT, Palampur and transferred to M/s RJ Saints, which is set to revolutionize stevia processing in the country. To give further impetus to stevia technology, CSIR-IHBT released an improved variety of stevia 'Him Stevia Utkrisht' and also distributed the stevia seeds to farmers for cultivation. The launch of stevia-based products (Rudra Shakti Herbs Private Limited, Hamirpur, Himachal Pradesh) was also held on the same day.

During the 2024-25 period, there was a heightened focus on fostering linkages between research, academia, society, and industry to promote entrepreneurship and societal advancement. Our scientists successfully published 210 research articles, of which 51 have an impact factor greater than 5 and 11 have an impact factor greater than 10. The institute actively participated in various national and international trade fairs and exhibitions to showcase its technologies. The institute signed 27 Technology Transfer Agreements; 14 Agreements with Startups; 02 with Incubatees; 01 Need-based Agreement; 134 Material Transfer Agreements, 41 MoUs, and one International Agreement with Empowering Farmers Foundation (EFF), Tanzania for developing industries in Africa through the introduction of modern methods of tissue culture, hydroponic, and aeroponic methods of growing plants and Himalayan high-value floriculture and aromatic crops.

This year, the Social Scientific Responsibility (SSR) Activities reached 11,467 students and teachers through various events. This included 9804 individuals from schools participating in the CSIR-JIGYASA program and 1,663 students and faculty members from universities, institutes, and colleges across 11 states and union territories.

Additionally, under the different Skill Development Programs (SDPs), 320 individuals received training, including 189 research interns and trainees from different states and UTs. Furthermore, we have established partnerships with various academic institutions and stakeholders for the SDPs. Notably, we also successfully conducted an MSME-sponsored Entrepreneurship Skill Development Programme (E-SDP) this year.

I am extremely happy to express heartfelt gratitude to my staff for their continued support. This support has not only helped us to focus our efforts on new goals but has also strengthened our commitment to use science for the betterment of humanity. I express my sincere appreciation to the scientific community and the staff of the institute for their invaluable cooperation and hard work in realizing the new initiatives of the institute and in compiling this report.

Jai Hind !

(Sudesh Kumar Yadav)

TECHNOLOGIES AVAILABLE AND ROLLED OUT

TECHNOLOGY TRANSFER AGREEMENTS

S. No.	Title of Agreement	Name of Party	Date of signing
	BIOTECHNOLOGY		
1	Technology for cultivation and production of Brahmi under the vertical aeroponic system)	Kangra (Komal) Innovation and wellness initiative (KIWI), Nagrota Baghwan, Distt Kangra (H.P)	13.05.2024
2	Technology for Hydroponic stevia cultivation	M/s Satvik Agritech Labs Private Limited, Kanpur (U.P) through NRDC, New Delhi	13.05.2024
3	Technology for aeroponic technology for Valeriana Jatamansi production and extraction of the produce	Jnaani Nutritionals Private Limited, Plot No. 12, Survey No. 394/35,36, Modern Nagar, Dindigul, Tamil Nadu	02.07.2024
4	Technology for Hydroponic Plant (Lettuce, Spinach, Kale, Microgreens, Capsicum, Tomatoes)	Himalayan Bliss, 0,2232,0, V.P.O Gopalpur Tehsil Palampur, Distt Kangra, 176059, (H.P.)	05.09.2024
5	Technology for Brahmi and Jatamansi production under aeroponic system	M/s Satvik Agritech Labs Private Limited, 3rd Floor, 302, White Pearls, White Pearl Road, Galaxy Aventura, Adajan, Surat, Gujarat, India- 394510	17.10.2024
	FOOD TECHNOLOGY		
1	Technology for manufacturing Energy/Granola bars (Millet and cereals, protein based)	M/s Good Food Boutique Pvt. Ltd., 32, NRI Block, Carlton Woods, South City, Ludhiana, 142027	24.06.2024
2	Technology for manufacturing/processing of Multigrain Protein Powder	M/s Good Food Boutique Pvt. Ltd., 32, NRI Block, Carlton Woods, South City, Ludhiana, 142027	24.06.2024
3	Technology for manufacturing/processing of Iron and zinc enriched Spirulina based bar (Peanut Bar) product of two variants	M/s Good Food Boutique Pvt. Ltd., 32, NRI Block, Carlton Woods, South City, Ludhiana, 142027	24.06.2024
4	Technology for manufacturing/ processing of millet panjeeri having three variants (i) Plain millet panjeeri, (ii) Multi millet panjeeri (iii) Millet based beverage mixes i.e. multipurpose flour for ladoo and other preparation	Tashvika India Food Pvt. Ltd, Third Floor, Plot No. 34, Sector 3, Dwarka, New Delhi-110075	05.11.2024
5	Technology for manufacturing/processing of Multigrain Protein Powder	Mahalaxmi Malt Products Pvt Ltd., D-13 Shopping Center-II, Mansarover Garden, New Delhi-110015 (Factory Address: Village Rehrana, Tehsil and Distt Palwal, Haryana-121102)	15.03.2025
6	Transfer of Technology 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) Ragi green gram porridge mix powder, and v) Multi grain porridge mix powder	Mahalaxmi Malt Products Pvt Ltd., D-13 Shopping Center-II, Mansarover Garden, New Delhi-110015 (Factory Address: Village Rehrana, Tehsil and Distt Palwal, Haryana-121102)	15.03.2025
	CHEMICAL TECHNOLOGY		
1	Technology for Herbal Tea (Rhododendron tisane and tea blends, and one more variant)	M/s SudKrishna Himproduct Private Limited, Panchkula, Haryana	15.04.2024
2	Technology for Lavender Tea and Instant Sea buckthorn Tea	Prorima Health Care, Jobner, Jaipur, Rajasthan, 303328	13.05.2024
3	Technology for making herbal incense cones and sticks from temple waste flower	Himaliya Ucch Shikhariya Utpaad Mahila Samuh Village Nalda, Post Office Jahalman, Tehsil Udaipur, District Lahaul & Spiti Himachal Pradesh- 175139	20.11.2024
4	Technology for Herbal formulation for cartilage health	M/s Auretics Ltd., New Delhi	17.01.2025
5	Technology for Standardized fraction of *Picrorhiza kurroa* for the treatment of Non Alcoholic Fatty Liver Disease (NAFLD)	Themis Medicare Ltd, Valsad, Gujarat	17.01.2025
6	Technology for making herbal incense cones and sticks from temple waste flowers	Shailza Self Help Group, Village and Post Office Gugga Saloh, Block Bhawarna, Tehsil Palampur, Distt Kangra- 176102 (H.P.)	26.02.2025
7	Technology for making travel/pocket perfumes (4-5 variants)	M/s Phadicraft, Gagret, Distt UNA (H.P.)-177201	26.02.2025
	AGROTECHNOLOGY		
1	Technology for (KNOWHOW of Lilium bulb processing including grading, sorting packaging and cold storage of bulbs)	Gondla Cut Flower Cluster (GCFC), Lahaul and Spiti, (H.P)	13.05.2024
2	Technology for artifact making using dry flower	Pragati Social Development Initiative, 26/B, Chanditala Lane, Kolkata- 700040	05.09.2024
3	Technology for the Lilium and Tulip processing including grading, shorting, packaging and cold storage of bulbs	M/s Dhariti Agro Farms Pvt. Ltd., Vill Kheda, Goula Par, Haldwani, Nainital, Uttrakhand-263139	26.09.2024

S. No.	Title of Agreement	Name of Party	Date of signing
4	Technology for Crude Ethyl Acetate Leaf Extract, A Composition, Process of Preparation and Application Thereof (Development of Botanical Formulation from Plant Extracts and Seed Oil of *Triadica Sabifera* (L) Small for the control of Aphid, *Aphis craccivora* Koch (Aphid Control)	P.I. Industries Limited, Udaipur, Rajasthan	16.10.2024
5	Technology for artifact making using dry flower	Shiv Shakti Self Help Group, VPO Bhuana, Tehsil Palampur, Distt Kangra- 176076	05.11.2024
6	Technology for artifact making using dry flower	Gurudwara Self Help Group, VPO Kailashpur, Tehsil Panchrukhi, Distt Kangra	05.11.2024
7	Technology for the Lilium bulb processing including grading, sorting packaging and cold storage of bulbs	Shansha Cut Flower Cluster (SCFC), Village Dalang, P.O. Gondhla, Tehsil Keylong, Distt Lahaul and Spiti- 175140, (H.P.).	01.12.2024
8	Technology for full spectrum operations for preparation of biofertilizer using the desired microbe	M/s Biomimicry Technologies Pvt. Ltd., Address at 120, Mayur Vihar, DLF Galleria, MV Extension, Delhi- 110091	27.01.2025
9	Technology for artifact making using dry flowers	Grihini Sawyam Swarojgar Sangh, VPO Malahari Tehsil Indora, Distt Kangra H.P. Pin Code-176401	28.02.2025

MATERIAL TRANSFER AGREEMENT (MTA)

S. No.	Title of Agreement	Name of Party	Date of signing
		AGROTECHNOLOGY	
1	Material Transfer Agreement (MTA) for 300 plants for Heenga (Ferula assa-foetida) provided free of cost under "**Phytopharmaceutical Mission Phase - III**".	Dr. Amina Qari, Principal, Government Degree College, Kargil, (PI) Unnat Bharat Abhiyan, Ladakh UT-194103	**17.04.2024**
2	Material Transfer Agreement (MTA) for Lavender rooted plant (500Nos.) of which 250 Nos. provided Free of cost and 250 Nos.@ Rs. 13/plant and Rosemary (200Nos.) of which 1000 Nos. provided Free of cost and 100 Nos under "**CSIR Aroma Mission Phase-III**"	Mr. Charanjeet Singh, Village Sumnam P.O. Tandi Distt Lahaul & Spiti, (H.P.)	**19.04.2024**
3	Material Transfer Agreement (MTA) for Tagetes seeds (10 Kg) provided free of cost under " **CSIR Aroma Mission Phase-III**".	Jan Kalyan Sabha, Pantehar, Tehsil Baijnath, Distt Kangra (H.P.)	**02.05.2024**
4	Material Transfer Agreement (MTA) for Rosemary (105 Nos.), Viola (Banasha) (05 Nos.), Miscellaneous (05 Nos.), Chia Seeds (50gm), Chamomile seeds (50gm), Curcumin Aromatic (5Kg), Hedychium Spicatum (5Kg) and Ginkgo Biloba Plants (60 Nos.).	Mr. Karanjit Singh, 405, sector 71, Mohali, Punjab- 160071	**07.05.2024**
5	Material Transfer Agreement (MTA) for Rhizome of Black Turmeric (Curcuma caesia) (30 Kg) provided free of cost under "**MLP-0202)**".	Mr. Pawan Kumar, Village Talla, P.O Samote, Tehsil Bhatiyat, Distt Chamba (H.P.)	**14.05.2024**
6	Material Transfer Agreement (MTA) for Stevia Seeds (100 gm) and Black Turmeric Rhizomes (1 Kg) provided free of cost under "**GAP- 0293 and MLP-0202**".	Ms. Narwinder Kaur, Village Muthada Kala, Tehsil Phillaur, Distt Jalandhar, Punjab-144409	**17.05.2024**
7	Material Transfer Agreement (MTA) for Tagetes seeds (7 Kg) provided free of cost under " **CSIR Aroma Mission Phase-III**".	Jan Kalyan Sabha, Pantehar, Tehsil Baijnath, Distt Kangra (H.P.)	**17.05.2024**
8	Material Transfer Agreement (MTA) for 5 plants for Heeng (Ferula assa-foetida) provided free of cost under "**Phytopharmaceutical Mission, Phase - III**".	Mr. Rajinder Parshad, S/o Late Sh. Munshi Ram, Village Tanda, P.O. Rajpur, Teshil Palampur, Distt Kangra (H.P.)	**24.05.2024**
9	Material Transfer Agreement (MTA) for Tagetes seeds (50 Kg) provided free of cost under " **CSIR Aroma Mission Phase-III**".	Mr. Surender Mohan, Himalayan Phytochemical & Growers Association, Baggi, Distt Mandi, (H.P.)	**27.05.2024**
10	Material Transfer Agreement (MTA) for Tacoma (05 Nos.), Araucaria (05 Nos.), Bougainvillea (05 Nos.), Boxwood (05 Nos.), Ficus Spp (05 Nos.), Nerium (05 Nos.), Hibiscus (05 Nos.), Schefflera (05Nos.), Bower Plants (5 Nos.), Madhumalti (05 Nos.) provided free of cost under " **CSIR Floriculture Mission Phase-II**".	Mr. Surjeet Singh, Principal, Government Middle School Biara, Tehsil Palampur, Distt Kangra ,176103 (H.P.)	**12.06.2024**
11	Material Transfer Agreement (MTA) for Tacoma (05 Nos.), Araucaria (05 Nos.), Bougainvillea (05 Nos.), Boxwood (05 Nos.), Ficus Spp (05 Nos.), Nerium (05 Nos.), Hibiscus (05 Nos.), Schefflera (05 Nos.), Bower Plants (5 Nos.), Madhumalti (05 Nos.) provided free of cost under " **CSIR Floriculture Mission Phase-II**".	Mr. Brij Mohan Sharma, Principal, Government Model Senior Secondary School Bir,Tehsil Baijnath, Distt Kangra, 176077 (H.P.)	**12.06.2024**

S. No.	Title of Agreement	Name of Party	Date of signing
12	Material Transfer Agreement (MTA) for Tacoma (05 Nos.), Araucaria (05 Nos.), Bougainvillea (05 Nos.), Boxwood (05 Nos.), Ficus Spp (05 Nos.), Nerium (05 Nos.), Hibiscus (05 Nos.), Schefflera (05 Nos.), Bower Plants (05 Nos.), Madhumalti (05 Nos.) provided free of cost under " **CSIR Floriculture Mission Phase-II**".	Mr. Yudhister Rana, Principal, Government Senior Secondary School, Chauntra, Mandi, 175032 (H.P)	**12.06.2024**
13	Material Transfer Agreement (MTA) for Tacoma (03 Nos.), Araucaria (02 Nos.), Bougainvillea (05 Nos.), Boxwood (05 Nos.), Ficus Spp (03 Nos.), Nerium (05 Nos.), Hibiscus (05 Nos.), Schefflera (02 Nos.), Bower Plants (03 Nos.), Madhumalti (02 Nos.) provided free of cost under " **CSIR Floriculture Mission Phase-II**".	Ms. Reetika, Principal, Government Primary School, Educational Block, Biara, Tehsil Palampur, Distt Kangra, 176103 (H.P.)	**12.06.2024**
14	Material Transfer Agreement (MTA) for Tacoma (02 Nos.), Araucaria (03 Nos.), Bougainvillea (05 Nos.), Boxwood (05 Nos.), Ficus Spp (05 Nos.), Nerium (05 Nos.), Hibiscus (05 Nos.), Schefflera (05 Nos.), Bower Plants (05 Nos.), Madhumalti (05 Nos.) provided free of cost under " **CSIR Floriculture Mission Phase-II**".	Ms. Abha Sharma, Principal, Neugal Public School Andretta, Panchrukhi, Teshil Palampur, Distt Kangra, 176103 (H.P)	**12.06.2024**
15	Material Transfer Agreement (MTA) for Tagetes seeds (1.5 Kg) provided free of cost under " **CSIR Aroma Mission Phase-III**".	Mr. Vishal Chand Katoch S/o Sh. Amresh Chand Katoch, V.P.O Rajehar, Tehsil Palampur, Distt Kangra, 176061 (H.P.)	**19.06.2024**
16	Material Transfer Agreement (MTA) for provided 20,100 Plants of free of cost (FOC) and 2,100 Plants on Payment basis [Lavender (rooted Plant) 4500 free of cost and 500 rooted plant, Matricaria (Seeds per gm) 50gm free of cost and 50 gm, Damask Rose (rooted plant) 50 rooted plant free of cost and 50 rooted plant, Rosemary (rooted plant) 4500 rooted plants free of cost and 500 rooted plant, Clary Sage (rooted plant) 5500 rooted plant free of cost and 500 rooted plants, Wild Marigold (seed per gm) 500 gm seeds free of cost, Mushakwala (rooted plant) 5000 rooted plants free of cost and 500 rooted plant in actual cost.	Mr. Puran Chand, Pangi Agrarians Farmer Producer Company Ltd. Kilar, Pangi, Distt Chamba (H.P.)	**21.06.2024**
17	Material Transfer Agreement (MTA) for Tagetes seeds (3 Kg) provided free of cost under " **CSIR Aroma Mission Phase-III**".	Mr. Vishal Thakur, V.P.O Chachian, Tehsil Palampur, Distt Kangra, Pin 176059, (H.P.)	**27.06.2024**
18	Material Transfer Agreement (MTA) for Tagetes seeds (50 Kg) provided free of cost under " **CSIR Aroma Mission Phase-III**".	Mr. Himanshu Kaushal, President, Jai Mateshwari Vikas Samiti, Sarupda, Tehsil Sihunta, Distt Chamba (H.P.)	**02.07.2024**
19	Material Transfer Agreement (MTA) for Valeriana Jatamansi Plant (35,000 Nos.) provided free of cost under " **CSIR Aroma Mission Phase-III**". **(HCP-0007 and GAP-293)**	Mr. Kripal Singh, President, Tridev Aushdiya Paudh Utpadan Society Rohal Tehsil Chadgaon Distt Shimla- 171208 (H.P)	**12.07.2024**
20	Material Transfer Agreement (MTA) for Lemon Grass Slips (2.25 Lakh), aromatic marigold seed variety "**Him Swarnima**" (1.0 Kg) provided free of cost under " **CSIR Aroma Mission Phase-III**".	Ms. Kristeena Grover, International Centre for socially Resposible Businesses (ICSRB), 9D, Singh Plot No. 21, Sector 9, Rohini, Delhi-110085	**15.07.2024**
21	Material Transfer Agreement (MTA) for Lemongrass rooted Slips (25,000), provided free of cost under " **CSIR Aroma Mission Phase-III**".	Ms. Anjani Mankotia, Village Upper Barol, P.O. Dari, Tehsil Dharamshala, Distt Kangra (H.P.)	**16.07.2024**
22	Material Transfer Agreement (MTA) for Marigold Seedlings (5000 Nos) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**.	Ms. Kanchan Sharma,Molichak, Banuri Khas, Palampur, Kangra, (H.P.)	**19.07.2024**
23	Material Transfer Agreement (MTA) for Marigold Seedlings (5000 Nos) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**.	Mr. Munish Sharma,Hose No. 46-A, Pink Park, Ludhiana, Punjab	**19.07.2024**
24	Material Transfer Agreement (MTA) for Chrysanthemum Rooted Cuttings (5000 Nos) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**.	Ms. Anita Devi, W/oPraveen Kumar, Dayangil. Sunni, Shimla, (H.P.)	**22.07.2024**
25	Material Transfer Agreement (MTA) for Chrysanthemum Rooted Cuttings (5000 Nos) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**.	Mr. Vinay Kumar, S/o Puran Dass, Dayangil. Sunni, Shimla, (H.P.)	**22.07.2024**

S. No.	Title of Agreement	Name of Party	Date of signing
26	Material Transfer Agreement (MTA) for Chrysanthemum Rooted Cuttings (5000 Nos) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**.	Mr. Hitender Prakash, Khatnol, Dhalli, Dalana, Shimla, (H.P.)	**22.07.2024**
27	Material Transfer Agreement (MTA) for Chrysanthemum Rooted Cuttings (5000 Nos) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**.	Mr. Pankaj Kumar, S/o Puran Dass Thakur, Dyangil, Sunni, Shimla, Himachal Pradesh	**22.07.2024**
28	Material Transfer Agreement (MTA) for 2000 Kg Compost Booster.	Sh. F. Lalramchuana, Senior Curator, Mizoram Science Centre, Government of Mizoram, Aizal	**24.07.2024**
29	Material Transfer Agreement (MTA) for Pencil Pine (05 Nos.), Araucaria (05 Nos.), Boxwood (15 Nos.), Aechmea (05 Nos.), Sago Palm (02 Nos.), American Dracaena (10 Nos.), Peace Lily (10 Nos.), Schefflera (10 Nos.), Snake Plant (05 Nos.), Dracaena (15Nos.), Rohio (10 Nos.), Ficuss Spp. (15 Nos.), Spider Plant (20 Nos.), Rubber Plants (02 Nos.), and Topiary Plant (02 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II"**.	Mr. Dhanpal, Airports Authority of India, Civil Airport Shimla, Jubberhatti, 171011, (H.P.)	**13.08.2024**
30	Material Transfer Agreement (MTA) for Valeriana Jatamansi Plant (12,000 Nos.) provided free of cost under " **CSIR Aroma Mission Phase-III**". **(HCP-0007 and GAP-0293)**	Mr. Bhagto S/o Sh. Ravan, Member, Collective Efforts for Volunteer Action (CEVA), Village Tadoli, Post office Saru, Distt Chamba, 176310, (H.P.)	**13.08.2024**
31	Material Transfer Agreement (MTA) for Monk Fruit (10 plants) provided free of cost under "**GAP-0293".**	Mr. Hibu Taker, Village Honga, P.O Ziro, Distt Lower Subansiri,791120, Arunachal Pradesh	**20.08.2024**
32	Material Transfer Agreement (MTA) for Carnation rooted cuttings (5000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**.	Mr. Dinesh Kumar S/o Sh. Surender Kumar, Jhajha (451), Solan- 173217 (H.P.)	**03.09.2024**
33	Material Transfer Agreement (MTA) for Carnation rooted cuttings (5000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**.	Mr. Kuldeep Singh S/o Sh. Man Singh, Shakog (453), Jhajha Solan, Kandaghat-173217 (H.P.)	**03.09.2024**
34	Material Transfer Agreement (MTA) for Carnation rooted cuttings (2000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**.	Mr. Babu Ram S/o Sh. Krishan Dutt, Dewag, Jumag (146), Shimla-171218, (H.P.)	**03.09.2024**
35	Material Transfer Agreement (MTA) for Carnation rooted cuttings (5000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**.	Mr. Sanjeev Kumar S/o Man Singh, Shakog (453), Jhajha, Solan, Kamdaghat- 173217, (H.P.)	**03.09.2024**
36	Material Transfer Agreement (MTA) for Carnation rooted cuttings (5000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**.	Smt. Anchal C/o Rajesh, P.O Janedghat, Balawag,	**03.09.2024**
37	Material Transfer Agreement (MTA) for Carnation rooted cuttings (5000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**.	Mr. Pardeep Kumar S/o Sh. Hari Mohan Jhajha (451), Solan- 173217, (H.P.)	**03.09.2024**
38	Material Transfer Agreement (MTA) for Carnation rooted cuttings (2000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**.	Mr. Amit Chauhan S/o Late Sh. Durga Singh Chauhan, P.O Talai, Tehsil Junga, Balawag, Shimla- 173217, (H.P.)	**03.09.2024**
39	Material Transfer Agreement (MTA) for Carnation rooted cuttings (6000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**.	Mr. Tek Chand, Bayla Balahu, P.O Nayagram (924), Solan- 173220, (H.P.)	**03.09.2024**
40	Material Transfer Agreement (MTA) for Carnation rooted cuttings (5000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**.	Mr. Sandeep Kumar S/o Sh. Roop Singh, Nagali (497), Solan- 173217, (H.P.)	**03.09.2024**
41	Material Transfer Agreement (MTA) for Carnation rooted cuttings (5000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**.	Mr. Shubham Sharma S/o Sh. Baldev Prakash Sharma, Near water tank, Anand Niwas, Tehsil Solan- 174001,(H.P.)	**03.09.2024**
42	Material Transfer Agreement (MTA) for Carnation rooted cuttings (5000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**.	Mr. Vivek Kumar S/o Sh. Kuldeep Chand Sharma, Village Marura, P.O. Talai, Tehsil-Jhandutta, Marura, Bilaspur,- 174030, (H.P.)	**03.09.2024**

S. No.	Title of Agreement	Name of Party	Date of signing
43	Material Transfer Agreement (MTA) for Carnation rooted cuttings (1000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**.	Mr. Raj Verma, S/o Sh. Geeta Ram Verma, VPO Jhajha (451), Tehsil Kandaghat Solan -173217, (H.P.)	**03.09.2024**
44	Material Transfer Agreement (MTA) for Carnation rooted cuttings (5000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**.	Mr. Manmohan Thakur S/o Sh. Bhopal Singh Thakur, Village Jungal Mashobra (247), Post Office Mashobra, Shimla-171007, (H.P.)	**04.09.2024**
45	Material Transfer Agreement (MTA) for Carnation rooted cuttings (5000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**.	Mr. Rajender Kumar S/o Devi Ram, Village Kot Kufri, Shogi (95), Shimla- 171219 (H.P.)	**05.09.2024**
46	Material Transfer Agreement (MTA) for Carnation rooted cuttings (5000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**.	Mr. Bhanu Prakash S/o Atam Swaroop, Mahog (471), Chail, Solan- 173217 (H.P.)	**06.09.2024**
47	Material Transfer Agreement (MTA) for Carnation rooted cuttings (5000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**.	Smt. Shobha Devi W/o Sh. Joginder Singh, V.P.o Khabli (582), Tehsil Derha, Distt Kangra- 177101, (H.P.)	**30.09.2024**
48	Material Transfer Agreement (MTA) for Stevia Seeds (50 gm) provided under " **MLP-0202".**	Ms. Shraddha Sontakke Jain, House No. 36,, Vivekanand Colony, Jhabua, Madhya Pradesh- 457661, India	**01.10.2024**
49	Material Transfer Agreement (MTA) for aromatic crop German Chamomile (Matricaria Chamomilla) Seeds (1 Kg) provided free of cost under " **CSIR Aroma Mission Phase-III**"	Mr. Sewa Singh, V.P.O Malkana Tehsil Talwandi Sabo, Distt Bathinda- 151301 (Pb)	**03.10.2024**
50	Material Transfer Agreement (MTA) for Dracaena (05 Nos.), Monstera (05 Nos.), Money Plant (05Nos.), Sago palm (01 Nos.), and Rubber Plant (05 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II"**.	Mr. Rakesh Mohan Dabral, Principal, Laxman Vidyalaya Inter College, Pathri Bag, Dehradun, Uttarakhand	**04.10.2024**
51	Material Transfer Agreement (MTA) for Dracaena (05 Nos.), Monstera (05 Nos.), Money Plant (05Nos.), Sago palm (01 Nos.), and Rubber Plant (05 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II"**.	Mr. Balbir Singh Panwar, Principal, Government Inter College, Mehuwala Mafi, Raipur, Dehradun, Uttarakhand	**04.10.2024**
52	Material Transfer Agreement (MTA) for Dracaena (05 Nos.), Monstera (05 Nos.), Money Plant (05 Nos.), Sago palm (01 Nos.)and Rubber Plant (05 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II".**	Mr. Ashtosh Kumar Sharma, Shree Goverdhan Saraswati Vidya Mandir, Inter College Dharampur, Dehradun- 248001, Uttarakhand	**04.10.2024**
53	Material Transfer Agreement (MTA) for Dracaena (05 Nos.), Monstera (05 Nos.), Money Plant (05Nos.), Sago palm (01 Nos.), and Rubber Plant (05 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II"**.	GS Khatri, Principal, Government Inter Colloge, Industrial Area, Patel Nagar, Dehradun, Uttarakhand	**04.10.2024**
54	Material Transfer Agreement (MTA) for Stevia Seeds (200 gm) provided under "**MLP -0202**" and stevia plants (2000 Nos.) provided free of cost under "**GAP- 0293**".	Mr. Gurvinder Singh, Village Rampur Sahiwal, Distt Patiala, 147104 Punjab	**07.10.2024**
55	Material Transfer Agreement (MTA) for Araucaria (02 Nos.), Bougainvillea (03 Nos.), Duranta (25 Nos.), Wild Ginger (02 Nos.), Chandni (02 Nos.), Pot Spider (02 Nos.), Bower Plant (02 Nos.), Broken Heart (02 Nos.), Dracaena (02 Nos.), Pencil Pine (02 Nos.), Ficus (03 Nos.), Boxwood (03 Nos.), Cupea (03 Nos.), and Sago palm (01 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II".**	Mr. Subodh Kumar, Head Master, Government Primary School, Banander, Chauntra-2, Lad Bharol, Mandi- 176125, (H.P.)	**10.10.2024**
56	Material Transfer Agreement (MTA) for Araucaria (03 Nos.), Bougainvillea (04 Nos.), Duranta (25 Nos.), Wild Ginger (03 Nos.), Chandni (03 Nos.), Pot Spider (03 Nos.), Bower Plant (03 Nos.), Broken Heart (03 Nos.), Dracaena (03 Nos.), Pencil Pine (03 Nos.), Ficus (04 Nos.), Boxwood (04 Nos.), Cupea (04 Nos.), and Sago palm (02 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II".**	Mr. Rishab Awasthi, Managing Director, Crayons World School, Near Railway Crossing, Pandol Road, Baijnath- 176125, (H.P.)	**10.10.2024**

S. No.	Title of Agreement	Name of Party	Date of signing
57	Material Transfer Agreement (MTA) for Araucaria (03 Nos.), Bougainvillea (04 Nos.), Duranta (25 Nos.), Wild Ginger (03 Nos.), Chandni (03 Nos.), Pot Spider (03 Nos.), Bower Plant (03 Nos.), Broken Heart (03 Nos.), Dracaena (03 Nos.), Pencil Pine (03 Nos.), Ficus (04 Nos.), Boxwood (04 Nos.), Cupea (04 Nos.), and Sago palm (02 Nos.) provided free of cost under "CSIR Floriculture Mission Phase-II".	Mr. Sanjeev Kumar, Principal, Government Degree College Lad Bharol, Mandi- 175016, (H.P.)	**10.10.2024**
58	Material Transfer Agreement (MTA) for Araucaria (02 Nos.), Bougainvillea (03 Nos.), Duranta (25 Nos.), Wild Ginger (02 Nos.), Chandni (02 Nos.), Pot Spider (02 Nos.), Bower Plant (02 Nos.), Broken Heart (02 Nos.), Dracaena (02 Nos.), Pencil Pine (02 Nos.), Ficus (03 Nos.), Boxwood (03 Nos.), Cupea (03 Nos.), and Sago palm (01 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II".**	Mr. Sushma Kumari, Head Master, Government Middle School, Maman, Chauntra-2, Lad Bharol, Mandi- 175016, (H.P.)	**10.10.2024**
59	Material Transfer Agreement (MTA) for Bottle Palm (01 Nos.), Areca Plam (01 Nos.), Araucaria (01 Nos.), Golden Cypress (01 Nos.), Hibiscus (03 Nos.), Ashoka (04 Nos.), Schefflera (05 Nos.), Thuja (01 Nos.), Green Cypress (01 Nos.), Hamelia (04 Nos.), Fan Palm (01 Nos.), Bougainvillea (05 Nos.), Croton (01 Nos.), Boxwood (16 Nos.), Sago Palm (01 Nos.), and Dracaena (01 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II".**	Mr. Pravesh Chandel, Principal, Minerva Sr. Sec. School Ghumarwin, Distt Bilaspur-174021, (H.P.)	**22.10.2024**
60	Material Transfer Agreement (MTA) for Bottle Palm (01 Nos.), Areca Plam (01 Nos.), Araucaria (01 Nos.), Golden Cypress (01 Nos.), Hibiscus (03 Nos.), Ashoka (04 Nos.), Schefflera (05 Nos.), Thuja (01 Nos.), Green Cypress (01 Nos.), Hamelia (04 Nos.), Fan Palm (01 Nos.), Bougainvillea (05 Nos.), Croton (01 Nos.), Boxwood (16 Nos.), Sago Palm (01 Nos.), and Dracaena (01 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II".**	Mr. Paramjeet, Principal, Shaheed Vijay Pal Memorial Government, Girls Senior Sechndary School, Ghumarwin, Bilaspur-174034, (H.P.)	**22.10.2024**
61	Material Transfer Agreement (MTA) for Areca Plam (02 Nos.), Araucaria (02 Nos.), Golden Cypress (02 Nos.), Hibiscus (04 Nos.), Ashoka (05 Nos.), Schefflera (05 Nos.), Thuja (02 Nos.), Green Cypress (02 Nos.), Hamelia (04 Nos.), Fan Palm (01 Nos.), Bougainvillea (05 Nos.), Croton (01 Nos.), Boxwood (17 Nos.), Sago Palm (01 Nos.), and Dracaena (02 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II".**	Ms. Simro Bhatnagar, Principal, Government Senior Secondary School, Auhar, Bilaspur-174024, (H.P.)	**22.10.2024**
62	Material Transfer Agreement (MTA) for Bottle Palm (01 Nos.), Areca Plam (01 Nos.), Araucaria (01 Nos.), Golden Cypress (01 Nos.), Hibiscus (03 Nos.), Ashoka (04 Nos.), Schefflera (05 Nos.), Thuja (01 Nos.), Green Cypress (01 Nos.), Hamelia (04 Nos.), Fan Palm (01 Nos.), Bougainvillea (05 Nos.), Croton (01 Nos.), Boxwood (16 Nos.), Sago Palm (01 Nos.), and Dracaena (01 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II".**	Mr. Suresh Kumar Bhardwai, Principal, Government Senior Secondary School Dadhol, Bilaspur- 174023, (H.P.)	**22.10.2024**
63	Material Transfer Agreement (MTA) for Bottle Palm (01 Nos.), Areca Plam (01 Nos.), Araucaria (01 Nos.), Golden Cypress (01 Nos.), Hibiscus (03 Nos.), Ashoka (04 Nos.), Schefflera (05 Nos.), Thuja (01 Nos.), Green Cypress (01 Nos.), Hamelia (04 Nos.), Fan Palm (01 Nos.), Bougainvillea (05 Nos.), Croton (01 Nos.), Boxwood (16 Nos.), Sago Palm (01 Nos.), and Dracaena (01 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II".**	Mr. Rekha Sharma, Principal, Government Senior Secondary School, Dangar, Bilaspur-174023, (H.P.)	**22.10.2024**
64	Material Transfer Agreement (MTA) for Gypsophila plants (500 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II".**	Mr. Gopal Singh Thakur S/o Sh. Kundan Lal Thakur, Village Katli, PO. Kiar Koti, Kandi (312), Mashobra, Shimla, Himachal Pradesh- 171007	**28.10.2024**

S. No.	Title of Agreement	Name of Party	Date of signing
65	Material Transfer Agreement (MTA) for Dracaena (05 Nos.), Ficus (05 Nos.), Golden Cypress (02 Nos.), Hamelia (05 Nos.), Schefflera (05 Nos.), Duranta (67 Nos.), and Nerium (05 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II".**	Ms. Susheela Katoch, Principal, Government Sernior Secondary School, Dehan, Palampur, Distt Kangra- 176102, (H.P.)	**28.10.2024**
66	Material Transfer Agreement (MTA) for Dracaena (05 Nos.), Ficus (05 Nos.), Golden Cypress (02 Nos.), Hamelia (05 Nos.), Schefflera (05 Nos.), Duranta (66 Nos.), and Nerium (05 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II".**	Mr. Nageshwar Singh, Rana Man Chand Memorial Government Senior Secondary School Sullah, Kangra- 176085 (H.P.)	**28.10.2024**
67	Material Transfer Agreement (MTA) for Dracaena (05 Nos.), Ficus (05 Nos.), Golden Cypress (02 Nos.), Hamelia (05 Nos.), Schefflera (05 Nos.), Duranta (67 Nos.), and Nerium (05 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II".**	Mr. Yoginder Sharotri, Head Master, S.L.S Memorial Z.A.V. Public School Sulah, Kangra- 176102 (H.P.)	**28.10.2024**
68	Material Transfer Agreement (MTA) for Gerbera plants (1000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II".**	Mr. Ghanshyam,S/o Sh. Besar Ram, Kharsi (147), PO. Devdhar, Tehsil Chachyot, Mandi, Himachal Pradesh- 175029	**28.10.2024**
69	Material Transfer Agreement (MTA) for Lavender rooted plant (2000 Nos.), Rosemary rooted plant (500 Nos.), Chamomile seed (100 gm) Provided free of cost under **"CSIR Aroma Mission Phase-III".**	Mr. Prahlad Bhag, President, Chamunda Krishak Society, Village Maira, Tehsil Salooni, Distt. Chamba (H.P.)	**05.11.2024**
70	Material Transfer Agreement (MTA) for Gerbera plants (5000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II".**	Mr. Om Prakash Sharma S/o Sh. Gauri Das Sharma, VPO Khushnagri Tehsil Churah Tissa(412), Chamba, Himachal Pradesh-176316	**11.11.2024**
71	Material Transfer Agreement (MTA) for Gypsophila plants (500 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II".**	Mr. Bharat Kumar, S/O Sh. Inder Singh , Tehsil Thunag, Kandhi(95), Mandi Himachal Pradesh- 175035	**11.11.2024**
72	Material Transfer Agreement (MTA) for Gypsophila plants (1200 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II".**	Mr. Om Prakash, S/o Sh. Chain Singh, Shamror (568), Oachghat, Solan, Himachal Pradesh- 173223	**11.11.2024**
73	Material Transfer Agreement (MTA) for Gypsophila plants (1500 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**	Mr. Kuldeep Singh, S/o Sh. Maan Singh, Shakog (453), Jhaja, Solan, Himachal Pradesh- 173217	**11.11.2024**
74	Material Transfer Agreement (MTA) for Gerbera plants (1500 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II".**	Ms. Meera Rani, C/o Sh. Sanjeev Kumar, Village Makkar, PO. Karer, Tehsil Barsar, Makar (40/13), Hamirpur, Himachal Pradesh- 1743311	**11.11.2024**
75	Material Transfer Agreement (MTA) for Gypsophila plants (2000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II".**	Mr. Dinesh Kumar, S/o Sh. Surender Kumar, Jhajha (451), Solan, Himachal Pradesh- 173217	**11.11.2024**
76	Material Transfer Agreement (MTA) for Gypsophila plants (500 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II".**	Mr. Rajat, S/o Sh. Pratap Singh, Mahog (471), PO. Chail, Solan, Himachal Pradesh-173217	**12.11.2024**
77	Material Transfer Agreement (MTA) for Gypsophila plants (1000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II".**	Mr. Sandeep, C/o Sh. Madan Lal, Chadoli (120), PO.- Anandpur, Shimla, Himachal Pradesh- 171219	**13.11.2024**
78	Material Transfer Agreement (MTA) for Gerbera plants (1000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II".**	Mr. Sanjeev Kumar, S/o Sh. Kishan Chand, Ward Number 5, PO. Samnoli, Tehsil Amb, Nari Chintpurni, Una, Himachal Pradesh-177110	**13.11.2024**
79	Material Transfer Agreement (MTA) for Gypsophila plants (2500 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II".**	Ms. Shashi Kala Sharma, W/o Sh. Lekh Raj Sharma, Agriculture Residential Building, PO Mashobra Tehsil Shimla, Himachal Pradesh- 171007	**13.11.2024**
80	Material Transfer Agreement (MTA) for Gerbera plants (500 Nos.), and Gypsophila plants (2000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**	Mr. Mohinder Singh, S/o Sh. Saran Dass, Ghiana Khurd (477), PO. Jheol, Tehsil Dharamshala, Kangra, Himachal Pradesh-176001	**13.11.2024**
81	Material Transfer Agreement (MTA) for Gypsophila plants (500 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II".**	Mr. Narender Kumar, S/o Sh. Rajinder Kumar, Sub Tehsil Junga, Malansheet (Kalho), Janedghat, Shimla, Himachal Pradesh- 173217	**13.11.2024**
82	Material Transfer Agreement (MTA) for Gypsophila plants (500 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II".**	Mr. Netar Singh, S/o Sh. Jhabe Ram, Tehsil Thunag, Kandhi(95), Mandi Himachal Pradesh- 175035	**18.11.2024**

S. No.	Title of Agreement	Name of Party	Date of signing
83	Material Transfer Agreement (MTA) for Gypsophila plants (500 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II".**	Mr. Nitish Singh, S/o Sh. Kishan Chand, Tehsil Thunag, Kandhi(95), Mandi Himachal Pradesh- 175035	**18.11.2024**
84	Material Transfer Agreement (MTA) for Gerbera plants (2000 Nos.) provided 10% actual price under "**CSIR Floriculture Mission Phase-II"**	Mr. Vinod Kumar, S/O Prem Lal, Village-Badah, Mohal (35/84), Kullu, Himachal Pradesh - 175126	**18.11.2024**
85	Material Transfer Agreement (MTA) for Gerbera plants (1500 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II".**	Mr. Ravinder Kumar, S/o Sh. Ram Swarup, Ward no. 2 VPO Badehar, Una, Himachal Pradesh-174306 on 18.11.2024	**18.11.2024**
86	Material Transfer Agreement (MTA) for Gerbera plant (1000 Nos.), and Gypsophila plant (500 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**	Mr. Rajeev Rajput, S/ Sh. Jaghardip Rajput, Ghaghru-Btahral (99), Palampur, Kangra, Himachal Pradesh- 176085	**19.11.2024**
87	Material Transfer Agreement (MTA) for Damask rose rooted plants (250 Nos.) or (250 Nos.) free of cost , and Chamomile seeds (500 grams) provided free of cost under **"CSIR Aroma Mission Phase-III"**	SLN Agro Association (SLN), Nira Narasingpur, Tehsil Indapur, Distt Pune – 413211, Maharashtra	**22.11.2024**
88	Material Transfer Agreement (MTA) for Gerbera plant (1000 Nos.), and Gypsophila plant (500 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**	Sh. Shamsher Singh, DDO, Government Girls High School, Matour, Kalayat, Kaithal, Haryana – 136117	**26.11.2024**
89	Material Transfer Agreement (MTA) for Dracaena (05 Nos.), Areca Palm (02 Nos.), Hibiscus (03 Nos.), Araucaria (03 Nos.), Golden Cypress (02 Nos.), Hamelia (03), Green Cypress (03 Nos.), Thuja (02 Nos.), Boxwood (20 Nos.), Shfflera (05), Bougainvilea (03 Nos.), Duranta (20 Nos.), Croton (03 Nos.), Jade Plant (20 Nos.), and Peace Lily (05 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II"**	Smt. Parveen Kumari, JBT Teacher, Government Girls Model Sanskriti Primary School, Kalayat, Kalayat, Kaithal, Haryana – 136117	**26.11.2024**
90	Material Transfer Agreement (MTA) for Dracaena (05 Nos.), Areca Palm (02 Nos.), Hibiscus (03 Nos.), Araucaria (03 Nos.), Golden Cypress (02 Nos.), Hamelia (03), Green Cypress (03 Nos.), Thuja (02 Nos.), Boxwood (20 Nos.), Shfflera (05), Bougainvilea (03 Nos.), Duranta (20 Nos.), Croton (03 Nos.), Jade Plant (20 Nos.), and Peace Lily (05 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II"**	Sh. Sanjeev Kumar, Headmaster, Government Middle School, Dubbal, Kalayat, Kaithal, Haryana – 136117	**26.11.2024**
91	Material Transfer Agreement (MTA) for Dracaena (05 Nos.), Areca Palm (02 Nos.), Hibiscus (03 Nos.), Araucaria (03 Nos.), Golden Cypress (02 Nos.), Hamelia (03), Green Cypress (03 Nos.), Thuja (02 Nos.), Boxwood (20 Nos.), Shfflera (05), Bougainvilea (03 Nos.), Duranta (20 Nos.), Croton (03 Nos.), Jade Plant (20 Nos.), and Peace Lily (05 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II"**	Sh. Rajender Sharma, Headmaster, Government Middle School, Wazirnagar, Kalayat, Kaithal, Haryana – 136117	**26.11.2024**
92	Material Transfer Agreement (MTA) for Dracaena (05 Nos.), Areca Palm (02 Nos.), Hibiscus (03 Nos.), Araucaria (03 Nos.), Golden Cypress (02 Nos.), Hamelia (03), Green Cypress (03 Nos.), Thuja (02 Nos.), Boxwood (20 Nos.), Shfflera (05), Bougainvilea (03 Nos.), Duranta (20 Nos.), Croton (03 Nos.), Jade Plant (20 Nos.), and Peace Lily (05 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II"**	Smt. Umesh Kumari, Headmistress, Government Model Sanskriti Primary School, Kalayat City, Kalayat, Kaithal, Haryana – 136117	**26.11.2024**
93	Material Transfer Agreement (MTA) for Dracaena (05 Nos.), Areca Palm (02 Nos.), Hibiscus (03 Nos.), Araucaria (03 Nos.), Golden Cypress (02 Nos.), Hamelia (03), Green Cypress (03 Nos.), Thuja (02 Nos.), Boxwood (20 Nos.), Shfflera (05), Bougainvilea (03 Nos.), Duranta (20 Nos.), Croton (03 Nos.), Jade Plant (20 Nos.), and Peace Lily (05 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II"**	Sh. Raj Kumar, Headmaster, Government Primary School, Seemla, Kalayat, Kaithal, Haryana – 136117	**26.11.2024**
94	Material Transfer Agreement (MTA) for Dracaena (05 Nos.), Areca Palm (02 Nos.), Hibiscus (03 Nos.), Araucaria (03 Nos.), Golden Cypress (02 Nos.), Hamelia (03), Green Cypress (03 Nos.), Thuja (02 Nos.), Boxwood (20 Nos.), Shfflera (05), Bougainvilea (03 Nos.), Duranta (20 Nos.), Croton (03 Nos.), Jade Plant (20 Nos.), and Peace Lily (05 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II"**	Sh. Gora Singh, Principal, Government Senior Secondary School, Badhsikri, Kalayat, Kaithal, Haryana – 136117	**26.11.2024**

S. No.	Title of Agreement	Name of Party	Date of signing
95	Material Transfer Agreement (MTA) for Dracaena (05 Nos.), Areca Palm (02 Nos.), Hibiscus (03 Nos.), Araucaria (03 Nos.), Golden Cypress (02 Nos.), Hamelia (03), Green Cypress (03 Nos.), Thuja (02 Nos.), Boxwood (20 Nos.), Shfflera (05), Bougainvilea (03 Nos.), Duranta (20 Nos.), Croton (03 Nos.), Jade Plant (20 Nos.), and Peace Lily (05 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II"**	Sh. Ramesh Kumar, Principal, Government Senior Secondary School, Kailram, Kalayat, Kaithal, Haryana – 136117	**26.11.2024**
96	Material Transfer Agreement (MTA) for Dracaena (05 Nos.), Areca Palm (02 Nos.), Hibiscus (03 Nos.), Araucaria (03 Nos.), Golden Cypress (02 Nos.), Hamelia (03), Green Cypress (03 Nos.), Thuja (02 Nos.), Boxwood (20 Nos.), Shfflera (05), Bougainvilea (03 Nos.), Duranta (20 Nos.), Croton (03 Nos.), Jade Plant (20 Nos.), and Peace Lily (05 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II"**	Sh. Ranvir Singh, Principal, Government Senior Secondary School, Khadalwa, Kalayat, Kaithal, Haryana – 136117	**26.11.2024**
97	Material Transfer Agreement (MTA) for Dracaena (05 Nos.), Areca Palm (02 Nos.), Hibiscus (03 Nos.), Araucaria (03 Nos.), Golden Cypress (02 Nos.), Hamelia (03), Green Cypress (03 Nos.), Thuja (02 Nos.), Boxwood (20 Nos.), Shfflera (05), Bougainvilea (03 Nos.), Duranta (20 Nos.), Croton (03 Nos.), Jade Plant (20 Nos.), and Peace Lily (05 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II"**	Sh. Rajeev Kumar, Principal, Government Senior Secondary School, Seemla, Kalayat, Kaithal, Haryana – 136117	**26.11.2024**
98	Material Transfer Agreement (MTA) for Gladiolus corms (5000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**.	Sh. Bhu Dev S/O Puran Dutt, Village Panjyali Tehsil Sunni, Ward No 4, Khatnol (78), Shimla-171007, (H.P.)	**01.01.2025**
99	Material Transfer Agreement (MTA) for Gladiolus corms (5000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**.	Sh. Bishan Singh S/O Molak Ram, PO-Gumma, Tehsil Shimla, Shimla -171007, (H.P.)	**01.01.2025**
100	Material Transfer Agreement (MTA) for Gladiolus corms (5000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**.	Sh. Devinder Kumar S/O Tulsi Ram, Village Koti, Tehsil Junga, PO- Koti, Shimla -171007, (H.P.)	**01.01.2025**
101	Material Transfer Agreement (MTA) for Gladiolus corms (5000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II".**	Sh. Dhani Ram S/O Keshav Ram, Village Sipur, Tehsil, Shimla- 171007, (H.P.)	**01.01.2025**
102	Material Transfer Agreement (MTA) for Gladiolus corms (10,000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**.	Sh. Naresh Sharma S/O Naresh Sharma, Tehsil Aut, Nagwain, Distt. Mandi, (H.P.)	**01.01.2025**
103	Material Transfer Agreement (MTA) for Gladiolus corms (10,000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**.	Sh. Jai Prakash Sharma S/o Naresh Sharma, Tehsil Aut, Nagwain, Distt. Mandi, (H.P.)	**01.01.2025**
104	Material Transfer Agreement (MTA) for Gladiolus corms (5000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**	Sh. Kishor Kumar S/o Kashmir Singh, Village Khal, Tehsil Baijnath, Kangra, (H.P.) -176128	**02.01.2025**
105	Material Transfer Agreement (MTA) for Gladiolus corms (20,000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II".**	Sh. Lekh Raj Sharma S/o Late Sh. Sadh Ram PO- Mashobra, Tehsil Shimla, Shimla, (H.P.) -171007	**02.01.2025**
106	Material Transfer Agreement (MTA) for Gladiolus corms (10,000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**	Sh. Gitesh Verma S/o Diwan Chand Verma, Durgapur, Shimla, (H.P.) -171007	**02.01.2025**
107	Material Transfer Agreement (MTA) for Gladiolus corms (10,000 Nos.) provided 10% actual price under "CSIR Floriculture Mission Phase-II".	Sh. Maninder Jit Singh S/o Khushdev Singh Machhian Kalan, Ludhiana, Borra, Punjab -141126	**02.01.2025**
108	Material Transfer Agreement (MTA) for Gladiolus corms (5000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**.	Sh. Naresh Kumar S/o Gurdyal Sharma Village Pal, PO- Khatnol, Tehsil Sunni, Shimla, (H.P.) -171007	**02.01.2025**
109	Material Transfer Agreement (MTA) for Gladiolus corms (2000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II"**.	Sh. Raj Kumar S/o Dhuni Chand, Tehsil Shimla, Deothi (250), Shimla, (H.P.) -171007	**03.01.2025**
110	Material Transfer Agreement (MTA) for Gladiolus corms (3000 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II".**	Smt. Rajni Devi C/o Anupam Sharma, Village Lolehar (717), Post Office - Kachhiari, Kangra, Himachal Pradesh -176001	**03.01.2025**
111	Material Transfer Agreement (MTA) for Ponytail palm (01 Nos.), Araucaria (02 Nos.), Bottle palm (02 Nos.), Ficus (02 Nos.), Nerium (05 Nos.), Ashoka (03 Nos.), Bougainvillea (03 Nos.) and Sago palm (01 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II"**	Smt. Shabnam Sharma, Principal, Government Senior Secondary School, Saliana, Dist. Kangra- 176103, (H.P.)	**03.01.2025**

S. No.	Title of Agreement	Name of Party	Date of signing
112	Material Transfer Agreement (MTA) for Ponytail palm (01 Nos.), Araucaria (02 Nos.), Bottle palm (02 Nos.), Ficus (02 Nos.), Nerium (05 Nos.), Ashoka (03 Nos.), Bougainvillea (03 Nos.) and Sago palm (01 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II"**	Sh. Shubh Karan, Principal, PM Shri Government Utkrisht Senior Secondary School, Paprola, Dist. Kangra - 176115, (H.P.)	**03.01.2025**
113	Material Transfer Agreement (MTA) for Ponytail palm (01 Nos.), Araucaria (02 Nos.), Bottle palm (02 Nos.), Ficus (02 Nos.), Nerium (05 Nos.), Ashoka (03 Nos.), Bougainvillea (03 Nos.) and Sago palm (01 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II"**	Sh. Man Singh, Principal, Government Senior Secondary School, Rakkar, Teh. Baijnath, Kangra-176063, (H.P.)	**03.01.2025**
114	Material Transfer Agreement (MTA) for Ponytail palm (01 Nos.), Araucaria (02 Nos.), Bottle palm (02 Nos.), Ficus (02 Nos.), Nerium (05 Nos.), Ashoka (03 Nos.), Bougainvillea (03 Nos.) and Sago palm (01 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II"**	Sh. Sikander Kumar, Principal, GAV Senior Secondary School, Saliana, Palampur, Kangra-176103, (H.P.)	**03.01.2025**
115	Material Transfer Agreement (MTA) for Golden Cyprus (05 Nos.), Euphorbia (02 Nos.), Green Cyprus (02 Nos.), Araucaria (01 Nos.), Hibiscus (05 Nos.), Dracaena (05 Nos.), Box wood (10 Nos.), Schefflera (05 Nos.), Ashoka (03 Nos.), Thuja (03 Nos.), Nerium (05 Nos.), Duranta (20 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II"**	Sh. Sanjay Sharma, Principal, Bharti Vidya Peeth Public Senior Secondary School, Baijnath, Dist. Kangra- 176125, (H.P.)	**06.01.2025**
116	Material Transfer Agreement (MTA) for Golden Cyprus (05 Nos.), Euphorbia (02 Nos.), Green Cyprus (02 Nos.), Araucaria (01 Nos.), Hibiscus (05 Nos.), Dracaena (05 Nos.), Box wood (10 Nos.), Schefflera (05 Nos.), Ashoka (03 Nos.), Thuja (03 Nos.), Nerium (05 Nos.), Duranta (20 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II"**	Sh. Vivek Kumar, Principal, Sarswati Vidya Mandir High School, Baijnath, Dist. Kangra-176125, (H.P.)	**06.01.2025**
117	Material Transfer Agreement (MTA) for Golden Cyprus (05 Nos.), Euphorbia (02 Nos.), Green Cyprus (02 Nos.), Araucaria (01 Nos.), Hibiscus (05 Nos.), Dracaena (05 Nos.), Box wood (10 Nos.), Schefflera (05 Nos.), Ashoka (03 Nos.), Thuja (03 Nos.), Nerium (05 Nos.), Duranta (20 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II"**	Smt. Shailja, Principal, Sarswati Vidya Mandir, Paprola, Dist. Kangra-175115, (H.P.)	**06.01.2025**
118	Material Transfer Agreement (MTA) for Golden Cyprus (05 Nos.), Euphorbia (02 Nos.), Green Cyprus (02 Nos.), Araucaria (01 Nos.), Hibiscus (05 Nos.), Dracaena (05 Nos.), Box wood (10 Nos.), Schefflera (05 Nos.), Ashoka (03 Nos.), Thuja (03 Nos.), Nerium (05 Nos.), Duranta (20 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II"**	Sh. Rajan Sharma, Superintendent G-II , Government Degree College, Baijnath, Dist. Kangra- 176125, (H.P.)	**06.01.2025**
119	Material Transfer Agreement (MTA) for Golden Cyprus (05 Nos.), Euphorbia (02 Nos.), Green Cyprus (02 Nos.), Araucaria (01 Nos.), Hibiscus (05 Nos.), Dracaena (05 Nos.), Box wood (10 Nos.), Schefflera (05 Nos.), Ashoka (03 Nos.), Thuja (03 Nos.), Nerium (5 No.), Duranta (20 No.) provided free of cost under **"CSIR Floriculture Mission Phase-II"**	Smt. Renu Sharma, Binwa Public Senior Secondary School, Baijnath, Kangra - 176125	**06.01.2025**
120	Material Transfer Agreement (MTA) for Ponytail palm (01 Nos.), Araucaria (02 Nos.), Bottle palm (02 Nos.), Ficus (02 Nos.), Nerium (05 Nos.), Ashoka (03 Nos.), Bougainvillea (03 Nos.) and Sago palm (01 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II"**	Sh. Lalit Kumar, Head Master, Government High School Majherna, Teh. Baijnath, Distt Kangra-176063, (H.P.)	**08.01.2025**
121	Material Transfer Agreement (MTA) for Golden cyprus (03 Nos.), Pencil pine (03 Nos.), Green cyprus (03 Nos.), Schefflera (05 Nos.), Nerium (05 Nos.) Dracenea (05 Nos.), Fishtail Palm (03 Nos.), Hibiscus (05 Nos.) and Hemelia (10 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II"**	Sh. Shesh Raj , TGT (A), Government High School, Sagoor, Baijnath, Distt Kangra-176063, (H.P.)	**08.01.2025**

S. No.	Title of Agreement	Name of Party	Date of signing
122	Material Transfer Agreement (MTA) for Golden cyprus (03 Nos.), Pencil pine (03 Nos.), Green cyprus (03 Nos.), Schefflera (05 Nos.), Nerium (05 Nos.), Dracenea (05 Nos.), Fishtail Palm (03 Nos.), Hibiscus (05 Nos.) and Hemelia (10 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II"**	Smt. Raksha Devi, JBT, Global public central School, Sagoor, Baijnath, Distt Kangra- 176063, (H.P.)	**08.01.2025**
123	Material Transfer Agreement (MTA) for Money Plant (30 Nos.), Spider Plant (30 Nos.), Rohio plant (30 Nos.) and Shatavari (30 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II"**	Manjeet Bajaj, Pradhan , Gram Panchyat Majherna, Teh Baijnath, Distt Kangra-176063, (H.P.)	**09.01.2025**
124	Material Transfer Agreement (MTA) for Money Plant (30 Nos.), Spider Plant (30 Nos.), Rohio plant (30 Nos.) and Shatavari (30 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II"**	Renu Bala, Medical Incharge, Ayush Health Clinic, Majherna Khas, Teh. Baijnath, Distt Kangra-176063, (H.P.)	**09.01.2025**
125	Material Transfer Agreement (MTA) for Money Plant (45 Nos.), Spider Plant (30 Nos.), Rohio plant (30 Nos.) and Shatavari (30 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II"**	Sh. Ravinder Kumar, Principal, Government Industrial Training Institute, Saliana Distt Kangra-176063, (H.P.)	**09.01.2025**
126	Material Transfer Agreement (MTA) for Schefflera (10 No.), Euphorbia (05 Nos.), Golden Cyprus (05 Nos.), Thuja (05 Nos.), Boxwood (30 Nos.), Ficus (05 Nos.), Fishtail palm (05 Nos.), Poney tail Palm (04 Nos.), Hemelia (05 Nos.), Araucaria (03 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II"**	Sh. Ravinder Kumar, Principal, Government Industrial Training Institute, Saliana Distt Kangra-176063, (H.P.)	**09.01.2025**
127	Material Transfer Agreement (MTA) for Euphorbia (10 Nos.), Schefflera (10 Nos.), Spider plant (20 Nos.), Ponytail palm (01 Nos.), Golden Cyprus (04 Nos.), Thuja (05 Nos.) and Dracaena (10 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II"**	Dr. Sanjay Gupta, Principal, Shaheed Captain Vikram Batra Government College, Palampur, Himachal Pradesh -176061	**10.01.2025**
128	Material Transfer Agreement (MTA) for Money plant (80 Nos.) and Rohio (40 Nos.) provided free of cost under **"CSIR Floriculture Mission Phase-II"**	Dr. Sanjay Gupta, Principal, Shaheed Captain Vikram Batra Government College, Palampur, Himachal Pradesh -176061	**10.01.2025**
129	Material Transfer Agreement (MTA) for Grafted rose plant (3500 Nos.) provided 10% actual price under **"CSIR Floriculture Mission Phase-II".**	Sh. Lalit Sharma S/o Ramesh Sharma, #1710/2, Sector-39B, Chandigarh - 160036	**17.02.2025**
130	Material Transfer Agreement (MTA) for Stevia Seeds (4 kg) provided under " **MLP-0202".**	Sh. J.A.C.S. Rao, CEO, Chhattisgarh Tribal Local Local Health Traditions & Medicinal Plant Board Raipur, Chhattisgarh, Zero Point, Raipur, Chhattisgarh- 492007	**21.02.2025**
131	Material Transfer Agreement (MTA) for Stevia Seeds (100 gm) under " **MLP-0202".**	Ms. Heena Vashisht, Modi Mohalla Bazaar UNA (H.P.)	**03.03.2025**
132	Material Transfer Agreement (MTA) for Aromatic Marigold Seeds (50 kg) provided under " **CSIR Aroma Mission Phase-III**".	Sub Divisional Agriculture Office Marh, Distt Jammu, Pin 180002	**06.03.2025**
	BIOTECHNOLOGY		
1	Material Transfer Agreement (MTA) on "Violacein pigment biomolecule (2.4 gms) from the Himalayan Microbes"for need-based R&D collaboration	Mr. Adesh M. Shah and Mr. Bishrut Jayaswal, B-34, Dariya Mahal, Nepesansea Road, Mumbai-400006, Maharashtra, India	**24.09.2024**
2	Material Transfer Agreement (MTA) for Valeriana Jatamansi seeds (100 Grams) under **MLP-0202**	Mr. Mohsin Ali Shirazi, 7/3 Aga Abdullah Street, Richmond Town, Bangalore 560025, Karnataka	**18.11.2024**

MISCELLANEOUS MOUs

S. No.	Title of Agreement	Name of Party	Date of signing
	BIOTECHNOLOGY		
1	MoU for develop the Industry in Africa through introduction modern methods of tissue culture, Hydroponic, and Aeroponic methods of growing plants and Himalayan high value floriculture and aromatic crops	Empowering Farmers Foundation (EFF), 9th floor, Harbour View Tower Samora Avenue-Dar es salaam, Tanzania- P.O. Box 77817	**02.07.2024**
2	Confidentiality Agreement for process for production of dual bio-product (bioplastic and violacein pigment) from Himalayan Bacterial isolate PCH194 and either isolates utilizing waste material	M/s Adesh M. Shah and Mr. Bishrut Jayaswal, B-34, Dariya Mahal, Nepesansea Road, Mumbai- 400006, Maharashtra, India	**05.08.2024**

S. No.	Title of Agreement	Name of Party	Date of signing
3	Agreement for establishing set up of Municipal Solid Waste Disposal System under a collaborative project	Darjeeling Municipality, Laden La Road, Chauk Bazaar, Darjeeling, West Bengal 734101 and CSIR- Central Mechanical Engineering research Institute, Mahatma Gandhi Road, opposite NIT, City Center, Durgapur, West Bengal 713209 (Incubation)	**22.10.2024**
4	MoU for microbial based bio formulations	V S Lignite Power Private Limited, Trendz Inspire, 4th Floor, Plot No. 265, Survey No. 43P,44P,45,46 and 48, Kavuri Hills, Guttala Begumpet, Hyderabad, Telangana-500081	**02.02.2025**
	CHEMICAL TECHNOLOGY		
1	MoU for Electrohomepathic Medicines, food supplements, spagyric essence working in the areas of manufacturing and research of electrohomeopathic/spagyric medicines	Parteek True Herbals, Ajitwal, Moga, Punjab	**28.10.2024**
2	Confidentiality Agreement for extraction of steviol glycosides	VKDP Life Science Private Limited, NCC Urban One, Narsingi, Hyderabad, 5000075	**06.12.2024**
	FOOD TECHNOLOGY		
1	Confidentiality Agreement for Shiitake Mushroom cultivation and its value addition for commercializing	Mushroom Development Foundation, 32, Lamb Road, Ambari, Guwahati, 781001, Assam, India	**30.05.2024**
2	Confidentiality Agreement for Shiitake mushroom cultivation and its value addition	Mushroom Development Foundation, 32, Lamb Road, Ambari, Guwahati, 781001, Assam, India	**03.12.2024**
	AGROTECHNOLOGY		
1	MoU for procure essential oils from the farmers doing cultivation and extraction of aromatic crops	Purvik Global, A/104 Vishwas City- 6, Opp. Vishwas City- 5, Near Auda Water Tank Gota, Ahmedabad, Gujarat- 382481, India	**10.05.2024**
2	MoU for Joint collaboration in the area of essential oil	SAMA Essentials, S-18, CPL Mansion, Gurdaspur Road, Pathankot, Punjab 145001	**11.05.2024**
3	MoU for Joint collaboration in the area of essential oil	M/s LIVE NATURALLY Limited, Sai Sahaj Angan, Shop-3, Plot-24, Sector-4, Pune, Naisk Road Mosdji Pune-412105	**12.06.2024**
4	MoU for Joint collaboration in the area of essential oil	M/s Parwaaz Organics, Booth No. 145, Urban estate, Phase 2, Jalandhar, 144022	**21.06.2024**
5	MoU for Joint collaboration in the area of essential oil	GSM Global Service, Gali No. 18 Shivaji Nagar, Rishikesh, Dehradun 249203, Uttarakhand, India	**16.07.2024**
6	MoU for Refrigerated Van facility for post-harvest handling of lilium and other cut-flower crops from farmers field to flower market under "**CSIR-Floriculture Mission Phase-II**"	Green Vedam Pvt. Ltd., No. 4739, Sector 11, Urban Estate, Jind, Haryana, 126102	**06.08.2024**
7	MoU for Refrigerated Van facility for post-harvest handling of lilium and other cut-flower crops from farmers field to flower market under "**CSIR-Floriculture Mission Phase-II**"	Shansha Flower & Vegetable Pro Sfurti Cluster, Post Office Gondhla, Tehsil Keylong, Thorang, Distt Lahul & Spiti (H.P.)	**12.08.2024**
8	Collaboration Agreement for Development of botanical formulation from plant extracts and seed oil of Triadica sebifera (L.) Small for the control of aphid, Aphis craccivora Koch	Centre for Cellular and Molecular Platforms, NCBS-TIFR Campus, GKVK Post, Bellary Road, Bangalore- 560065 an d CSIR-Central Institute of Medicinal and Aromatic Plants, P.O CIMAP, Near Kukrail Picnic Spot, Lucknow- 226015, Uttar Pradesh	**06.09.2024**
9	MoU for Joint collaboration in the area of essential oil	M/s Tuvai Nature Pvt. Lt.d, Koderma, Jharkhand	**20.09.2024**
10	MoU for R&D Collaboration in the area of aromatic crops, essential oils, floriculture, tissue culture and/or any other area mutually decided areas	Rural Technology and Development Centre, V.P.O Kamlehar, Tehsil Palampur, Distt Kangra (H.P)	**23.09.2024**
11	MoU for Joint collaboration in the area of essential oil	M/s Natural BioTech Products, V.P.O Baggi, Distt Mandi, Pin 175027, (H.P.)	**23.09.2024**
12	MoU for Refrigerated Van facility for post-harvest handling of lilium and other cut-flower crops from farmers field to flower market under "**CSIR-Floriculture Mission Phase-II**"	M/s Dhariti Agro Farms Pvt. Ltd., Vill Kheda, Goula Par, Haldwani, Nainital, Uttrakhand-263139	**26.09.2024**
13	MoU for distillation unit for extraction of essential oil and sell the products	Meghalaya Basin Development Auhotiy (MBDA), Upper Nogrim Hills, Meghalaya-793003 and Farmer Malai Sohmat Protection Group, East Khasi Hills	**28.01.2025**

S. No.	Title of Agreement	Name of Party	Date of signing
14	MoU for distillation unit for extraction of essential oil and sell the products	Meghalaya Basin Development Auhotiy (MBDA), Upper Nogrim Hills, Meghalaya-793003 and Pynbhami Multipurpose Co. Operative Society, West Jaintia Hills (WJH), Thadmuthlong C, Pharmer Village, Laskein Block,	**29.01.2025**
15	MoU for distillation unit for extraction of essential oil and sell the products	EWOK Mid-Himalayan Farmer Producer Company Limited, Village Salgi , P.O. Kamand, Tehsil Sadar, District Mandi-175005	**12.03.2025**
16	MoU for distillation unit for extrection of essentail oil and sell the products	Dhanvantri Gram Sangthan, Village Patta Jatian, PO Jakhara, Tehsil Fatehpur, Distt Kangra (H.P.)	**15.03.2025**
	ENVIRONMENTAL TECHNOLOGY		
1	MoU for designing and developing a Dry Toilet with dry-flush system	CSIR-NEERI,Nagpur, Maharastra, 440020 and Lahol Society, Registration No. 1/ Lahaul/2010, Near Shashur Monastery, V.P.O Keylong, Tehsil Lahaul, Distt Lahaul and Spiti, (H.P.)	**06.08.2024**
2	MoU for designing and developing a Dry Toilet with dry-flush system	CSIR-NEERI,Nagpur, Maharastra, 440020 and Krishak Vikas Sabha, V.P.O Marbal, Tehsil Lahaul, Distt Lahaul and Spiti, (H.P.)	**06.08.2024**
3	MoU for designing and developing a Dry Toilet with dry-flush system	CSIR-NEERI,Nagpur, Maharastra, 440020 and Gram Vikas Sehkari Sabha, V.P.O Thorang, Tehsil Lahaul, Distt Lahaul and Spiti, (H.P.)	**06.08.2024**
4	MoU for designing and developing a Dry Toilet with dry-flush system	CSIR-NEERI,Nagpur, Maharastra, 440020 and Jyoti Mahila Mandal, V.P.O Mooling, Tehsil Lahaul, Distt Lahaul and Spiti, (H.P.)	**06.08.2024**
	MISCELLANEOUS		
1	Non-Disclosure Agreement for R&D Collaboration	PANACEA BIOTECH Limited, Ambala-Chandigarh Highway, Lalru- 140501, Punjab, India	**01.05.2024**
2	Agreement for need based R&D project (sponsorship by party) for co-development (New Product) and value addition (in the existing products)	M/s Baijnath Pharmaceutical Private Limited, Paprola, Baijnath, (H.P)	**13.05.2024**
3	Confidentiality Agreement for designed Low cost indigenized bioreactor system	M/s Gupta Scientific Industry, #57 Industrial Estate H.S.I.D.C., Ambala Cant-133006, Haryana	**27.05.2024**
4	MoU for Strategic partnership as well as implementation based principles of mutual strengths and benefits for the purpose of livelihood promotion and rural development in Chamba District, Himachal Pradesh	Deputy Commissioner/DRDA, Chamba, (H.P.)	**19.07.2024**
5	Confidentiality Agreement for lab scale for Natural color plants/vegetables sources	M/s Softbio Pharma Pvt. Ltd., J1/144 GF Khirki Extension, Adj. Krishna Temple, New Delhi-17	**21.08.2024**
6	Confidentiality Agreement for R&D Hopes (Cultivation & Quality Assessment)	Oi Brewing Company, Gate No. 1295-1-10, 1296-1-10, 1140, 1122 & 12129 Shirwal, Tal, Khandala, Satara, 412802, India	**06.09.2024**
7	MoU for manage and strengthen knowledge for natural resources and sustainable livelihoods by joint research and extension project which will benefit the state of Meghalaya	Institute of Natural Resources (INR), Meghalaya, Lachumiere, Shillong- 793001	**17.10.2024**
	ACADEMICS		
1	MoU for Cooperation in rersearch and academic activites in the designated Subject of Biotechnolgy, Bioinformatics, Chemcial science or any other field/discipline of mutual interest	University of Petroleum and Energy Studies, Dehradun , Uttarakhand	**01.04.2024**
2	MoU for Academic and Research Collaboration	National Institute of Technology (NIT), Delhi, Plot No. FA 7, Zone P1, GT Karnal Rd, Delhi, 110036	**08.08.2024**
3	Umbrella MoU for R&D and Academic Collaboration	ICAR- Indian Veterinary Research Institute, Izatnagar, Bareilly (U.P.), 243122, India	**05.09.2024**
4	MoU for R&D and Academic Collaborations	D.D.U. Gorakhpur University, Gorakhpur, India- 273 009	**17.10.2024**
5	MoU for R&D and Academic Collaborations	Axis Institute Of Pharmacy,Milestone- 478, NH-2, Chakeri Ward, Hathi Pur, Rooma, 209402 Kanpur (U.P.)	**20.12.2024**
6	MoU for R&D and Academic Collaborations	Govt. Arya Degree College, Nurpur, Kangra-176202 (H.P.)	**20.01.2025**

AGREEMENTS WITH INCUBATEES/ START-UPS

S. No.	Title of Agreement	Name of Party	Date of signing
	BIOTECHNOLOGY		
1	Agreement under "CM Startup Scheme" for "Tissue culture and Aeroponic cultivation of Dragon Fruit and Potato	Mr. Akshay Kumar, Village Gurer, Distt Kangra	15.04.2024
2	Agreement under "CM Startup Scheme" "Tissue culture and Hydroponic Cultivation of Persimmon and Black Berry".	Mr. Prateek Sharma, Village Langhu, Distt Kangra	15.04.2024
3	Agreement under "CM Startup Scheme" for Production of Honey Wine "Mead"	Mr. Arun Kumar, V.P.O Guglehr, Sub Tehsil Gagret, Kaloh	16.04.2024
4	Agreement Under "CM Startup Scheme" for "Hydroponic production of withania somnifera"	Mr. Sagar Chand, Village & P.O Dohag, Tehsil Jogindernagar, Distt Mandi- 175015 (H.P.)	21.10.2024
5	Agreement Under "CM Startup Scheme" for "Saffron production under controlled condition and throughout the year round supply"	Mr. Chirag Chand, Vill Plassi Bajar, P.O. Dhurkhari, Landmark Near UCO Bank, Plassi, Tehsil Baldwara, Distt Mandi (H.P.)-175034	29.10.2024
	CHEMICAL TECHNOLOGY		
1	Agreement Under "CM Startup Scheme" for " Herbal Tilak from Natural Sources".	Ms. Nikita Chouhan, Vill Barohal, P.O. Panchrukhi, Tehsil Palampur , Distt Kangra 176103 (H.P.)	21.10.2024
	FOOD TECHNOLOGY		
1	Agreement under "CM Startup Scheme" for "production of Peanut Butter Incorporated with local Millets"	Mr. Anoop Kumar, Village Gabli Dari, P.O. Dari, Tehsil Dharamshala, Distt Dharamshala	22.04.2024
2	Agreement Under "CM Startup Scheme" for "Development of honey based beverage viz. Lemon honey and rhododendron flower with honey".	Mr. Purushotam Lal, Vill Dhara, P.O Fozal, Tehsil & Distt Kullu 175129 (H.P.)	16.10.2024
3	Agreement Under "CM Startup Scheme" for "Development of honey based emulsion spread".	Mr. Chand Kishor, Vill Dhara, P.O Fozal, Tehsil & Distt Kullu 175129 (H.P.)	16.10.2024
4	Agreement Under "CM Startup Scheme" for "Value addition of Spirulina platensis towards production of ready to use foods and healthy snacks".	Ms. Preeti katoch, 22 Civil Lines Dharamshala, 176215 (H.P)	05.11.2024
	AGROTECHNOLOGY		
1	Agreement under "CM Startup Scheme" "Tissue culture of ornamental plants and nursery raising"..	Mr. Nitin Azad, Village Barain, P.O. karot, Tehsil Sujanpur, Distt Hamirpur 176108 (H.P.)	09.10.2024
2	Agreement Under "CM Startup Scheme" for "Making of flower based resin encapsulated products such as coaster, paper weight, jewellery and table tops etc."	Ms. Seema Kumari, Village and P.O. Banuri, Tehsil Palampur, Distt Kangra 176061 (H.P.)	22.10.2024
3	Agreement Under "CM Startup Scheme" for "Himalayan Organic Herbs"	Mr. Gurinder Kumar Vashist, S/o Sh. Kamal Parkash, Green City, Raikot- 141109	05.11.2024
4	Agreement Under "CM Startup Scheme" for "Development and Marketing of Green/Black Tea, Honey, Essential Oil, and Rose Water".	Mr. Tanishq Sodhi, Village Rajpur, PO Tanda, Tehsil Palampur Distt Kangra-176062 (H.P.)	21.11.2024
	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.)	23.10.2024
2	Agreement for R&D and analytics facility	Malkana Research Lab, Palampur, Thala Warla Road, Near Health Dispensary Dargunu, Village Darugno, Tehsil Palampur, District Kangra 176061 (H.P.)	05.11.2024
	NEED BASED AGREEMENT		
1	Agreement for R&D activities on bioresource for catalyzing bioeconomy in a sustainable manner	Alternative Protein Solution Pvt. Ltd. (Good Food Institute India), HD-168, WeWork Chromium, CTS No. 106, 106/1-5, Jogeshwari-Vikhroli Link Road (JVLR), Near L & T Junction, Milind Nagra, Powai, Mumbai, Maharashtra, India, 400076	31.07.2024

MISSION MODE PROJECTS

CSIR-AROMA MISSION

Nodal: Dr. Sanjatsujat Singh

Co-Nodal: Dr. Rakesh Kumar

CSIR-IHBT INTERVENTIONS UNDER CSIR-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 wastelands. 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 2024 to March 2025 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	1200 kg	500 kg
2	Damask rose	70000 rooted plants	51265 rooted plants
3	Rosemary	50000 plants	25523 plants
4	Palmarosa	50 kg	35 kg
6	Geranium	25000 plants	10226 plants
7	Chamomile	100 kg	60 kg
8	Lavender	50000 plants	27155 plants
9	Lemon grass	10 lakhs	5 lakhs

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

New variety of aromatic crops were evolved

The variety 'Him Kanti' of German Chamomile has been developed through half-sib progeny selection approach. The selection recorded high capitulum yield (4.08 t /ha) and essential oil content (3.49 g/kg) in Himachal Pradesh.

The variety 'Him Aarohi' of Lavender has been developed through hybridization and clonal selection approach. The CSIR-IHBT- LOH15141 is a F1 clone developed by hybridization between 'SeK-1' and 'No9'. This F1 clone has high spike yield (4.84 t/ha) and essential oil content (12.59 g/kg) in Himachal Pradesh.

Training and awareness programmes for skill development

Between April 2024 and March 2025, a total of twenty-three 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 2024 to March 2025 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	Kangra	CSIR-IHBT	24/04/2024	3	0	3
2	Himachal Pradesh	Kangra	CSIR-IHBT	2/5/2024	0	1	1
3	Himachal Pradesh	Kangra	CSIR-IHBT	9/5/2024	3	1	4
4	Himachal Pradesh	Mandi	IIT Kamand, Mandi	13/06/2024	13	9	22
5	Himachal Pradesh	Chamba	CSIR-IHBT	26/06/2024	2	0	2
6	Himachal Pradesh	Mandi	Chailchowk, Mandi	28/06/2024	16	11	27
7	Himachal Pradesh	Kangra	CSIR-IHBT	3/7/2024	16	9	25
8	Himachal Pradesh	Kangra	CSIR-IHBT	8/7/2024	1	16	17
9	Himachal Pradesh	Kangra	CSIR-IHBT	10/7/2024	16	13	29
10	Himachal Pradesh	Kangra	CSIR-IHBT	12/7/2024	4	4	8
11	Himachal Pradesh	Kangra	CSIR-IHBT	18/07/2024	5	0	5
12	Himachal Pradesh	Kangra	Vill. Dhobar Teh. Bangana, Una	29/07/2024	8	4	12
13	Himachal Pradesh	Kangra	CSIR-IHBT	22/08/24	12	4	16
14	Himachal Pradesh	Kangra	CSIR-IHBT	30/08/2024	22	2	24
15	Himachal Pradesh	Kangra	CSIR-IHBT	30/09/2024	6	0	6
16	Himachal Pradesh	Kangra	Vill. Kandkosri Teh. Baijnath, Kangra	1/10/2024	9	3	12
17	Himachal Pradesh	Una	Vill. Chowki Maniar, Teh. Bangana, Una	16/10/2024	6	0	6
18	Himachal Pradesh	Kangra	CSIR-IHBT	18/10/2024	5	0	5
19	Himachal Pradesh	Kangra	CSIR-IHBT	21/11/2024	5	0	5
20	Himachal Pradesh	Kangra	CSIR-IHBT	29/01/2025	1	3	4
Total					**153**	**80**	**233**

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	Meghalaya	East Khasi Hills	Thadmuthlong C Phramer, WJH	03/09/2024 and 04/09/2024	19	21	40
2	Himachal Pradesh	Kangra	CSIR-IHBT	13/09/2024	40	20	60
3	Himachal Pradesh	Kangra	CSIR-IHBT	23/09/2024	65	35	100
Total					**124**	**76**	**180**

Exposure visit by Agriculture students of Banaras Hindu University

Training to farmers associated with Village Forest Development Council, Chailchowk, Mandi

Training on post-harvest management, Una

Training held at Kandkosri, Baijnath

Fig. 2 CSIR–IHBT organized a series of training programs at multiple locations to reach a wider farming community and promote the adoption of aromatic crop technologies across diverse regions.

Fig. 3 Farmers, Scientist & Industry Meet conducted on 23/09/2024 at CSIR-IHBT.

Fig. 4 Farmers developed a range of value-added products using technologies transferred by CSIR–IHBT, enhancing both product diversity and market potential.

Fig. 5 Skill Development program held at Thadmuthlong C Phramer, WJH, Meghalaya for the farmers from 03/09/2024 to 04/09/2024.

Fig. 6 Essential oil of aromatic marigold produced by a farmer was processed at CSIR–IHBT's distillation unit and handed over to the industry partner in the presence of the Director and scientists of CSIR–IHBT.

CSIR FLORICULTURE MISSION-II

Nodal: Dr. Bhavya Bhargava

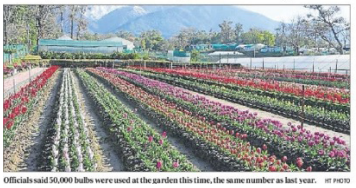
Co-Nodal: Dr. Poonam Kumari

The CSIR-Floriculture Mission aims to boost farmers' income and promote entrepreneurship through high-value floriculture using CSIR technologies. To support large-scale cultivation, CSIR-IHBT produced around 52.19 lakh quality planting materials and brought 170 hectares under floricultural crops. The institute conducted 49 training and awareness programs focused on cultivation techniques and value addition, including flower dehydration, benefiting 1,721 participants comprising farmers and students. Additionally, 50 school gardens in Himachal Pradesh and Haryana and 10 vertical gardens in public sector offices were developed to promote green initiatives. Under Phase II, efforts were scaled through partnerships and outreach. A total of 109 Material Transfer Agreements (MTAs) were signed with farmers and schools across different states to facilitate access to planting materials and technical know-how. Furthermore, 7 technologies were transferred and 3 Memorandums of Understanding (MoUs) were formalized with various organizations. On 26th February 2025, three new gerbera varieties—Him Kumud, Him Prabha, and Him Aruna—were released by Dr. Jitendra Singh, Hon'ble Minister of Science & Technology and Vice-President of CSIR, marking a significant milestone in floricultural innovation. Several farmers and stakeholders were honored with the **Rose Puraskar** for their contributions to floriculture. Mrs. Meena Sunil Chandel (Bilaspur) and Sh. Gurvinder Sohi (Punjab) received the award during the Outlook Agritech Summit in New Delhi. Others, including Sh. Prem Chand (Lahaul), Ms. Tashi Angmo and Dr. Abass Hashim (Ladakh), Smt. Kamla Devi (Mandi), and representatives from the industry such as Sh. Balbir Singh Kambhoj, Sh. Arjun Singh, and Dr. Rigzen Tsewang, were felicitated during the **Tulip Festival and National Symposium on Ornamental Bulbous Plants** held on 18–19 February 2025. CSIR-IHBT organized multiple **Pushp Krishi Melas** under the CSIR Floriculture Mission II, including events on its 42nd Foundation Day (July 2, 2024), **Janjatiya Gaurav Diwas** (Nov 20, 2024), the **One Week One Theme** program (Nov 5, 2024), and during the **Tulip Festival and National Symposium** (Feb 18–19, 2025), focusing on tulip and lilium bulb production for farmers.

Lilium bulb production at Leh, Ladakh.

[FIRST TIME SINCE OPENING IN 2022]

Footfall at Palampur's Tulip Garden crosses 1-lakh mark



HT Correspondent
letters.hp@hindustantimes.com

DHARAMSHALA : The vibrant blooms at Palampur's Tulip Garden drew 1 lakh visitors this year, a first since the garden was inaugurated in 2022, officials said.

They said that last year, the garden saw a footfall of around 80,000 visitors. The garden remained open for visitors from February 26 to March 30 this year.

The facility, which is Himachal's first Tulip Garden, was developed by CSIR-Institute of Himalayan Bioresource Technology (IHBT), Palampur.

Tulips are bulbous cut flowers that have a significant international and domestic demand. It ranks third in the world's top cut flower trade.

The institute first imported tulip bulbs from Holland in 2018 and started trials for localised production.

This year, seven varieties of tulips, strong gold (yellow), laptop (purple), mount tacoma (white), lucky one (bright red), pink breeze (pink), 1all bela (orange) and rodio drive (red) have been grown in the garden.

Officials said 50,000 bulbs were used at the garden this time, the same number as last year.

Officials said 50,000 bulbs were used at the garden this time, the same number as last year. HT PHOTO

News clipping on Tulip Garden 4.0.

Pushp Krishi Mela" as a part of CSIR Floriculture Mission II to celebrate the institute's 42nd foundation day on July 2, 2024.

Pushp Krishi Mela was held on the occasion of Tulip Festival and national symposium on ornamental bulbous plants.

Training cum awareness program on Commercial Floriculture given to students and teachers from GSSS Marhi Mandi 27.03.2025.

Visit to farmer's field in district Mandi and Kullu Himachal Pradesh.

WASTE TO WEALTH: COMPREHENSIVE SOLUTIONS TOWARDS CIRCULAR ECONOMY AND SUSTAINABILITY

Theme: CSIR Mission Mode Project

Principal Investigator: Dr. Sarita Devi

The Waste-to-Wealth Mission aims to improve waste processing science to develop a country with zero landfills and zero waste. Through research and innovation, all 38 CSIR laboratories contribute to maximize the benefits to society by making use of waste. CSIR-IHBT aims to develop psychrotrophic microbial consortia that will effectively break down organic waste (solid and liquid) in anaerobic environments, resulting in improved biomethane production. In order to evaluate these microbial consortia, an anaerobic gas lift reactor (AGR) established by CSIR-IICT has been utilised in the cold Himalayan region. Apart from this, CSIR-IHBT is also trying to develop process technology for faecal sludge fertilizer production by developing microbial consortia.

1. Improvement of biomethanation and enrichment of biogas (Bio-CNG) in Himalayan regions

For the biogas production in 20L batch scale, the food waste was collected from the Hostel Mess at CSIR-IHBT, while cow dung was sourced from a nearby cattle farm **(Fig. 1)**. A 50L anaerobic digester was prepared by filling it with shredded food waste, cow dung, and a microbial consortium in a 1:1:1 ratio, reaching a total volume of 20L, with the remaining space left for biogas production. The digester was fed weekly, and samples were collected regularly to analyze various parameters, including pH, COD, volatile fatty acid (VFA), and alkalinity.

Fig. 1 Microbial Consortia; food waste and cow dung slurry.

Psychrophilic microbial consortia gave significant performance at 14-20^{0}C. The pH value ranged from 6.2- 7.4 and reduction in total solids (TS) and volatile solids (VS) signified the liquefaction of substrate. Three reactors were set up, each supplemented with a different combination of food waste and microbial consortia. Reactor 1 (Control) contained food waste, cow dung, and distilled water. Reactor 2 (T1) included food waste, cow dung, and a microbial consortium of 10 isolates with the highest hydrolytic index. Reactor 3 (T2) contained food waste, cow dung, and a microbial consortium with all 20 isolates. The biogas production obtained for each reactor are shown in **Fig. 2**.

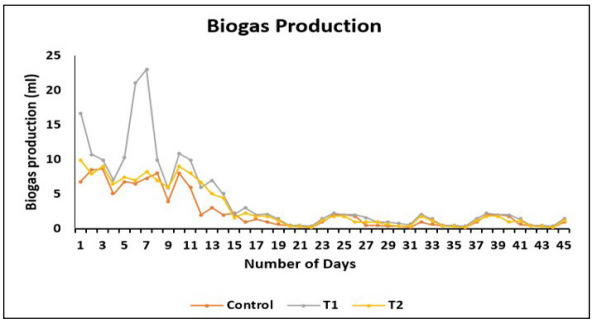


Fig. 2 Biogas production.

Reactor T1 had shown the good performance, which was supplemented with a selective microbial consortium of 10 isolates showing high hydrolytic activity as compared to control and T2 with TS reduction (42.86%), VS reduction (47.30%), COD removal (23.45%), indicating enhanced organic matter, VFA degradation (32.01%), and biogas production (194 L). These results emphasized that Reactor T1, with a selectively curated microbial consortium, was the most effective in enhancing organic matter degradation and biogas yield, underscoring the potential for targeted microbial consortia in optimizing anaerobic digestion processes.

2. Process technologies to create WEALTH from Biotic Wastes: Special reference to Faecal sludge and Biomedical wastes

For In-vessel co-composting, kitchen waste and dry leaves, microbial consortia and the recycled plastic compost bins with feeding capacity of 20L were used. The in-vessel co-composting study was carried out, for checking the efficiency of consortia in composting process, for which kitchen waste was collected from the Indian army

waste management site, Holta, Palampur, and the dry leaves were collected from fields at CSIR-IHBT, Palampur. The composting inoculum was made by mixing Biochar: Cocopeat: Consortia in the ratio 1:1:2. Composting bins were filled with kitchen waste: dry leaves: composting inoculum in the following ratio, (10:1):1. The composting experiment was set up for following treatments in triplicates as follows: Test- containing composting inoculum; Control- containing carrier only, without consortia. The composting period lasted for 30 days, and during this period the feedstock was mixed thoroughly by hand. During the composting, temperatures were measured, using a digital thermometer (range: 20–100°C). Triplicate composite samples were collected periodically after every turning and mixing. For each treatment group, samples were randomly collected from different points and mixed to obtain composite samples. The pH, electrical conductivity (EC), and moisture content were analyzed using digital pH and EC meter (Eutech, India) and a moisture analyzer (Shimadzu, Japan), respectively. The determination of organic matter (OM), total organic carbon (TOC), total nitrogen (TN), and total phosphates (TP) were done as per the standard methods for testing compost materials (Rice et al., 2017). The metal elements i.e., Zinc (Zn), Magnesium (Mg), Manganese (Mn), Iron (Fe), Copper (Cu), Cadmium (Cd), Lead (Pb), and Chromium (Cr) from each sample were extracted using the hot aqua regia digestion method and analyzed using Atomic Absorption Spectrometer (Shimadzu AA-6300, **Fig. 3**).

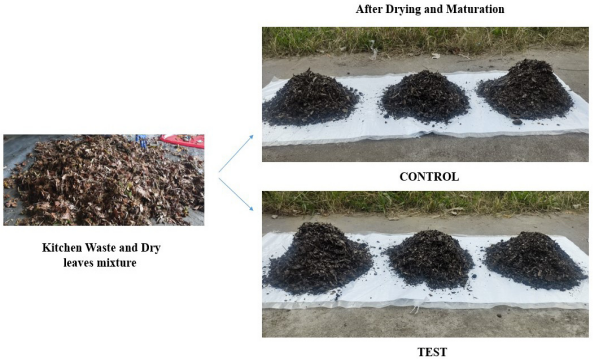


Fig. 3 Initial and final appearance of kitchen waste used for composting.

Initially, both control and treatment setups emitted a foul odor of kitchen waste. However, over time, this smell gradually diminished, faster in case of consortia treated waste, and by the final stage, it had transformed into an earthy, soil-like scent, indicating the successful completion of composting. The final compost was soil like brown in color. The waste, when composting process started off, was coarse, chunky, and irregular, by the end, it had developed a loose and crumbly texture. There was approximately a 64% volume reduction in the control group and a 69% reduction in the test group. The rise in temperature was primarily due to high microbial activity and the release of CO_2 which was observed higher in case of test group. In both setups, the pH followed the ideal progression from acidic to neutral. Higher EC values which were observed in case of control group (Fig 4), is indicative of high salinity and immaturity of the compost, could potentially signify phytotoxic effects on plant growth. Additionally, other parameters such as organic matter (OM), total organic carbon (TOC), total nitrogen (TN), and total phosphates (TP), along with metal elements like Zinc (Zn), Magnesium (Mg), Manganese (Mn), Iron (Fe), Copper (Cu), Cadmium (Cd), Lead (Pb), and Chromium (Cr) were all found to be within the range suggested by Fertilizer Control Order (FCO) standards and were better in the compost produced using consortia.

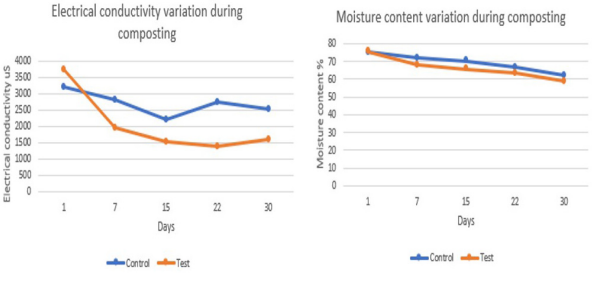


Fig. 4 Electrical conductivity (EC) variation and Moisture content during composting.

REGION-SPECIFIC SMART AGROTECHNOLOGIES FOR ENHANCING PLANT AND SOIL HEALTH

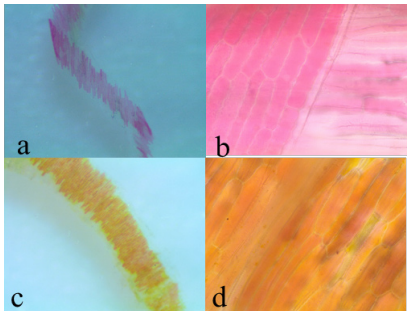
Project Investigation: Dr. Rakesh Kumar

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 integrating modelling, predictive analytics, indigenous drone-based surveillance and spraying, IoT measurement systems, and controlled environment agriculture techniques using grow lights, the project seeks to address region-specific challenges in improving plant and soil health sustainably. Capacity-building workshops at participating CSIR labs will facilitate knowledge sharing and provide training to stakeholders such as agro-industries, startups, agricultural universities, and farming communities.

Experimental plots for paddy, gerbera, and apple crops were set up across Himachal Pradesh to assess growth, phenology, yield and precision management. Data showed that the improved paddy variety (HPR 1068) outperformed local varieties, yielding the highest at harvest. In June 2024, an Agricultural Environmental Station was installed in the paddy field to collect weather data, which was shared with the 4PI lab to correlate climate factors with crop performance. In 2024, drone-based multispectral imaging was used to monitor paddy and apple orchards, capturing data during key stages like ripening and harvesting. Soil samples from apple orchards were analyzed for High-Density (HDP) and Low-Density Planting (LDP) systems in collaboration with CSIR labs, revealing higher phosphorus and potassium levels in HDP orchards. Based on these findings, customized fertilization schedules were created, and farmers received tailored recommendations. On January 29-30, 2025, a training session on nutrient management using SoilOptix soil maps was held for apple farmers in Naggar, Kullu, HP, helping them to optimize soil health and orchard productivity.

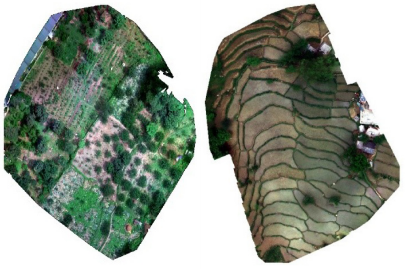
Pest and disease monitoring of gerbera crops at farms in Tang Narwana, Kangra, HP, included microscopic analysis of samples to study cellular structure, stomatal characteristics, and anthocyanin distribution. The research also investigated the effects of foliar micronutrient applications on gerbera growth and flower quality, with a particular emphasis on color values as a part of the quality evaluation. In addition, phenological data for paddy, apple, and gerbera crops were collected. These activities collectively highlight CSIR IHBT's dedication to improving agricultural practices and boosting crop productivity through research, technology, and field demonstrations, with a strong emphasis on sustainability and optimization.



Microscopic Analysis of Gerbera varieties

Installed Weather station and use of Soil optix in the Paddy field

Installed Weather station and use of Soil optix in the Paddy field



Multispectral Drone imaging in Apple Orchard and Paddy field

Advisory to Farmers

Harvesting and Grading of Apple

Fig. 1 Insights of project activities at different experimental plots.

CSIR- MISSION MODE PROJECT ON 'MILLET - SUSTAINING HEALTH THROUGH RESEARCH AND INNOVATION BY ANALYSIS OF NUTRIENTS AND NUTRACEUTICALS TO ACHIEVE GLOBAL AWARENESS (SHRI ANNA)

Theme: CSIR Mission Mode Project on Millet

Principal Investigator: Dr. Mahesh Gupta

Co-Principal Investigator: Dr. Vidyashankar Srivatsan

Work done in the area

Survey, characterization and value addition of traditional millet varieties towards development of innovative food products

Based on the initial survey, the most commonly consumed millets in Western Himalayan region are finger millet, sorghum, pearl millet, little millet, kodo millet and Barnyard millet.

Total of 25 varieties/ cultivars have been characterized for nutritional composition, including 18 varieties from the State Agriculture University, KVK centres, as well as 7 cultivars traditionally grown by farmers in the Sirmour, Mandi, Chamba, and Una districts of Himachal Pradesh.

Predominant millet-eating regions of H.P

Finger millet, Proso millet, Foxtail millet and Kodo millet were historically known to be grown in this region. A total of 18 traditional dishes have been identified in the survey for mapping of traditional millet foods of Western Himalayas.

Nutritional composition of local millets

Parameter	Protein (%)	Fat (%)	Crude Fibre (%)	Carbohydrate (%)
Pearl millet	11.13	5.38	1.87	71.41
Finger millet	7.91	1.99	3.08	73.6
Barnyard millet	9.13	3.24	7.32	69.29

Bio-efficacy of value-added millet products in ameliorating iron deficiency anaemia and protein energy malnutrition.

Bio-efficacy of millet panjeeri & high protein panjeeri, millet beverage mixes in alleviation of micronutrient malnutrition in experimental animal models. Preliminary findings indicate that a millet-based diet with enhanced feed conversion ratio resulted in increase in weight of rats in comparison to wheat-based diet.

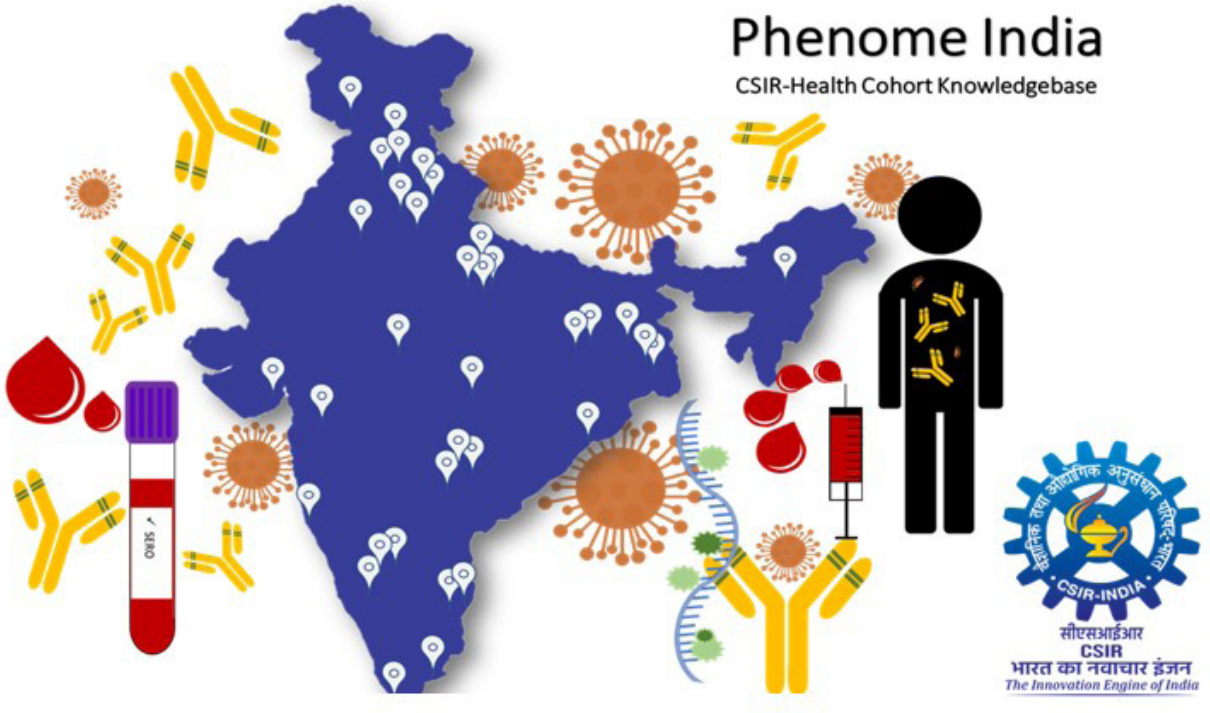
Human supplementation studies in target population and integration of millet- based products in malnutrition programs in collaboration with Directorate of Women and Child Development.

District administration Chamba, an aspirational district of Himachal Pradesh, has signed an MoU on 19th July 2024 with CSIR-IHBT for integration of millet-based food products for mass nutritional supplementation programs under POSHAN Abhiyaan for target beneficiaries. Integration of millet-based food products to the Directorate of Women and Child Development, District Administration Chamba, Himachal Pradesh, through tender for procurement is under process.

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

Principal Investigator: Dr. Yogendra S. Padwad

A pan CSIR activity under the network megaproject entitled 'Phenome India- CSIR Health Cohort Knowledgebase (PI-Check/CSIR Cohort) HCP0047' has been organised at CSIR-IHBT, Palampur for employees, superannuated staff and their spouses. The specific objectives of the project are estimating the metabolic disease burden in population, identifying the risk factors and development of risk prediction models, to develop India-specific normalized values for accurate diagnosis and developing methods and procedures for personalized medicines. To achieve these goals, the first phase of the project was implemented at CSIR-IHBT on 28, 29, 30 April and 01 May, 2024. Blood samples were collected and other different noninvasive clinical tests were performed on 211 participants by the trained staff and technicians.CSIR employees, superannuated staff and their spouses from CSIR-IHBT were overwhelmingly participated. The study comprised 116 male participants and 95 female participants who provided their samples. Stool samples were collected from 154 participants for gut microbiome analysis. This activity carried out at CSIR-IHBT, Palampur was highly beneficial for the participants who came to know about their comprehensive health conditions. Each participant was provided with their diagnostic reports on multiple parameters like body composition analysis, ECG, lung spirometry, lung osciometry, liver fibroscan, blood biochemistry and skin testing. This will bring awareness about the overall health and well-being of the participants. All the test results were shared in a typical diagnostic format which can be used furtherfor the consultation with doctors/physicians or health consultants to take an opinion about the health status. All the tests were free of cost to all our employees, superannuated staff and their spouses.



PHYTOPHARMACEUTICAL MISSION

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

Under the CSIR-Phytopharmaceutical Mission, CSIR-IHBT works in two verticals. Under vertical A, the Institute is working for the development of phytopharmaceutical products from *Inula racemosa.* Numerous studies on *I. racemosa's* phytochemistry have resulted in the identification of novel secondary metabolites and their biological properties. The plant's extensive therapeutic potential is largely due to the presence of significant amounts of sesquiterpene lactones, particularly eudesmanolides like alantoloactone (ALT) and isoalantolactone (IALT). Inunal, isoinunal, alantodiene, and many other sesquiterpene esters may also be found. Sesquiterpene lactones, such as ALT and IALT, are typical members of the Compositae family of plants. Helenin (also known as Inula camphor), a combination of both lactones, has long been recognised. Elecampane (*Inula helenium*), which includes ALT and IALT, was used as a seasoning in ancient times and later started to be employed for medical purposes in the middle centuries. The active ingredient in the antiulcer medication "Alanton today" is derived from this blend and used for the treatment of both stomach and duodenal ulcers. Without significantly influencing a normal or elevated function, the medicine has anti-inflammatory effects, lowers the gastric juice's proteolytic activity, and decreases the stomach's acid production function. Keeping in mind the broad health benefits as per traditional and reported claims, the group has developed the lab scale process for the isolation of chemical markers and manufacture initial lead for phytopharmaceutical for non-alcoholic fatty liver disorder (NAFLD).

Under the vertical B, a number of field visits and on-farm training programs were organised throughout several districts of Himachal Pradesh to encourage the captive cultivation of high-value medicinal plants. The main objective was to educate farmers about new agrotechnologies and expand the area under *Picrorhiza kurroa, Inula racemosa* and Heeng (*Ferula asafoetida*) cultivation. Approximately 16.0 kg of *Inula racemosa* seeds were distributed to farmers in Lahaul & Spiti, Chamba, Kullu and Kinnaur districts. Similarly, 25900 Heeng plants have been distributed to the farmers of Distt. Kinnaur, Chamba, Kullu, Mandi and Lahaul & Spiti of Himachal Pradesh to cover an area of about 3.5 ha. Besides this, more than 2.5 ha of land has been covered under *Picrorhiza kurroa.* A total of 28 on-farm training programs and field visits were conducted during 2024-25 at farmers' fields across various high-altitude regions of Himachal Pradesh, focusing on the scientific cultivation of *Inula racemosa, Picrorhiza kurroa* and Heeng.

Salooni

Malkota

Samra

Madran

Jobrang

Tindi

Kosar

Hinsa

Kibber

Moorang

Pangi

Miroo

Bari

Dhara

Fig. 1 Interaction with farmers and monitoring of heeng in different villages of Janjehli.

Fig. 2 Interaction with farmers and monitoring of heeng in different villages of Kullu district.

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

Principal Investigator & Co-Principal Investigator: 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 pilot scale process for standardized tannin-enriched extract remains a key challenge. The project 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 highest tannin content (32.0 %) in T1. For further investigation, 100 g of T1 and 10 g each of T2 and T3 were sent to the CSIR-Central Leather Research Institute (CLRI) for detailed analysis. On CLRI inputs, aqueous solubility of the T1 extract was optimized and sent to CLRI to evaluate its performance in leather tanning applications. 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 preparation of tannin-enriched extract.

Tasks to be achieved in the next year

- Preparation of tannin-enriched 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.

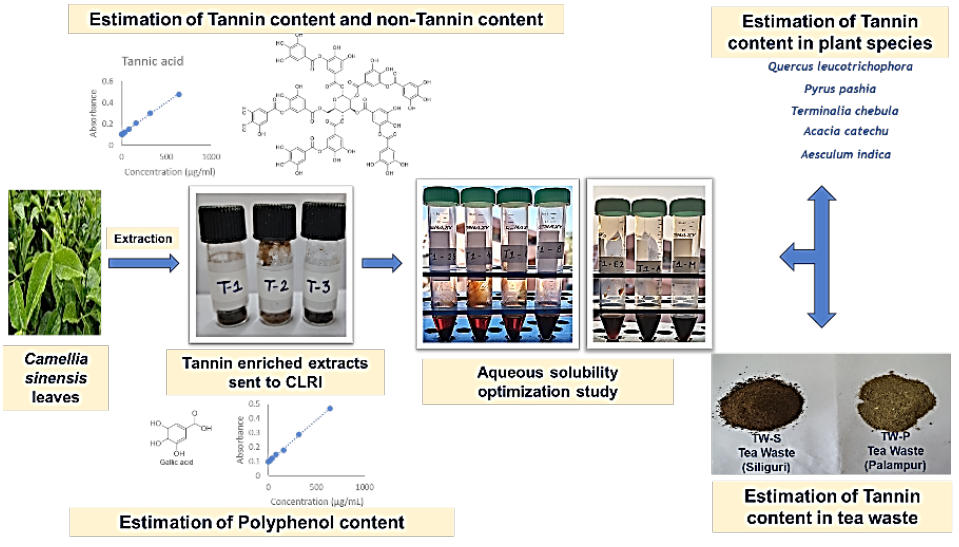


Fig.1 Tannin enriched extracts preparation from *Cammellia sinensis* for leather tanning.

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

IHBT Component: Optimization and pilot-scale production of lytic polysaccharide monooxygenase(s) for application in biomass deconstruction

The pressing need for sustainable energy (Sustainable Development Goals, SDG-7) has prompted a global transition from fossil fuel to bioenergy using biowastes. Chitin and lignocellulosic biomass (LCB) are renewable energy resources that are prevalent in nature. LCB consists of lignin, cellulose, and hemicellulose that upon complete deconstruction, produces fermentable sugars that may be transformed into biofuel and other useful products. Biomass degradation is the pivotal phase in bioenergy production, and the use of enzymatic processes is cost-effective, efficient, and sustainable for biomass conversion. The intricate polymeric network created by polysaccharide chains *via* intermolecular and intramolecular hydrogen bonding restricts glycoside hydrolases' (GHs) access to glycosidic linkages, leading to diminished efficiency and suboptimal yield of the end product. The recent identification of lytic polysaccharides monooxygenases (LPMOs), which use an oxidative mechanism to sever glycoside bonds in biopolymers such as cellulose, hemicellulose, chitin, and starch, has transformed the understanding of lignocellulosic biomass deconstruction. LPMOs have shown a remarkable enhancement of the saccharification process, leading to a substantial increase in end-product yield. LPMOs utilize monocopper ions in their active sites to facilitate the electron oxidation of C1/C4 atoms on the glycosidic linkages of polysaccharide substrates, resulting in chain cleavages and the exposure of additional reducing and non-reducing ends that act as "access points" for GHs, thereby enhancing the saccharification process (Kumar et al., 2024). A synergistic interaction between LPMOs and other GHs is essential for complete biomass breakdown (Fig.1). In this context we have identified an LPMO-encoding gene from *Bacillus* sp. PCH94. Using *in-silico* approaches, we predicted its structure by AlphaFold2 and assessed substrate affinity by using CB Dock2. Molecular docking reveals that the LPMO^{Bl} have substrate affinity towards cellulose and chitin. For further investigations, we successfully cloned and expressed LPMO^{Bl} in *E. coli* BL21 cells using optimized conditions (0.5 mM IPTG, 0.1 mM $CuSO_4$, 37°C temp, 5 h time duration). A two-step purification process (Ni-NTA affinity and size exclusion chromatography technique) was utilized for the purification of enzyme. Further biochemical assays revealed that the enzyme has both monooxygenase and peroxygenase activity (maximum activity at pH 7.0 and temp 30°C). The K_m and V_{max} of LPMO^{Bl} were determined to be 2.31± 0.25 mM and 20.36 ±0.5 Units mg^{-1}, respectively. SEM and UHPLC-ESI-MS guided approaches were further used to validate the structural deconstruction of chitin and phosphoric acid swollen cellulose (PASC) by LPMO^{Bl}, independently and synergistically with chitinase and cellulase. For pilot-scale production (22.7 L), we optimized the conditions to 10% dissolved oxygen (DO_2), 250 rpm agitation, and Terrific Broth supplemented with 0.4% glycerol as the optimal medium for enzyme production. These findings revealed LPMO^{Bl} as a potential candidate for biomass deconstruction, thereby providing tremendous possibility for industrial-scale uses. Its ability to synergistically work with other hydrolytic enzymes makes it useful for enhancing the effectiveness of conventional biomass conversion techniques. We are currently in the process of developing a UHPLC-ESI-MS method for the quantification of products released after biomass deconstruction, as well as assessing the effectiveness of LPMO^{Bl} on complex substrates.

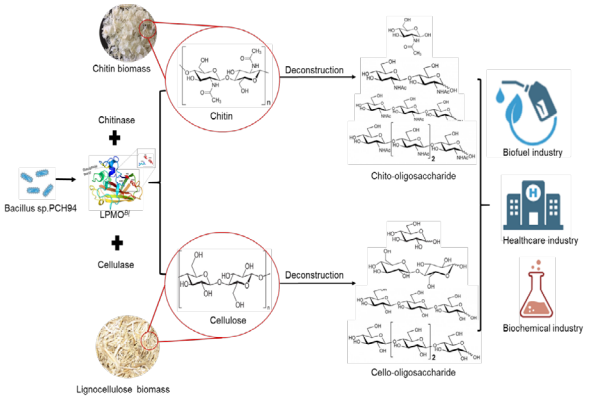


Fig. 1 Schematic representation of biomass (Chitin and Cellulose) deconstruction using LPMO^{Bl} in synergy with GHs (Chitinase and Cellulase) and their industrial application.

GENOME-EDITING FOR CROP IMPROVEMENT (GE-CROPS)

Principal Investigator: Dr. Shiv Shanker Pandey

Under the CSIR-Genome-editing mission project, the following plants and their selected genes were targeted for editing-

- *Camellia sinensis* reducing Polyphenol oxidase (*PPO*) and Caffeine synthase (*TCS*) expected to have improved qualities and health benefits of tea.
- *Crocus sativus* (Saffron) silencing flowering repressors *TFL1-2* and *SVP* genes for improved flower productivity.
- *Stevia rebaudiana* editing *UGT74G1* (encoding UDP-glycosyltransferase 74G1) to increase steviol glycosides specially Rebaudioside A to reduce the bitter aftertaste.

In the case of *Camellia sinensis*, first, the *in-vitro* regeneration protocol through somatic embryos was developed in promising tea cv. Him Sphurti. For obtaining high transformation efficiency, the CRISPR constructs for both the targeted genes, *PPO* and *TCS,* were transformed in *Agrobacterium* strain EHA105, which was further used for the transformation of somatic embryos. Now the somatic embryos of tea cv. Him Sphurti were successfully transformed with *Agrobacterium* strain containing CRISPR constructs for *PPO* and *TCS,* and putative transformants were regenerated into tea plantlets. Cas9 confirmation and editing in target genes was also found positive in regenerated plants. Auxiliary tea bud transformation was also optimized, and Cas9 confirmation and mutation detection in tea plants transformed through auxiliary tea bud transformation is in progress. RNP-mediated tea protoplast editing was also optimized. Optimization of tea protoplast regeneration is in progress.

In the case of genome editing of *Crocus sativus,* the target genes *TFL1-2* and *SVP2* were amplified, cloned and sequenced from saffron. Their gRNAs were designed and synthesized, and CRISPR constructs in pHSE401 vector were prepared. Callus multiplication was also performed. Transformation of CsatSVP2 and CsatTFL1-2 CRISPR constructs in callus of *C. sativus* is in progress. For doing RNP-mediated protoplast editing in saffron, suspension culture of saffron callus was also developed to isolate protoplast. Further, optimization of protoplast isolation and its purification is in progress.

In the case of genome editing of *Stevia rebaudiana, UGT74G1* target region was amplified, sequenced, and gRNAs were designed and synthesized. Validation of UGT74G1sgRNAs through *in-vitro* Cas9 assay was also performed. Further, the UGT74G1sg2:Cas9 knockout construct in pHSE401 vector was prepared, and confirmed through sequencing. UGT76G1 transactivation constructs were also prepared to achieve more steviol glycoside content. Callus cultures of selected stevia genotypes (1901 and Him Stevia) were also raised. Optimization of protoplast isolation for RNP complex transfection was also performed. *Agrobacterium* mediated transformation of nodal segments and calli using UGT74G1 knockout constructs is in progress.

FAST TRACK TRANSLATION (FTT)

&

FUNDAMENTAL INNOVATIVE RESEARCH IN SCIENCE OF TOMORROW (FIRST) PROJECTS

TECHNOLOGY UPSCALE FOR THE PRODUCTION OF NAPHTHOQUINONE RED PIGMENTS USING ARNEBIA EUCHROMA LEAF-INDUCED ADVENTITIOUS ROOTS IN INDIGENIZED BIOREACTORS

Theme: Fast Track Translation (FTT)

Principal Investigator: Dr. Shashi Bhushan

Objectives of the project:

- Scale-up studies on naphthoquinone pigment production using in vitro-induced adventitious root cultures
- Stability, shelf-life and safety assessment of extracted pigment in actual food and personal care products
- Process improvization to maximize productivity and feasibility studies in indigenized bioreactors

Overall process: *In vitro* leaf-induced *A. euchroma* adventitious roots were cultivated in different capacity of indigenized bioreactors (5.0 - 10.0 L) with two inoculum density (1.0 & 2.0%) and 50% (v/v) standardized Schenk and Hildebrandt (1972, SH) medium supplemented with 0.5 mg/L indole-3-butyric acid (IBA), 6.0 pH and 3.0% sucrose. The process was scaled up in different capacity (2,5, 10 L) indigenized bioreactor systems **(Fig. 1)**. The root biomass was harvested after 28 days of cultivation period. The relative growth, a key parameter in assessing the performance of any bioprocess, was found to decrease with an increase in bioreactor vessel size, however, at par at different bioreactor volumes. The total root biomass yield achieved in 10 L bioreactor was 425.00 g (fresh weight) per L medium, with 8-fold increase to initial inoculum.

Key features of the Technology

- **Sustainable:** *In vitro* adventitious root culture of *A. euchroma* as a sustainable source of natural pigment rather than uprooting plants from natural habitat
- **Year-around availability:** Compared to seasonal (April-September) availability in the wild, the in vitro system can provide year-round production
- **Shorter production cycle:** The cultivation cycle of adventitious roots is 5 weeks compared to 3-4 years in wild
- **Productivity:** Higher pigment accumulation (3 times to wild collected plants)

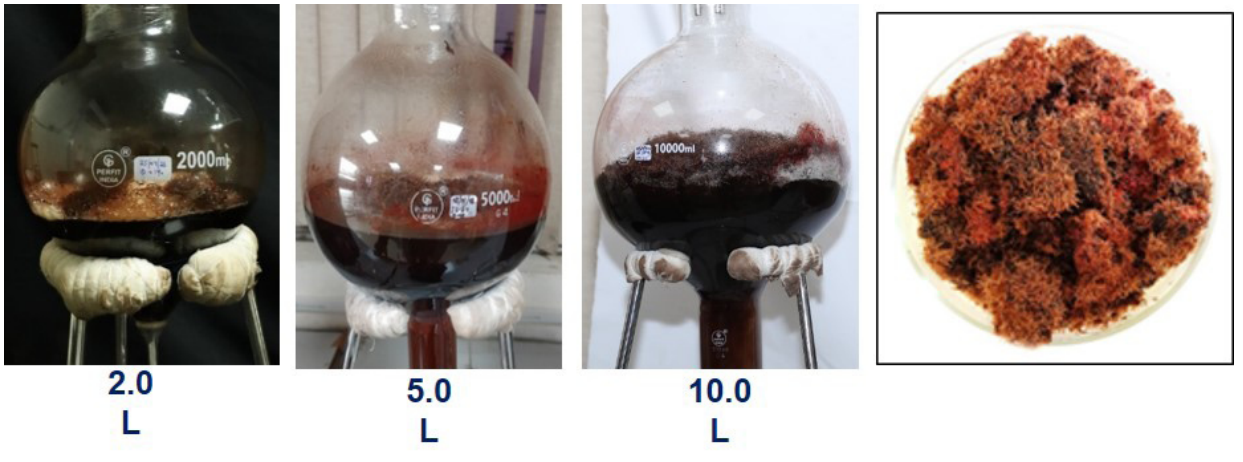


Fig. 1 Naphthoquinone pigment production scale up using *in vitro* induced adventitious root cultures in different capacity indigenized bioreactors.

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

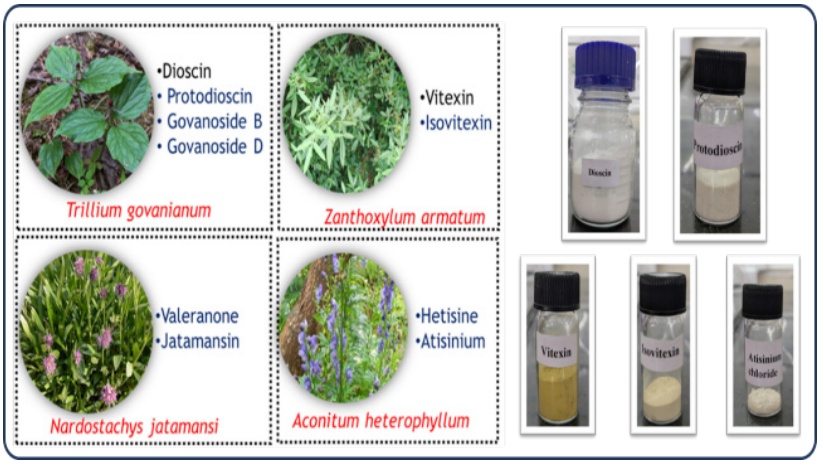
The project aims to develop CRMs/BND, specifically for phyto and aroma chemicals. These CRMs will play a critical role in ensuring the quality and safety of herbal and aroma-based products, supporting national efforts to establish standardized materials in line with international quality standards such 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 not available commercially or are expensive, often necessitating import from foreign sources.

Progress and significant achievements

The objective of current project is to develop a reproducible process for the gram-scale isolation of selected marker metabolites from these plants. This includes 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 five pure CRMs have been successfully developed. These include dioscin and protodioscin from *Trillium govanianum*, vitexin and isovitexin from *Zanthoxylum armatum*, and atisinium from *Aconitum heterophyllum*. All isolated compounds have been characterized using appropriate analytical techniques, and purity has been assigned. Further, homogeneity and short-term stability studies have been completed for dioscin, protodioscin, vitexin, and isovitexin to ensure consistency and reliability of the CRMs. In parallel, the laboratory has been granted ISO/IEC 17025:2017 certification by National Accreditation Board for Testing and Calibration Laboratories (NABL), making a significant step toward achieving quality and competence in testing and calibration activities.

Tasks to be achieved in the next year

- Gram scale process for the isolation of remaining five targeted CRMs.
- Characterization, purity assignment, homogeneity and stability study of all ten CRMs.
- Lab accreditation as per ISO17024:2016.



PHYCOBILIPROTEINS-BASED NUTRACEUTICAL FROM EDIBLE MICROALGAE FOR THE MANAGEMENT OF FATTY LIVER DISEASE

Theme: AgriNutriBiotech

Project type: Fast Track Translation (FTT)

Principal Investigator: Dr. Vikram Patial

Team: Dr. Vikram Patial and Dr. Vidyashankar Srivatsan

Fatty liver is the most prevalent metabolic condition globally. Lifestyle changes, a healthy diet, weight loss and avoiding alcohol are the only ways to prevent the development of fatty liver; however, conditions reoccur if these restrictions are not followed properly. Therefore, the availability of safe, effective and acceptable interventions for the management of fatty liver conditions is urgently needed. Nutraceuticals like phycobiliproteins from edible microalgae such as *Spirulina platensis*, *Chlorella* sp., possess strong antioxidant activity and ameliorate oxidative stress-mediated cellular damage. Therefore, in this project, a microalgal pigments-based nutraceuticals is being developed for managing fatty liver.

Objective:

- Development of phycobiliprotein-based nutraceutical formulations and evaluation of their stability.
- Safety and bioefficacy evaluation of phycobiliprotein formulation in experimental animal models.

Brief Progress:

A dehydration process was standardized to ensure consistency and quality in the preservation of phycobiliproteins. By employing a low-temperature dehydration method, the natural color and antioxidant properties of the compounds were effectively retained. Various C-phycocyanin variants or grades, differing in concentration, were optimized to suit specific applications. Efforts to stabilize these compounds using food-grade additives are currently underway. *In vitro* studies were conducted to assess cell viability and cellular uptake of phycobiliproteins in hepatic cell lines, providing insights into their bioactivity. A fatty acid-induced *in vitro* steatosis model was employed to evaluate the cytoprotective properties of phycobiliproteins, particularly their ability to inhibit reactive oxygen species (ROS). Additionally, the influence of phycobiliproteins on lipid accumulation, triglyceride levels, and mitochondrial membrane potential was investigated. Further studies also explored the compounds' role in modulating lipogenic factors, highlighting their potential in addressing hepatic lipid metabolism disorders **(Fig. 1)**.

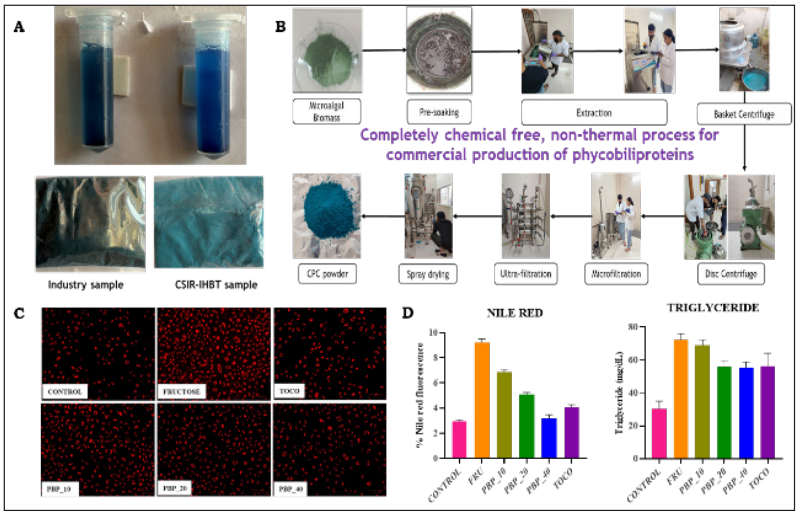


Fig. 1 Showing the phycobiliprotein samples (A), pilot scale standardized process of extraction (B) and *in vitro* bioactivity of phycobiliproteins (C, D).

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:

- Uncover the role of DNA methylation in plant stress responses, including heritable changes under heat stress.
- Establish HSFA2's role in heat stress signaling, epigenetic modulation, and long-term stress adaptation.
- Map HSFA2-mediated DNA methylation reprogramming and conduct cross-species comparisons in C3 (Arabidopsis) and C4 (Amaranth) plants.
- Correlate DNA methylation patterns with heat-responsive gene expression and validate regulatory interactions using genetic tools.

Brief Progress:

- **DNA Methylation Dynamics Under Heat Stress:** Methyltransferases (*DRM1*, *DRM2*, *MET1*, *MET2B*) and demethylases (*DML1*, *DML2*) showed temperature- and time-specific expression changes under 28°C and 38°C stress, with notable recovery patterns **(Fig. 1)**.
- **Distinct Roles of DNA Demethylases:** *DML1* was strongly induced (60-fold) under 38°C, while *DML2* and *DME* showed distinct expression patterns under 28°C and 38°C, highlighting functional specificity.
- **Genotyping of hsfa2 Mutant:** Homozygous *hsfa2* T-DNA insertion mutants were identified through kanamycin screening and PCR, enabling downstream analysis.
- **HSFA2 Overexpression Lines:** Three transgenic lines (HSFA2OX1, OX2, OX3) were developed to study HSFA2's regulation of methylation-related genes under heat stress **(Fig. 2)**.
- **Stress and Recovery Setup:** Mutant and transgenic lines were subjected to 28°C and 38°C stress for 48h, followed by recovery at 22°C, with systematic sampling for RNA and cDNA analysis.

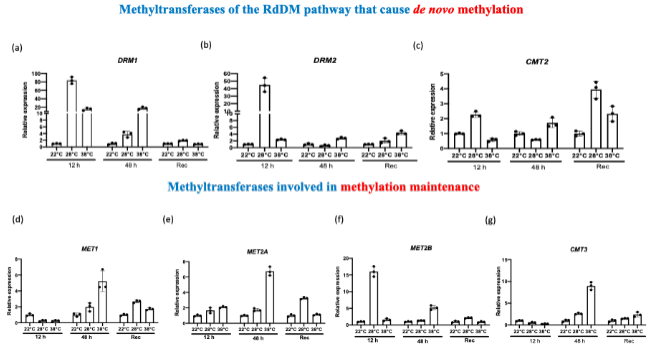


Fig. 1 Expression of genes encoding DNA methyltransferases under high temperature stress at different time points.

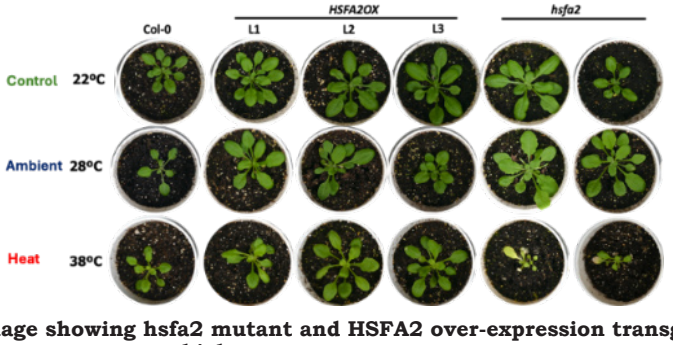


Fig. 2 Representative image showing hsfa2 mutant and HSFA2 over-expression transgenic lines subjected to higher temperature stress.

R&D SEED FUND (RDSF) PROJECTS

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

Principal Investigator: Dr. Rohit Joshi

Objectives:

i. Generation of large-scale *in vitro* quality planting material of monk fruit

ii. Field demonstration and crop production in Himachal Pradesh

iii. Capacity building of officers / farmers and other stakeholders

Targets Achieved:

i. Generation of large-scale *in vitro* quality planting material of monk fruit

- Shoot multiplication, rooting of microshoots, hardening and field transfer of *in vitro* raised plantlets going on simultaneously **(Fig. 1)**
- No. of total *in vitro* shoot cultures developed = 1700
- No. of available *in vitro* shoot cultures = 984
- No. of shoots available in *in vitro* rooting medium = 30
- No. of plantlets available in hardening = 232

ii. Field demonstration and crop production in Himachal Pradesh

- No. of total plants in poly sleeves = 240 **(Fig. 2)**
- No. of total plants under field conditions = 251
- No. of plants transferred to farmers = 275 (175 F and 100 M)

Fig. 1 *In vitro* mass scale proliferation and hardening of *Siraitia grosvenorii* plantlets. A) Multiple shoot proliferation under *in vitro* conditions; B-C) Hardening of plantlets under controlled conditions.

Fig. 2 Propagation of *in vitro* developed plantlets of *Siraitia grosvenorii* under field and pot culture. (A) Field acclimatization of *in vitro* developed plants; (B-D) Proliferation of monk fruit vines and fruit development under net house and polyhouse conditions; (E-F) Proliferation of monk fruit vines in pots and poly-sleeves.

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

Principal Investigator: Dr. Jeremy Dkhar

Kala Jeera seeds are darkish-brown in color and possess a small, linear and underdeveloped embryo **(Fig. 1)**. Therefore, the embryo must grow before the seed can germinate. To promote embryo growth, surface-sterilized seeds of Kala Jeera were exposed to different constant temperatures viz. 5, 10, 15, 20, and 25 °C, in dark, for 12 wk. Seeds were then examined periodically at 2, 4, 6, 8, 10 and 12 wk by cutting them into two halves using a razor blade and viewed under a stereo microscope. The embryo and seed lengths were measured and the embryo:seed ratio was calculated for each treatment. The results indicated that Kala Jeera embryo grows best at 5 °C. On the 8th wk, some of the seeds exposed to 5 °C started germinating (radicle begin to emerge). So, from the 8th wk onwards, we recorded seed germination percentage. By the 12th wk, more than 40 % seeds germinated at 5 °C, while about 6 % seeds germinated at 10 °C. Next, we exposed seeds to 0 °C in dark for 12 wk. However, exposure to 0 °C does not improve the embryo growth of Kala Jeera. Thereafter, we exposed the cold (5 °C) stratified seeds to different alternating temperatures viz. 15/5, 20/10, and 25/15 °C, in dark, for 12 wk. We found that Kala Jeera seeds stratified at 5 °C for 4 wk started germinating after 2 wk of exposure to alternating temperature of 15/5 °C. Thus, the amount of time needed for the Kala Jeera seeds to germinate has been reduced to 6 wk. This technology can be used to shorten the seed-to-seed cycle of Kala Jeera.

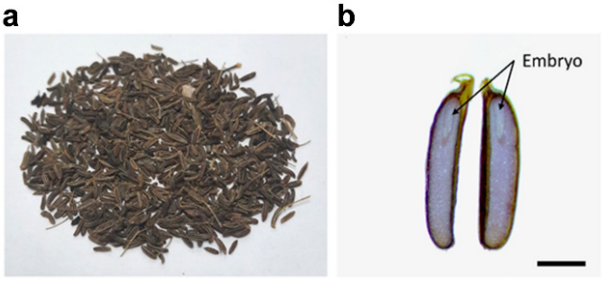


Fig. 1 (a) Darkish-brown ribbed seeds of Kala Jeera (b) dissected seeds of Kala Jeera showing an underdeveloped embryo. Bar=1 mm.

CHARACTERIZATION OF MANNANASE ENZYME (THMAN) FROM *TRICHODERMA HARZIANUM* FOR APPLICATIONS IN BIOMASS DECONSTRUCTION

Principal Investigator: Dr. Arun Kumar

Mannans are an important component of plant biomass and consist of β-1,4- linked D-mannopyranose backbone. They are widely distributed in nature and occur predominantly in softwood from gymnosperms but are also found in hardwood from angiosperms and serve as the major storage polysaccharide in legume seeds. On the basis of structural polymorphism, specifically the intermixing of backbone and galactose substitution, mannans are classified into four sub-families: linear mannan, glucomannan, galactomannan, and galactoglucomannan. The breakdown of mannan requires synergistic action of enzymes that include β-mannanase (1,4-β-d-mannan mannohydrolase), β-mannosidase (1,4-β-d-mannopyranoside hydrolase), β-glucosidase (1,4-β-d-glucoside glucohydrolase) and α-galactosidase (1,4-α-d–galactoside galactohydrolase).

The interest in mannan-degrading enzyme systems has surged during the past decade, notably due to its wide biotechnological uses. The global market for mannanase enzyme was estimated to total $15.28 billion in 2024, and its annual growth rate is predicted to be 7.33%. Importantly, mannan-degrading enzymes show potential applications in all three application sections (technical, food, and animal feed enzymes) of the industrial enzyme market, particularly in mannooligosaccharide production, animal feed, pulp bleaching, and coffee extracts for instant coffee production. The commonly used substrates for the production of mannanase are locust bean gum (*Ceratonia siliqua*), guar gum (*Cyamopsis tetragonoloba*), ivory nut (*Phytelephas macrocarpa*) mannan, an unbranched β-1,4-linked mannan homopolymer but the high cost of these substrates makes it expensive to produce. However, to reduce the production cost of enzymes, different biological waste may constitute a better alternative for the production of mannanase. In this regard, copra meal, a galactomannan (byproduct obtained after oil extraction from the dried kernels (copra) of coconut fruit *Cocos nucifera* L.), sugarcane bagasse, rice husk, wheat straw, palm kernel can be a suit able source for the production of excellent prebiotic mannooligosaccharides (MOS).

Previously, our lab has identified a *Trichoderma harzianum* strain from a natural lignocellulosic biomass (LCB) degradation site in the Himalayan region having a very high LCB degradation potential. Bioinformatic analysis led to the identification of Mannanases encoding gene that was highly expressed during its growth on LCB. This gene, referred to *Th*Man, was cloned and successfully expressed in *E. coli* but didn't turn out to be active. Therefore, as an alternative approach, the bacterial isolates from various environmental samples such as soil, pondwater, and domesticated animal feces were screened for mannanase activity. Based on the sole carbon source cultivation and mannolytic zone screening on LBG plates and by quantitative DNSA assay, the bacteria showing the highest mannanase activity (CS7) was adopted for further study **(Fig. 1)**. According to phylogenetic analysis of its 16SrRNA sequence, this strain was assigned to genus *Aeromonas*. Bioinformatical analysis revealed 729 aa beta-1,4 mannanase proteins under different accession IDs, although none of them has been characterized yet. Conserved domain analysis revealed that the deduced β-mannanase possesses the COG3934 superfamily domain and CBM6-CBM35-CBM36 like superfamily domain. This 2124 bp beta-1,4 mannanase gene was cloned and expressed in *E. coli* BL21(DE3), the gene was successfully expressed but exhibited no activity. Due to insufficient structural and functional understanding of mannanase from *Aeromonas*, further information on the enzyme's molecular weight, sequence, and other features is necessary for its recombinant production. Thus, parallelly the strain showing highest mannanase activity (CS7) was further inoculated in LBG enrichment media and checked for enzyme activity at different time intervals using DNSA and in gel assay **(Fig. 1)**. Further, the protein was partially purified by ammonium sulfate precipitation.

We are further aiming to develop a suitable heterologous expression system for the high-level expression of selected mannanase for overproduction, characterization, and potential applications.

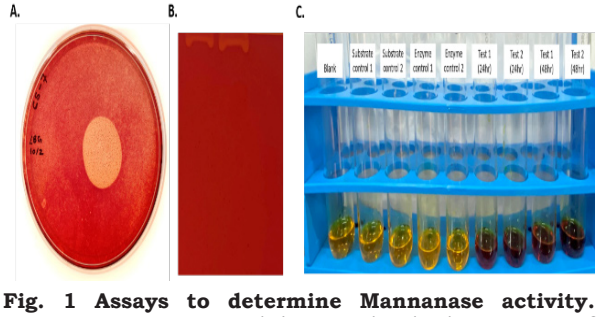


Fig. 1 Assays to determine Mannanase activity. (A) *Aeromonas* sp. exhibiting the highest zone of hydrolysis on LBG agar plate (B) Zymogram analysis illustrates in-gel analysis of mannanase activity. Lanes showing hydrolytic bands represent 24h and 48h culture supernatants; (C) Quantitative estimation of reducing sugar (mannose) by DNSA.

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 morpho-physiological traits and leaf essential oil yield. Data was recorded after the monsoon season on eight traits included- 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), chlorophyll content (TCC, mg/m²) and leaf essential oil content (ml/100g), which collectively determine the structural and growth characteristics of the plant. All the genotypes were having sufficient amount of genetic variability for all the studied traits indicates a diverse genetic pool essential for further selection **(Fig. 2)**. The maximum variability observed for canopy diameter and minimum for total chlorophyll content. Association analysis reveled that all the traits were positively correlated to each other **(Fig. 3)**.

Essential oils were extracted from 200 grams of fresh as well as shade dried leaves using the hydro-distillation for 5 hours of heating. Five Accessions viz., 101, 107, 109, 110 and 111 have shown the best leaf essential oil yield among studied all the studied genotypes **(Fig. 4)**.

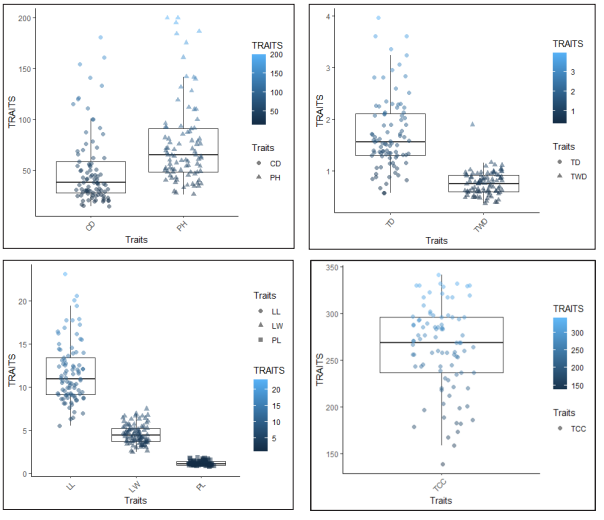


Fig. 2 Distribution of variability for all the morphological traits.

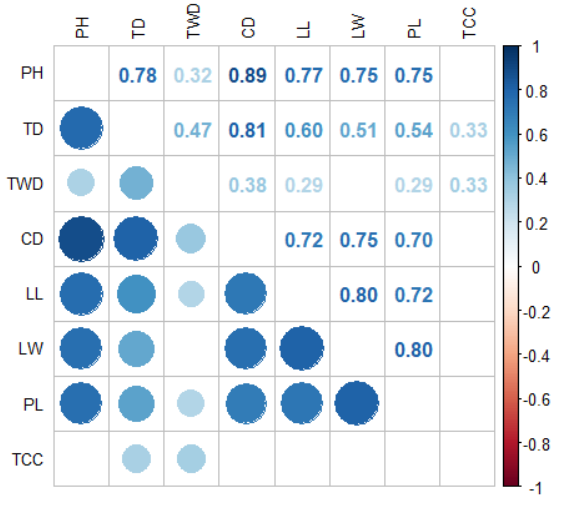


Fig. 3 Association among the traits.

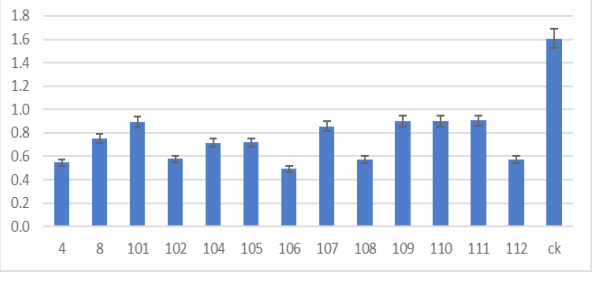


Fig. 4 leaf essential oil yield (ml/100g) of different genotypes.

UNRAVELLING HOW POLYPHENOL OXIDASE (PPO) SENSES STRESS AND TRIGGERS RETROGRADE SIGNALLING THROUGH THEAFLAVINS TO INDUCE STRESS RESILIENCE IN TEA (*CAMELLIA SINENSIS*)

Principal Investigator: Dr. Vivek Dogra

Progress: We have previously shown that drought-induced oxidative stresses directly affect chloroplast redox and activate polyphenol oxidase (PPO), and lead to accumulation of theaflavins (oxidized catechins), which trigger an inter-organelle communication leading to a programmed and regulated cell death, an essential stress survival phenomenon (*Mohapatra et al., Communicated*). This inter-organelle communication is heightened in susceptible genotypes. To further understand the operation of this PPO-activated signaling under other stresses, a set of Tea germplasm was analyzed under mild photoinhibitory conditions. A total of 9 genotypes were subjected to a daylight regime (from sunrise to sunset; 0 to 1300 µMol m-2 s-1) and 10 °C for 12 days. Chlorophyll fluorescence-based parameters revealed that Upasi9 and B157 have better photoprotection, whereas, TG1 and TV18 are highly susceptible. The susceptible genotypes showed higher oxidative damage and reduced chlorophyll contents with a concomitant increase in PPO activity, suggesting the operation of PPO-triggered stress signaling under such conditions.

As we also revealed that PPO-catalyzed products, Theaflavins, potentially induce a protein folding stress by inhibiting HSP90, it was further ascertained if TFs induce autophagy to regulate cell death. MDC-based staining and TEM-based analysis in Arabidopsis revealed that treatment of one of the Theaflavins, theaflavin-3-gallate (TF3G), causes the formation of time-dependent autophagosomes in both leaf and roots prior to the onset of cell death. The intensity of autophagosomes increases with time and likely results in cell death. The molecular factors linking autophagosomes and cell death are being investigated now.

Our results also indicated the potential action of Theaflavins as elicitors inducing defense response and likely modulating phytohormone responses. Our theaflavins-induced transcriptome analysis revealed that Theaflavins activate damage-associated molecular patterns (DAMPs), such as peptide hormones, that might affect plant growth. Biochemical analysis reinforced that Theaflavins mimic DAMPs, such as the elicitation of stress responses, including inhibition of primary roots and induction of secondary and tertiary roots. Besides, pure theaflavins and peptide hormones, the theaflavins-rich black tea extract also showed a similar response. The implication of such a root growth stimulating impact was ascertained and confirmed in a medicinal plant, where all three components promoted adventitious root biomass and secondary metabolite accumulation in Arnebia. Downstream mechanistic factors are being identified for their manipulation and utilization to enhance adventitious root biomass and secondary metabolite accumulation in Arnebia and other medicinal plants.

COLD OR HOT? OR BOTH? WHAT DETERMINES FLOWERING COMPETENCY IN SAFFRON? UNDERSTANDING THE ROLE OF CONTRASTING TEMPERATURES IN REGULATING SAFFRON FLOWERING.

Principal Investigator: Dr. Rajesh Singh

Saffron (*Crocus sativus* L.), a stemless perennial geophyte of the *Iridaceae* family, is cultivated primarily in Iran, Spain, Greece, India, Italy, and Nepal. The flowers and stigmas of saffron are highly valued as a spice, coloring agent, and in agro-food industries. The regulation of flowering is a key factor in determining saffron yield. In India, saffron cultivation is confined to Jammu and Kashmir and parts of Himachal Pradesh, where the temperatures and photoperiods are suitable for its growth. The low temperatures during its vegetative phase (November to February) provide essential chilling hours necessary for vernalization, which limits saffron cultivation to specific regions. If this vernalization requirement could be overcome, it may enable saffron cultivation in new regions. However, to date, there have been no specific studies on the vernalization requirement in saffron, and the molecular mechanisms underlying this process remain unclear.

To investigate the role of temperature on floral competency, we conducted an experimental study to examine phenotypic (morphological) and physiological changes in saffron corms under varying temperature conditions. Initially, corms were planted and maintained at 20°C/15°C for one month (October). After this period, the corms were exposed to two contrasting temperature conditions: a low ambient temperature of 15°C/5°C and a high ambient temperature of 15°C/10°C. Control corms were maintained under natural conditions for comparison. We observed that corm development occurred earlier under the low ambient temperature condition (15°C/5°C) **(Fig. 1)**. Corms from the different temperature conditions were sampled at regular intervals after planting. Apical meristem-enriched tissues from these corms will be subjected to transcriptome analysis to identify genes associated with vernalization. Additionally, to assess the flowering competency of the corms grown under different temperatures, they will be sown the following year to evaluate their ability to flower and determine the impact of temperature on floral induction.

Additionally, we have utilized in-house transcriptome datasets to identify thermoresponsive and vernalization-regulatory genes involved in the regulation of flowering. Through this approach, we identified the *CsVIN3* and *CsFRIGIDA* genes from the transcriptome database. Primers were designed to obtain the full-length coding sequences of these genes. The cloning of *CsVIN3* and *CsFRIGIDA* genes resulted in amplified products of 1.8 kb and 1.6 kb, respectively. These amplified gene fragments were first cloned into the Pjet1.2 blunt vector and subsequently inserted into the overexpression vector pBI121. Agrobacterium-mediated transformation was carried out in *Arabidopsis thaliana* using the floral dip method. As a result, we successfully generated 4-5 transgenic lines harboring the *CsVIN3* and *CsFRIGIDA* constructs, and homozygous plants have been developed. These transgenic lines will be further studied to investigate the impact of overexpression of the *CsVIN3* and *CsFRIGIDA* genes on the flowering pathway. Moreover, virus-induced gene silencing (VIGS) constructs of the targeted genes have been prepared to explore the role of vernalization-regulated genes in saffron plants. This approach will allow us to better understand how these genes influence the flowering process and their potential implications for saffron cultivation in diverse environments.

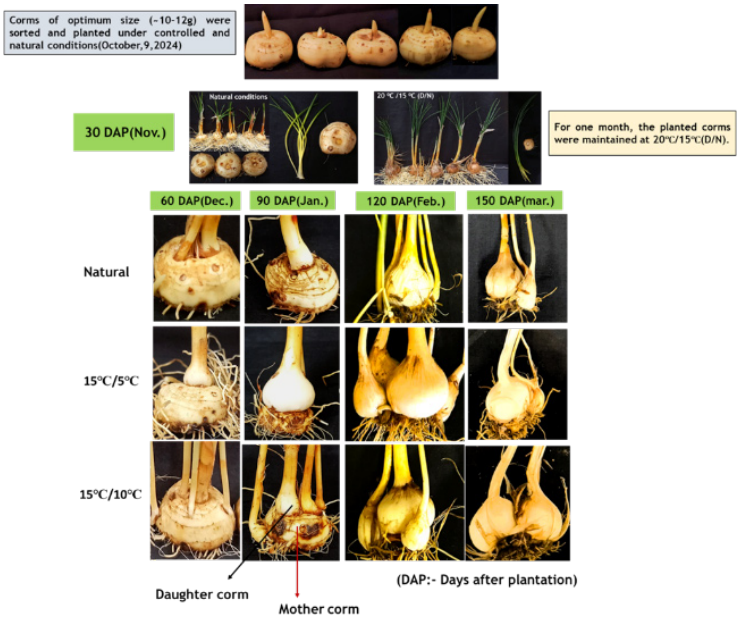


Fig. 1 Phenotypic (morphological) and physiological changes observed at two contrasting temperatures during vegetative phase from October-March. Observations shows that daughter corm development starts earlier in corms planted under low ambient temperature conditions (15°C/5°C D/N) as compared to high ambient temperature (15°C/10°C) and natural conditions.

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

Project Investigator: Dr. Vikas Kumar

Field Exploration and Collection: Field surveys were conducted in the Eastern Himalayas (Tawang, Arunachal Pradesh and Nathang, East Sikkim) for the collection of *Cremanthodium* species. In the Western Himalayas, we have surveyed the area of Rohtang (Kullu) and Baralacha Pass (Lahaul Spiti) region of Himachal Pradesh. These explorations resulted in the collection of seven distinct species belonging to the genus *Cremanthodium*.

Molecular and Taxonomic Analysis: Molecular studies of the nrDNA internal transcribed spacer (ITS) and chloroplast *trnC-petN* intergenic regions were done for all collected species. Phylogenetic analysis of the species is in progress. Comparative morphological studies revealed distinct traits in a few specimens, potentially representing new species. A detailed taxonomic characterization of the new species was made. Collected specimens were dried, mounted, identified, and deposited in the herbarium of CSIR-IHBT.

Phytochemical Work: GC-MS studies for collected plant species have been processed for volatile organic compounds, providing insight into the chemical constituents of the species. Polyphenolic profiling of plant secondary metabolites has been performed for the collected species.

Future Plans:

1. Collection of the remaining species and their sequencing to study the phylogeny.
2. Phytochemical profiling of the collected species.

Outcomes: Discovered one new species and one new addition to the flora of India.

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

Principal 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:

Differential Betalain Accumulation: The red-leaf cultivar (AH2) exhibited significantly higher betalain content, including betacyanin (up to 1.4 mg/g in dried leaves) and betaxanthin, compared to negligible levels in the green-leaf cultivar (AH4) **(Fig. 1)**.

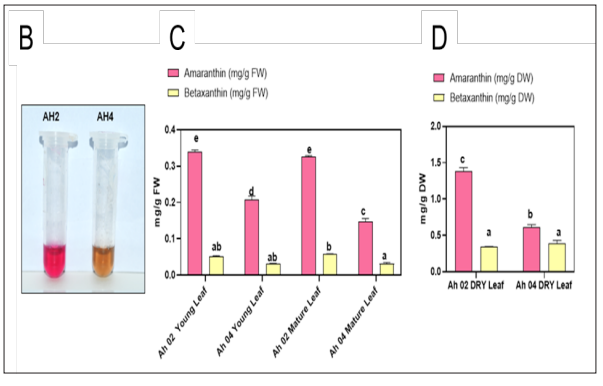


Fig. 1 A). Amaranth genotypes showing different leaf colour i.e., green (AH2) and red (AH4). B) Extracted total Betalain from Red (AH2) and Green (Ah4) cultivars. C). Quantification of amaranthin and betaxanthin from young and mature leaf samples of *Amaranthus hypochondriacius*.

Betalain Extraction and Quantification Methodology: Developed a reliable protocol for betalain extraction and quantification using acidified methanol and spectrophotometric analysis, enabling precise pigment measurement in fresh and dried tissues.

Identification of MYBs: Identified 146 R2R3-MYB transcription factors in *A. hypochondriacus*, with phylogenetic clustering of betalain-associated MYBs alongside other betalain-producing species such as pitaya and onion. Conserved R2R3 domains were characterized across MYBs **(Fig. 2)**.

Expression Analysis of Key Betalain Biosynthesis Genes: qPCR revealed significantly higher expression of betalain biosynthesis genes (*ADH*, *CYP76AD1*, *DODA1*) and betalain-associated MYBs (MYB2, MYB3, MYB6) in AH2, particularly in stems, petioles, and roots.

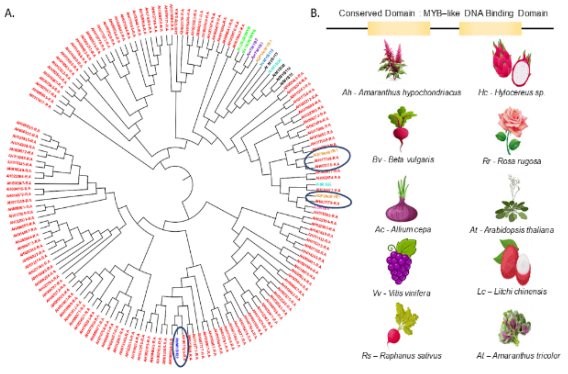


Fig. 2 A. phylogenetic tree construction of all MYBs in *A. hypochondriacus*. B. R2R3 domain structure found in MYBs.

EXPLORING THE POTENTIAL OF ORAL THIN FILMS FOR NUTRACEUTICAL DELIVERY

Principal Investigator: Dr. Ankit Saneja

Oral thin films (OTFs) are an innovative and emerging dosage form that offers numerous advantages for the delivery of nutraceuticals. These ultra-thin, flexible sheets are designed to be placed on the tongue, sublingual, or buccal mucosa, enabling rapid disintegration and absorption. The ease of administration, combined with a fast onset of action, makes OTFs a preferred choice for many patients, especially for those with difficulty swallowing traditional tablets or capsules. OTFs bypass the first-pass metabolism in the liver, enhancing the bioavailability of active ingredients.

The formulation of OTFs involves a variety of excipients, including film-forming polymers, plasticizers, and other additives, which influence the film's properties such as solubility, stability, and release profile. Furthermore, OTFs offer advantages like accurate dosing, portability, discretion in usage, and enhanced consumer acceptance. In this project, we are developing oral thin films containing nutraceuticals (e.g. Phloretin, Lipoic acid, Quercetin etc.).

Brief progress made so far

In this project, we have developed and characterized quercetin (QCT)-loaded sulfobutylether-β-cyclodextrin (SBE-β-CD) inclusion complexes (IC), incorporated into Eudragit S100 (ES100) nanofibers (NF) for targeted colon-specific delivery. Nuclear Magnetic Resonance (NMR) and 2D-NOE Spectroscopy (NOESY) studies provided detailed spatial correlations between the H-5 protons of SBE-β-CD and the aromatic protons of QCT, confirming the formation of the inclusion complex. Solid-state characterizations, including Fourier-transform infrared (FTIR), X-ray diffraction (XRD), and Thermogravimetric analysis (TGA)/Differential scanning calorimetry (DSC), revealed molecular interactions between QCT, SBE-β-CD, and ES100, resulting in the conversion of crystalline QCT into a more stable amorphous form with improved thermal stability. Morphological evaluation of the IC-loaded nanofibers showed a smooth, uniform, bead-free structure, while water contact angle (WCA) measurements indicated a hydrophobic surface. The *in vitro* release studies demonstrated colon-specific release of QCT, with approximately 81.85% of QCT released in the colonic phase. Additionally, both the IC and ES100/QCT/SBE-β-CD-IC-NF exhibited enhanced antioxidant activities (DPPH and ABTS radical scavenging), compared to native QCT. This work presented a novel approach combining inclusion complexation and electrospinning for the controlled, colon-specific delivery of quercetin.

AGROTECHNOLOGY DIVISION

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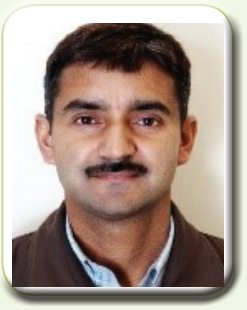
Plant Breeding



The research focuses on breeding, selection and multi-environment evaluation of floriculture, aromatic and medicinal plants for developing varieties for superior yield, quality and field performance.

Clary sage (*Salvia sclarea*)

Clary sage is an important aromatic herb with a high potential for commercial cultivation under the diversified climates of the Western Himalayas. The present study was carried out to understand the performance of genotypes and their interaction with the varied environments prevalent in the Western Himalayas and to identify stable and best-performing genotypes. The present experiment evaluated ten superior selections in four different environments as multi-location trials in a randomized block design with three replications over two years. The pooled analysis of variance revealed significant variations for genotypes, environments, and genotype × environment interaction for all the studied traits. The highest mean performance suggests that Env-1 has the most suitable conditions for clary sage cultivation. The genotypes CSIR-IHBT-SS-07 and CSIR-IHBT-SS-09 were found to be the best performers for fresh inflorescence weight (418.73 g/plant) and essential oil content (428.91 mg/kg), respectively. The results of Eberhart and Russell's regression-based model confirm that the genotype CSIR-IHBT-SS-07 is a stable and superior genotype for economically important traits. Further, the gas-chromatography mass spectroscopic characterization of essential oil disclosed that CSIR-IHBT-SS-07 was unique in terms of the highest sclareol content (23.39–45.17 %) across all the test environments. Genotype + Genotype × Environment biplot analysis confirmed that all the test environments form a single mega environment. The study is a pioneer in unraveling the stability response of clary sage in Western Himalaya and provides a strong base for the identification of superior genotypes and selection strategy for future genetic improvement programs of clary sage.

Chrysanthemum (*Dendranthema grandifora* Tzvelev)

Chrysanthemum is an important cut flower with high economic importance in the floriculture industry. Identifying stable and high-yielding chrysanthemum genotypes is paramount for ensuring its year-round production. In this context, the genotype by environment interaction effects on 22 chrysanthemum hybrids across six test environments were investigated. The experiment was conducted using randomized complete block design with three replications for 6 years and data on various agro-morphological and yield-contributing traits were evaluated. Our analysis revealed significant mean sum of squares due to environmental, genotypic and genotype by environment interaction variations for all examined traits. A 2D GGE biplot constructed using first two principal components computed as 59.2% and 23.3% of the differences in genotype by environment interaction for flower yield per plant. The GGE biplot identified two top performing genotypes, G2 and G5, while the AMMI model highlighted genotypes G17, G15, G6, G5, and G2 as the best performers. Genotype G17 ranked highest for multiple traits, while G2 displayed high mean flower yield as well as stability across all environments. According to AEC line, genotypes G2 and G5 exhibited exceptional stability, whereas genotypes G4, G18 and G19 demonstrated lower stability but maintained high average flower yields. The findings provide valuable insights into chrysanthemum hybrids that were not only best performing but also hold promise to meet the growers demand of the cut flower industry and can be recommended for large scale commercial cultivation.

Rose scented geranium (*Pelargonium graveolens*)

Rose scented geranium is one of the most important aromatic plants that have originated from South Africa. The genera Pelargonium has 700 spp. and out of those rose scented geranium is commercially the most important. The main

constituents of its essential oils are geraniol and citronellol. Eight mutant lines along with check variety Bourbon were tested in four different environments. Two-factor analysis of variation revealed considerable significant variation due to genotype and G × E interaction for almost all the traits. The CSIR-IHBT-PG-05 has highest biomass (1195.08 g/plant) and essential oil content (0.20%). Eberhart and Russell model of stability analysis was performed to predict the significant influence of different environments on mutant lines, which further revealed that line CSIR-IHBT-PG-05 has stable performance among the four environments studied. The present investigation provides a strong basis for identifying stable genotype and to carry out the process of selection and cultivar development in rose scented geranium.

Stevia (*Stevia rebaudiana* Bertoni)

In order to identify stable high-yielding stevia (*Stevia rebaudiana*) genotypes, a multi-environment testing was conducted over four different growing environments. The experiments were conducted in a randomized block design, with three replications during 2019 and 2020. The combined analysis of variance showed significant variation for genotype, environment, and G×E interaction for all studied traits. The highest mean performance for all the traits revealed that Hoshiarpur has favorable conditions for stevia cultivation, and CSIR-IHBT-ST-1801 followed by CSIR-IHBT-ST-G12 were the best performers over all the locations. The Eberhart and Russell model-based stability parameters demonstrated that CSIR-IHBT-ST-1801 was a stable performer for dry leaf biomass, and that was also further confirmed by GGE biplot analysis. Primary shoots were major contributors to the dry leaf biomass, as indicated by the substantial positive leaf biomass contribution shown by Pearson's correlation coefficients. As a result, primary shoots might be utilized as selection criteria to increase the dry leaf biomass. The CSIR-IHBT-ST-1801 could be used as a stable high-yielding variety for the targeted regions and also can be used for further stevia breeding programs.

Relevant Publications:

- Journal of Applied Research on Medicinal and Aromatic Plants. (2024), 100579.
- Journal of Applied Research on Medicinal and Aromatic Plants. (2024), 100548.
- Scientific Reports. (2024), 14, 14170.
- International Journal of Plant & Soil Science. (2024), 36(8): 80-89.

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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.

Chemical diversity and bioefficacy of aromatic grasses

Palmarosa, citronella and lemongrass are aromatic grasses with notable commercial value and broad-spectrum biological activity. This study explores the chemical and biological properties of their essential oils. GC/GC-MS analysis identified 19 volatile compounds in total, with lemongrass containing 11 (94.24%), citronella 6 (93.58%) and palmarosa 5 (97.77%). The essential oils exhibited antibacterial activity against three gram-positive and three gram-negative bacteria. Lemongrass (A2) showed the highest inhibition against *E. coli* MTCC 43 (21 ± 1.41 mm), followed by citronella (A3) against *Micrococcus luteus* MTCC 2470 (20.67 ± 0.94 mm), with MICs ranging from 0.31% to 5.00% (v/v). Lemongrass also had the highest total phenolic content (TPC), while palmarosa recorded the highest total flavonoid content (TFC) (**Fig. 1**). Antioxidant assays revealed lemongrass had the strongest activity with the lowest IC_{50} values for DPPH, ABTS and reducing power. Although palmarosa showed the weakest antioxidant activity, it exhibited the highest iron chelation (40.84%). All results were statistically significant except for reducing power (p = 0.6804).

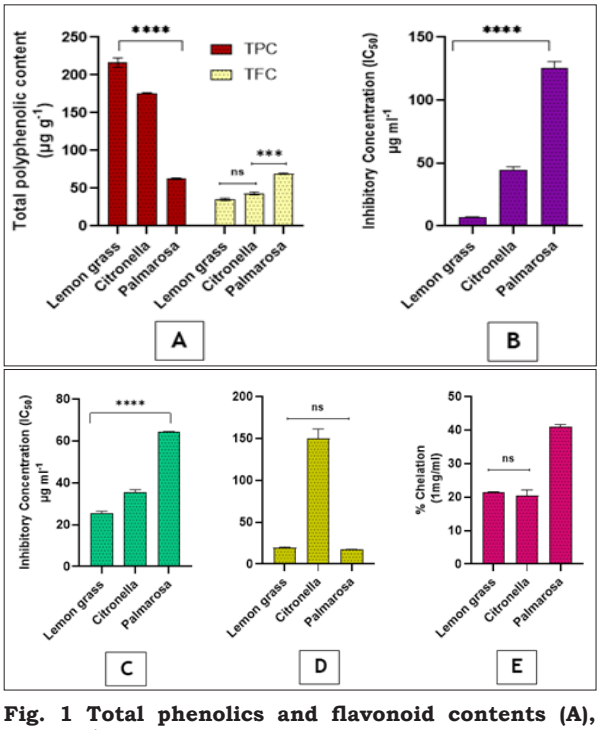

Fig. 1 Total phenolics and flavonoid contents (A), Antioxidant activities DPPH (B), ABTS (C,) Ferric reducing power (D), Fe-chelation effect (E). *** P<0.0001.

Standardization of micronutrients for aromatic marigold

Aromatic marigold (*Tagetes minuta* L.) (Family-Asteraceae), yields a high-grade essential oil utilized in various industries such as food, nutraceuticals, medicinal, flavor and fragrance. The experiment was conducted during 2023-24 to study the effect of micronutrients on growth, yield and essential oil composition of aromatic marigold in the western Himalayas (**Fig. 2**). The essential oil content and biomass

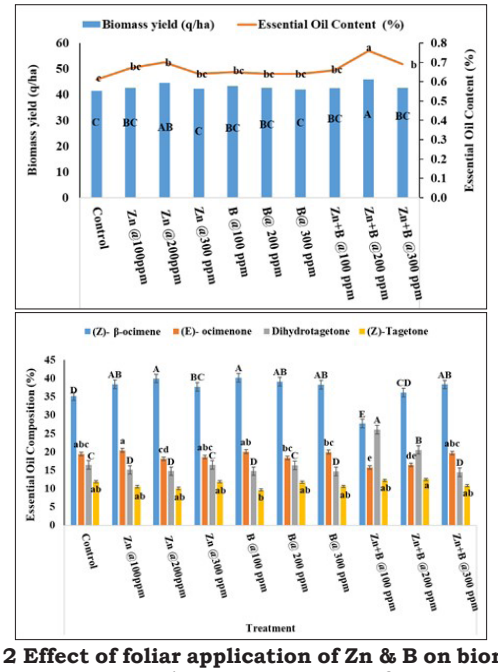

Fig. 2 Effect of foliar application of Zn & B on biomass and EO content and EO composition of *T. minuta*.

yield ranged between 0.6 - 0.8% and 40.6 – 46.4 q/ha, respectively. Zn + B @ 200 ppm significantly enhanced essential oil content and biomass yield by 25.3 and 14.1% as compared to control. The chemical analysis of essential oil included key constituents namely (Z)- β-ocimene (27.7-40.2%), (E)- ocimenone (15.7- 20.4 %), dihydrotagetone (14.5-26.1 %) and (Z)-Tagetone (9.7-12.5 %). The application of B @ 100 ppm recorded highest percentage of (Z)-β-ocimene (40.2 %) which was 14.3 % higher than control (water spray).

Optimizing concentration and application of seaweed on aromatic marigold

An experiment on aromatic marigold (*Tagetes minuta* L.) was conducted in 2023-24 to study the effect of different seaweed (*Solieria chordalis*) concentrations and their application methods on crop growth and yield. Foliar application of *S. chordalis* was found to be more effective than drenching in improving the biomass and essential oil of the crop. Application of *S. chordalis* at 4.5 mL/L led to a 38.7% increase in biomass, 41.4% in essential oil content as compared to control. The application of *S. chordalis* @ 3.0 mL/L resulted in 13.1% per cent increase of (Z)-β-Ocimene as compared to control (**Fig. 3**).

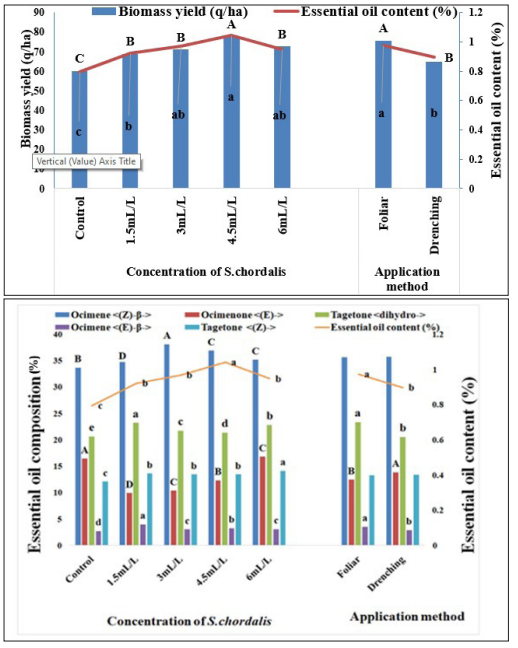

Fig. 3 Influence of *Solieria chordalis* on the biomass, essential oil content and essential oil composition of aromatic marigold.

Relevant Publications:

- Industrial Crops and Products. (2025), 226: 120670.
- Journal of Essential Oil Bearing Plants. (2025), 28(1): 1-23.
- BMC Plant Biology. (2025), 25: 84.
- Indian Journal of Natural Products and Resources. (2024), 15(4): 546-554.
- Journal of Horticultural Research. (2024), 32(2).
- Horticulture Environment and Biotechnology. (2024), 65: 817–829.

Research group: Dr Kiran Singh Saini, STO (2); Dr Arvind Verma STO (1); PhD student: Surbhi Sharma, Project Fellows: Dr. Babita Thakur, Dr. Swati Walia, Ayush Paul, Sumedha Thakur, Saizal Jamwal, Priyanka Raj, Swati, Shalini Jariyal, Ankush Garla, Anjali, Shubham, Akhilesh Kumar Sharma, Nidhi Negi and Aditya.

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Agronomy

For decades, India's agricultural research has largely been focused on traditional crops, leaving medicinal aromatic plants (MAPs) behind. Medicinal aromatic plants (MAPs) rich in bioactive compounds contribute to their diverse use in traditional and modern medicine as well as culinary and cosmetic applications. These plants are identified as promising crops for crop diversification, which can make agriculture more remunerative. As the demand for MAPs has increased, appropriate agronomic practices are missing. Therefore, our research group aims to provide suitable cultivation and management methods that would effectively translate research findings into actionable strategies for farmers.

Our group is focusing on developing improved agronomic strategies to elevate drought tolerance and reduce the use of inorganic fertilizers in Stevia (*Stevia rebaudiana*), which is generally known for its natural sweet taste and non-caloric diterpenoid steviol glycosides (SGs) content in its leaves. Growth, biomass yield and production of secondary metabolites in stevia are adversely affected by water stress. The consumption of inorganic fertilizers resulted in serious environmental and health issues. A pot experiment was conducted to test the hypothesis that the *Kappaphycus alvarezii*-based seaweed extract would trigger growth and secondary metabolites production in *S. rebaudiana* by stimulating physiological and enzymatic activities in plants and soil, and nutrient uptake from soil. Analyzed data demonstrated that the yield attributes and yield were significantly ($p \leq 0.05$) influenced by moisture stress and application of *K. alvarezii* extract. The water stress significantly ($p \leq 0.05$) decreased the dry leaf yield (g plant^{-1}) by 69.24% as compared with well-watered conditions (**Fig. 1).** Irrespective of moisture stress, the application of 100% NPK registered the maximum dry leaf yield (17.32 g plant^{-1}), followed by foliar application of 4% KAS-F (15.44 g plant^{-1}), and these two treatments remained statistically at par.

The interaction effects between the moisture level and seaweed treatments were significant ($p \leq 0.05$), and the maximum dry leaf yield (21.03 g plant^{-1}) was observed with the application of 100% NPK, followed by foliar application of 4% KAS-F under well-watered conditions. Under water deficit conditions, maximum (13.62 g plant^{-1}) dry leaf yield was observed with the application of 100% NPK, followed by foliar application of 8% KAS-F. Thus, stevia may be cultivated with exogenous foliar application of 4% KAS-F and 8% KAS-F under well-watered and water stress conditions, respectively **(Fig. 2)**.

Mentha piperita is one of the important herbaceous aromatic perennial herbs. Nitrogen

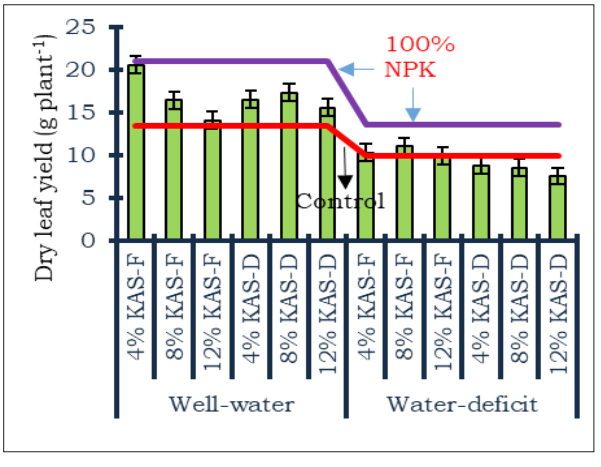

Fig. 1 The effect of moisture regimes and seaweed application of *Kappaphycus alvarezii* on stevia dry leaf yield (g plant^{-1}).

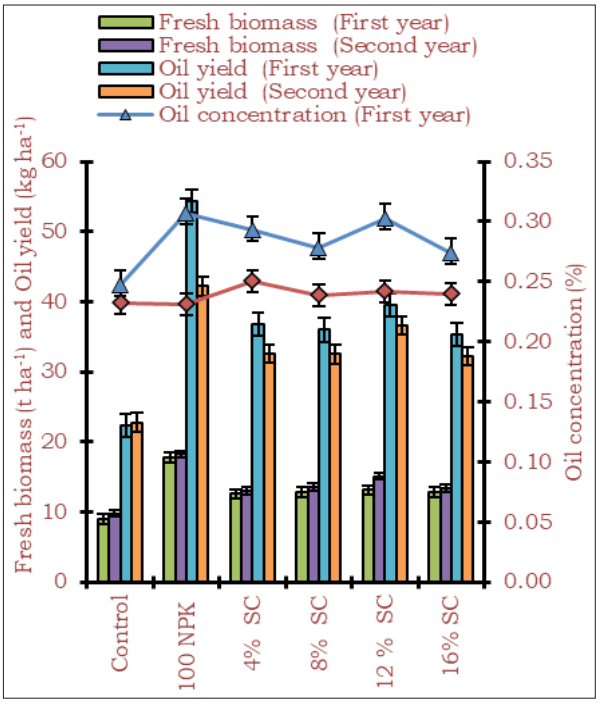

Fig. 2 Effect of different concentrations of seaweed extract (*Solieria chordalis*) on fresh biomass (t ha^{-1}), oil concentration (%) and oil yield (kg ha^{-1}) of *Mentha piperita*.

application significantly enhances essential oil yield in mentha species. However, excessive use of inorganic fertilizers in agriculture has resulted in severe environmental and health consequences. To counteract these negative impacts, a field experiment was conducted to understand the effect of foliar application of seaweed extract (*Solieria chordalis*) on biomass yield and quality of essential oil of *M. piperita*. The fresh biomass yield, oil concentration (%) in the fresh biomass, and oil yield (kg ha^{-1}) were significantly ($p \leq 0.05$) influenced by foliar application of seaweed extract during both the cropping seasons except oil concentration (%) in second growing season.

During first cropping season, the maximum oil concentration (0.31%) was registered with recommended dose of 100 % NPK followed by the application of *Solieria chordalis* extract at 12 %, while during second season maximum oil concentration (0.25%) was registered with treatment of 4% *S. chordalis* extract. The maximum fresh biomass (13.13 t ha^{-1} and 15.13 t ha^{-1}) was documented with the foliar application of 12% *S. chordalis*. The maximum oil yield (54.30 and 42.21 kg ha^{-1}) was observed with the recommended dose of 100% NPK followed by application of *S. chordalis* at 12% during both the growing seasons.

Relevant Publications:

- Journal of Applied Research on Medicinal and Aromatic Plants. (2024), 43:100580.
- Scientia Horticulturae. (2025), 339:113850.
- Frontiers in Plant Science. (2024), 15: 1465149.

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

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Coordinator-JIGYASA; Skill Development Programme; MSME; Trainings and Research Internship; Students' Visit

Development of Biopesticides

In the direction of identifying leads for developing biopesticides, we evaluated native entomopathogenic fungi (EPF), and plant extracts against insect and mite pests. EPFs *viz.*, *Tolypocladium inflatum* and *Clonostachys krabiensis* showed promising acaricidal activities against different life stages of two-spotted spider mite (TSSM), *Tetranychus urticae* Koch under laboratory conditions (**Fig. 1**). Adults were more susceptible to studied fungi followed by nymphs and eggs of TSSM. The combined application of *T. inflatum* and *C. krabiensis* was significantly effective in controlling TSSM adults (99.33%) followed by *T. inflatum* (93.34%) and *C. krabiensis* (85.33%). The combined application of studied EPF was found to be more effective against TSSM adults (LC_{50}=6.72×10^4 conidia/mL) followed by *T. inflatum* (LC_{50}=1.92×10^6 conidia/mL) and *C. krabiensis* (LC_{50}=7.90×10^6 conidia/mL). All three treatments at higher concentrations significantly reduced the adult and nymph populations. Scanning electron microscopy revealed the successful conidial adhesion, germination and penetration of native *T. inflatum* and *C. krabiensis* conidia on TSSM adults (**Fig. 2**). Thus, isolated native fungi can further be explored for developing fungal-based formulations for the sustainable management of mites.

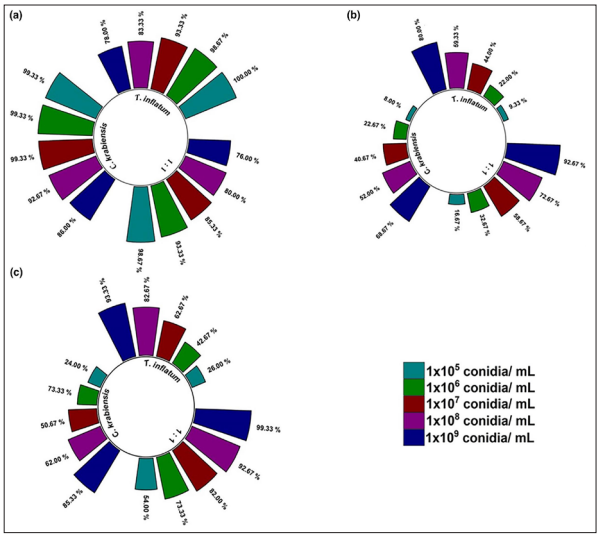

Fig. 1 Effect of *T. inflatum*, *C. krabiensis* and their combination (1:1) at different test concentrations against (a) eggs' hatchability (%) on 9th DAT (b) nymph's percent mortality and (c) adult's per cent mortality on 7th DAT.

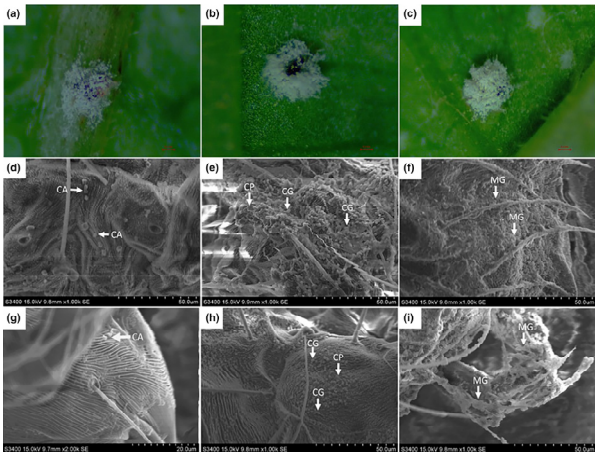

Fig. 2 Light and SEM observations (a–c) fungal outgrowth observed on TSSM adult cadavers on 10th DAT with *T. inflatum*, *C. krabiensis* and their combinations (1:1), respectively, under light microscope (d–f) Conidial Attachment (CA), Conidial Penetration (CP), Conidial Germination (CG) and Mycelial Growth (MG) of *T. inflatum* on TSSM adult under SEM (g–i) Conidial Attachment (CA), Conidial Penetration (CP), Conidial Germination (CG) and Mycelial Growth (MG) of *C. krabiensis* on TSSM adult under SEM.

Rearing and production of *Zophobas morio* (Superworms)

In a new initiative, introduced *Z. morio* in the lab and developed rearing method for its production and invited expression of interest for the same.

Apiculture

Maintained the apiary of CSIR-IHBT, monitored the activities of clusters associated with CSIR-IHBT, and provided technical know-how to them for rearing and producing honey and honey bee related products.

Advisory Services

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

Social Scientific (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 11,467 students and faculty

members participated and benefitted from different SSR activities during 2024-25.

Year 2024-25	Students and Teachers
School students and teachers (Jigyasa Programme)	9,804
College / University/ Institute students	1663
Total	**11,467**

Skill Development Programmes at CSIR-IHBT

Coordinated different Skill Development Programmes (SDPs) and activities of the Institute, including CSIR-Integrated Skill Initiative Programme and MSME sponsored Entrepreneurship Skill Development Programme (E-SDP).

This year, a total of 320 persons were trained in different SDPs, out of which 189 were research interns/ trainees (UG/ PG and PhD. students) from different states and UTs.

Linkages

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

- Linkages with MSME for E-SDP projects
- Gujarat State Biotechnology Mission (GSBTM)
- Academic and research institutions of Pan India (for summer and winter 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

Technologies Developed/ EoI:

- Fungal based lead for the management of insect and mite pests
- Rearing protocol for *Zophobas morio* (Superworms) as animal feed

Relevant Publications:

- Journal of Applied Entomology. (2024), 00:1–13.
- South African Journal of Botany. (2024), 171: 546–570.

Research group: Ms. Aakriti Sharma, Mr. Aditya Singh Ranout, Mr. Rahul Kumar, Ms. Rupinder Kaur, Ms. Supriti Parmar, Ms. Deeksha Jasrotia, Ms. Unnati Walia, Mr. Vivek Kumar Awasthi; Mr. Sahil Sharma, Mr. Pankaj Kumar, Ms. Bandana Kumari and Mr. Kashmir Singh.

Bhavya Bhargava, Principal Scientist
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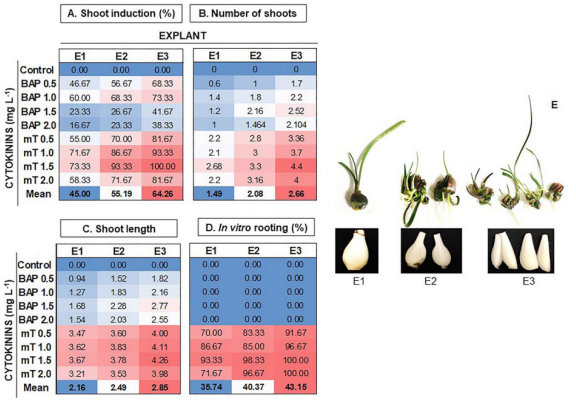
Smart Cultivation Systems for Floriculture/ Himalayan Wild Ornamentals/ Post-harvest Management of Cut Flowers

Our lab focuses on smart cultivation systems for floriculture and the conservation and utilization of Himalayan wild ornamentals. We also work on post-harvest management strategies to enhance the quality and shelf life of cut flowers.

Dual role of meta-topolin in mediating *in vitro* propagation and phytochemical elicitation in Pink Rain Lily

This study developed a high-efficiency clonal propagation protocol using mature bulb explants cultured on MS medium with meta-topolin (mT).



A. Shoot induction (%)

CYTOKININS (mg L⁻¹)	EXPLANT E1	E2	E3
Control	0.00	0.00	0.00
BAP 0.5	46.67	56.67	68.33
BAP 1.0	60.00	68.33	73.33
BAP 1.5	23.33	26.67	41.67
BAP 2.0	16.67	23.33	38.33
mT 0.5	55.00	70.00	81.67
mT 1.0	71.67	86.67	93.33
mT 1.5	73.33	93.33	100.00
mT 2.0	58.33	71.67	81.67
Mean	45.00	55.19	64.26

B. Number of shoots

CYTOKININS (mg L⁻¹)	E1	E2	E3
Control	0	0	0
BAP 0.5	0.6	1	1.7
BAP 1.0	1.4	1.8	2.2
BAP 1.5	1.2	2.16	2.52
BAP 2.0	1	1.464	2.104
mT 0.5	2.2	2.8	3.36
mT 1.0	2.1	3	3.7
mT 1.5	2.68	3.3	4.4
mT 2.0	2.2	3.16	4
Mean	1.49	2.08	2.66

C. Shoot length

CYTOKININS (mg L⁻¹)	E1	E2	E3
Control	0.00	0.00	0.00
BAP 0.5	0.94	1.52	1.82
BAP 1.0	1.27	1.83	2.16
BAP 1.5	1.68	2.28	2.77
BAP 2.0	1.54	2.03	2.55
mT 0.5	3.47	3.60	4.00
mT 1.0	3.62	3.83	4.11
mT 1.5	3.67	3.78	4.26
mT 2.0	3.21	3.53	3.98
Mean	2.16	2.49	2.85

D. *In vitro* rooting (%)

CYTOKININS (mg L⁻¹)	E1	E2	E3
Control	0.00	0.00	0.00
BAP 0.5	0.00	0.00	0.00
BAP 1.0	0.00	0.00	0.00
BAP 1.5	0.00	0.00	0.00
BAP 2.0	0.00	0.00	0.00
mT 0.5	70.00	83.33	91.67
mT 1.0	86.67	85.00	96.67
mT 1.5	93.33	98.33	100.00
mT 2.0	71.67	96.67	100.00
Mean	35.74	40.37	43.15

Fig. 1 Effect of different concentrations of cytokinins (BAP and mT) and explant type on *in vitro* propagation of *Z. grandifora* after 4 weeks of culture. Heat map depicting (%) shoot induction (A), number of shoots (B) and shoot length (C), *in vitro* rooting (D), and pictorial representation of *in vitro* organogenesis from differently sized explants (E).

Quartered bulbs (E3) showed 100% shoot induction, and MS medium with 1.5 mg L^{-1} mT, 0.5 mg L^{-1} NAA, and 0.25 mg L^{-1} GA_3 yielded optimal shoot length (15.3 cm) and bulblet production (10.33). Higher sucrose (120 g L^{-1}) and paclobutrazol (5 mg L^{-1}) further improved bulblet size and sugar content. Genetic uniformity was confirmed via SCoT markers, and mT-grown plants exhibited higher photopigment, phenolic, and flavonoid levels. Notably, *in vitro* bulblets had significantly increased galantamine content (303.33 µg g^{-1} FW), highlighting this protocol's potential for large-scale, quality propagation of this dual-purpose species **(Fig. 1)**.

Melatonin-capped copper nanoparticles enhance stem strength and post-harvest quality in *Gerbera jamesonii*

Gerbera jamesonii, a top global cut flower, suffers from poor stem strength and limited vase life, reducing its commercial value. This study explored the novel use of melatonin-capped copper nanoparticles (MT-CuNPs) to enhance both structural integrity and post-harvest longevity in gerbera. MT-CuNPs significantly improved photosynthesis, antioxidant activity, stem diameter, lignin content, and xylem cell wall thickness. These structural enhancements translated to stronger stems and delayed senescence. Treated flowers exhibited a 6-day longer vase life compared to control, supported by the upregulation of lignin biosynthesis genes as shown by qRT-PCR analysis. This work highlights the promising role of nanotechnology—specifically MT-CuNPs—in advancing post-harvest performance and mechanical quality in ornamental crops **(Fig. 2)**.

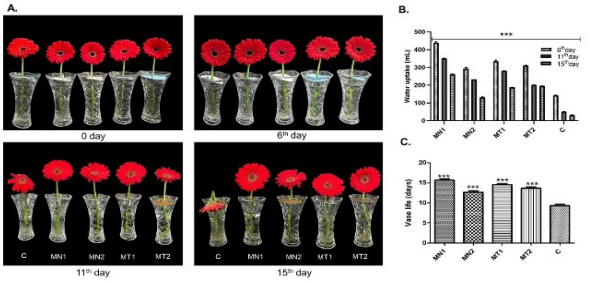


Fig. 4

Fig. 2 Effect of melatonin (MT) and melatonin-capped copper nanoparticles (MT-CuNPs) foliar spray on the vase life of gerbera; vase life at 0th day (A), 6th day, 11th day and 15th day; water uptake (B); vase life of gerbera in days (C).

Genome-wide characterization of melatonin biosynthetic pathway genes in carnation (*Dianthus caryophyllus* L.) and their expression analysis in response to exogenous melatonin

Dianthus caryophyllus (carnation) is a commercially important ornamental crop where flower yield is influenced by lateral branching. This study explored the role of exogenous melatonin, a multi-functional phytohormone, in modulating carnation growth and branching. Application of melatonin at optimal concentrations (100 µM and 500 µM) significantly enhanced branching and altered plant height. Genome-wide and in-silico analyses identified ten genes involved in the melatonin biosynthesis pathway, including key enzymes (TDC, T5H, SNAT, ASMT). Domain, promoter, and phylogenetic analyses confirmed their structural and functional relevance. Gene expression profiling under melatonin treatments

revealed a dose-dependent upregulation, peaking at 500 µM, with no response at 1000 µM. The findings suggest that exogenous melatonin boosts endogenous melatonin biosynthesis, enhancing branching through transcriptional activation of key pathway genes—offering a novel approach to improve carnation yield and quality.

Relevant publications:

- Scientia Horticulturae. (2024), 338: 113776.
- South African Journal of Botany. (2024), 175: 436-452.
- Postharvest Biology and Technology. (2025), 222: 113415.
- Journal of Plant Growth Regulation. (2025), 1-17.
- Plant Cell Reports. (2025), 44(1):1-5.

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, Dikasha Thakur, Anjali Chandel, Priti, Diksha Sharma, Himanshi Gupta, Shagun Rana, Gulshan Birsanta, Ujala, Sourabh Kumar, Neeraj Barwal, Deepti, Chhering Youdon, Rahul Bodh.

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Plant Biology

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

Endophytic microbes in the carnivorous plant *Nepenthes khasiana* most likely originate from the rhizosphere

Endophytic microbes or endophytes reside within plant tissues without causing harm, and are known to promote plant growth and enhance resistance to both biotic and abiotic stresses. While endophytes – primarily comprising bacteria and fungi – have been extensively studied in a variety of plant species, research on culturable endophytes, particularly bacteria, in carnivorous plants remains limited. To address this gap, we isolated and identified endophytic bacteria and fungi from various tissues, including seeds, of the carnivorous plant *Nepenthes khasiana*. We found that culturable endophytic bacteria were predominantly associated with roots and seeds, whereas endophytic fungi were more abundant in the different parts/zones of the *N. khasiana* pitcher. Although most endophytes were restricted to specific tissues, some exhibited a broader distribution across nearly the entire plant. To investigate the possible origin and migration routes of these endophytes, we performed metagenomic analysis of the pitcher fluid and rhizospheric soil of *N. khasiana*. The results revealed both distinct and overlapping microbial communities, with significant differences in the relative abundances of bacterial and fungal operational taxonomic units (OTUs). Several OTUs from rhizospheric soil matched endophytic bacteria and fungi at the genus level, whereas no overlap was observed between endophytes and OTUs from the pitcher fluid. Notably, some bacterial and fungal genera were detected both as endophytes and as free-living microbes in the pitcher fluid and rhizosphere. These findings suggest that endophytes in *N. khasiana* most likely originate from the rhizosphere, with possible migration into the pitcher fluid, whereas colonization via the pitcher fluid appears unlikely.

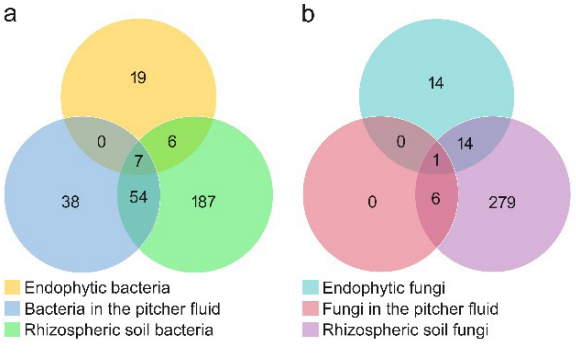

Fig. 1 Comparative analysis of the isolated endophytes and the OTUs identified in the pitcher fluid and rhizospheric soil of *N. khasiana*. Venn diagram showing the number of unique and shared bacterial genera (a), Venn diagram showing the number of unique and shared fungal genera (b).

A new species and a new record of *Cremanthodium* spp. from Arunachal Pradesh, India

Cremanthodium dibangii Vik. Kumar & Rahul Kumar (Asteraceae, Senecioneae) is described and illustrated as a new species from Dibang Valley District in Arunachal Pradesh, India. It morphologically resembles *C. reniforme*, but differs from it in several characters of leaves, involucres, and ray laminae, as well as the style length of ray florets, etc. We additionally report *C. oblanciligulatum* for the first time from India, collected from Tawang, Arunachal Pradesh. It is a threatened species and until now, it has only been known from China.

Relevant Publications:

- Annales Botanici Fennici. (2025), 62(1): 39-47.
- Physiologia Plantarum. (2024), 176(6): e14598.
- Physiologia Plantarum. (2024), 176(3): e14361.

Research group (From left to right): Kiran Dhiman, Manisha Devi, Yogesh Kandpal, Renu, and Dr. Tanvi.

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Floriculture

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

Effect of plant growth-promoting rhizobacteria on the growth performance, yield, and quality of *Gladiolus grandiflorus* Hort.

The present investigation assesses the effects of biofertilizer (*Bacillus altitudinis* (IHBT-705) and *Arthrobacter psychrochitiniphilus* (IHB B-13602) on growth, yield and biochemical characteristics of *Gladiolus grandiflorus*. A field experiment was conducted using a randomized block design (RBD) with five treatments *viz.* C= control; T1= IHBT-FS2 biofertilizer; T2= IHB B-13602 biofertilizer; T3= IHBT-705 + IHB B-13602 consortia and T4= recommended dose with four replications. The results indicated significant improvements in vegetative growth, reproductive and biochemical characteristics in plants treated with biofertilizers. Treatment T3 showed a significant increase in plant height (20%), early spike emergence (89.6 days), spike length (17%) and chlorophyll content (52%) compared to the control. Additionally, biofertilizer application improved rachis length (25%), floret diameter (19%), vase life (7.45 days). Further, marketable spike production was 43% higher in treatment T3 over the control. Biofertilizer application also enhanced total phenolic and flavonoid concentrations by 30% and 34%, respectively **(Fig. 1)**, along with elevated antioxidant enzyme activities including superoxide dismutase (SOD, 58%), guaiacol peroxide (GPX, 88%) and catalase (CAT, 85%) **(Fig. 2)**. Moreover, protein content increased by 25% in T3, and MDA content decreased by 7%, indicating improved stress tolerance. These findings highlighted biofertilizers as a sustainable substitute for chemical fertilizers, promoting environmentally responsible agriculture while enhancing floral quality, production and plant resistance under field conditions.

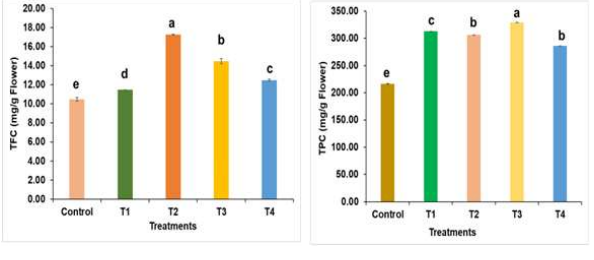

Fig. 1 Variation in the total phenolic and flavonoid content in gladiolus. Bars represent mean ±SE values of TPC and TFC content (mg/g) (n=3). Different letters a, b and c represent the significant difference at p<0.05.

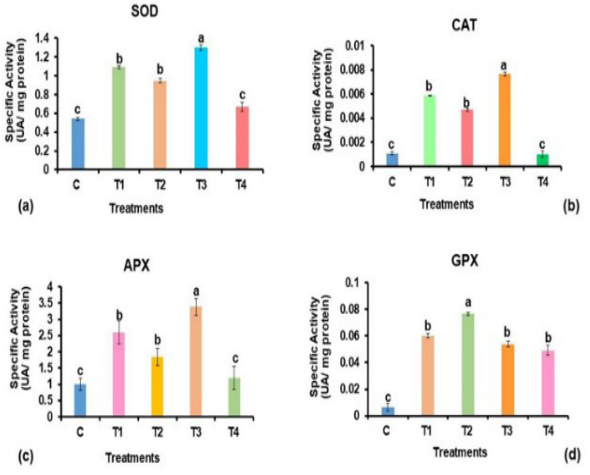

Fig. 2 Antioxidants estimation in the leaves of all the treatments. Bars represent mean ± SE values of specific enzyme activity (n=3).

***In-vitro* propagation of Miniature Rose cv. Ice Fairy: Role of growth regulators in shoot and root development**

Rose (*Rosa* × *hybrida* L.) is an amazing flower in the Rosaceae family, with over 200 species found throughout the Northern Hemisphere. The aim of this experiment was to optimize a procedure for *in-vitro* micro-propagation of miniature rose cv. Ice Fairy utilizing the nodal segments as an explant. The impact of cytokinins and gibberellins was investigated under *in-vitro* conditions. Different levels of BAP (6- Benzylaminopurine) (1, 1.5, 2, 2.5 mg L^{-1}), focusing on the developmental stages of explant whereas GA3 (Gibberellic acid) was employed for shoot elongation and flowering. Activated charcoal (1 g L^{-1}) was added into the medium to inhibit phenolic oxidation. The highest shoot initiation was found in treatment T4 (94%) with culture survival rate at 86% when Murashige and Skoog (MS) medium was supplemented with 2.5 mg L^{-1} BAP with 1 g L^{-1} activated charcoal. The greatest number of elongated shoots were seen in the medium containing 2.5 mg L^{-1} BAP with 1 mgL^{-1} GA3. It was observed that MS media supplemented with BAP was successful for shooting as well as for rooting. *In-vitro* plantlets with 5 to 6 roots, each measuring 4 to 5 cm in

length were carefully removed and transplanted into sterilized glass jars. The jars had a mixture of sand, coco-peat, and soil in a 1:1:2 (v/v) ratio moistened with 30% of MS basal liquid medium. These findings may therefore, contribute toward the commercial micropropagation of miniature roses. This protocol offers a reliable method for the mass production of miniature roses using in-vitro techniques. This method also ensures the production of disease free plants in a sterile environment, reducing the risk of pathogens. *In-vitro* techniques also enable mass propagation of uniform plants, ensuring genetic stability and high quality traits, such as flower size, color, and compactness. Overall, *in-vitro* propagation provides an efficient, reliable, and sustainable approach for cultivating miniature roses with desirable traits for commercial and ornamental use.

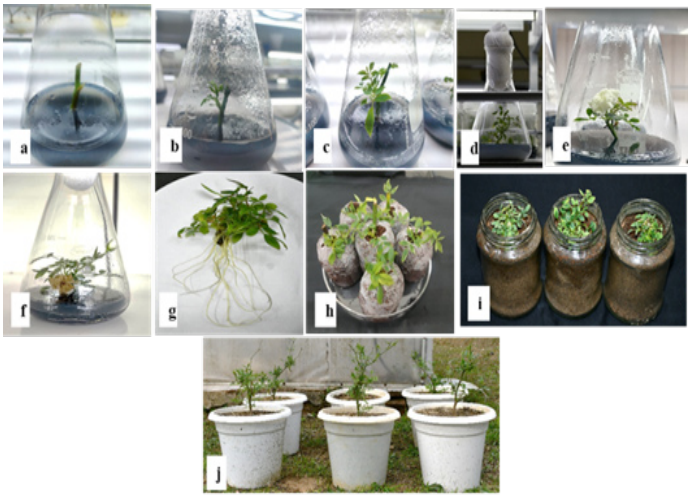

Fig. 3 Micropropagation of miniature rose cv. Ice fairy. explant cultured (a); culture showing shoot initiation (b); leaves appear on shoot after a week (c); after first subculturing (d); apperaence of first flowering after second subculturing (e); flask showing appearance of second bud (f); plant with elongated shoots and roots after third subculturing (g); healthy plants tranferred to cocopeat pellets (h); plants transferred to autoclaved jars containing sand:coco-peat:soil for a week (i); acclimatized plants in pots (j).

Relevant Publications:

- Plant Foods for Human Nutrition. (2025), 80(1): 60.
- Food Chemistry. (2025), 479: 143731.

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

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Plant Breeding

In our 'Plant Breeding' lab we are working on genetic improvement and varietal development of German chamomile (*Matricaria recutita*), lavender (*Lavandula angustifolia*), phuskarmool (*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 revival of traditional plants like grain amaranth species and different millets in Himachal Pradesh through identification of potential variability.

Assessment of variation in foxtail millet germplasm for yield and component traits in western Himalayan conditions

A total of one hundred sixty-six different genotypes of foxtail millet were evaluated in augmented design. Row to row distance was kept at 45 cm and plant to plant distance at 15 cm. Three plants from each genotype were randomly selected before harvesting and data of plant height (cm), number of tillers, panicle length (cm), panicle girth (mm), plant biomass (g/plant) and grain yield (g/plant) were observed **(Fig. 1)**. Significant variation was found in the observed traits through analysis of variance. Plant height ranged from 53.33 cm to 200 cm, number of tillers ranged from 1.67 to 19.33, panicle length ranged from 4.67 cm to 31.83 cm, panicle girth ranged from 5 cm to 31.73 cm, plant biomass ranged from 43.50 g to 309 g and grain yield ranged from 2.44 g to 18.99 g per plant. The overall average of plant height was 124.61 cm, number of tillers was 4.39, panicle length was 16.09 cm, panicle girth was 15.97 mm, plant biomass was 113.60 g and grain yield was 9.80 g per plant. Highest plant height was measured for the genotype FM164, highest number of tillers was found for FM26, highest panicle length was measured for FM14, highest panicle girth was measured in FM2, highest plant biomass was measured for FM166 and highest grain yield was measured for FM122.

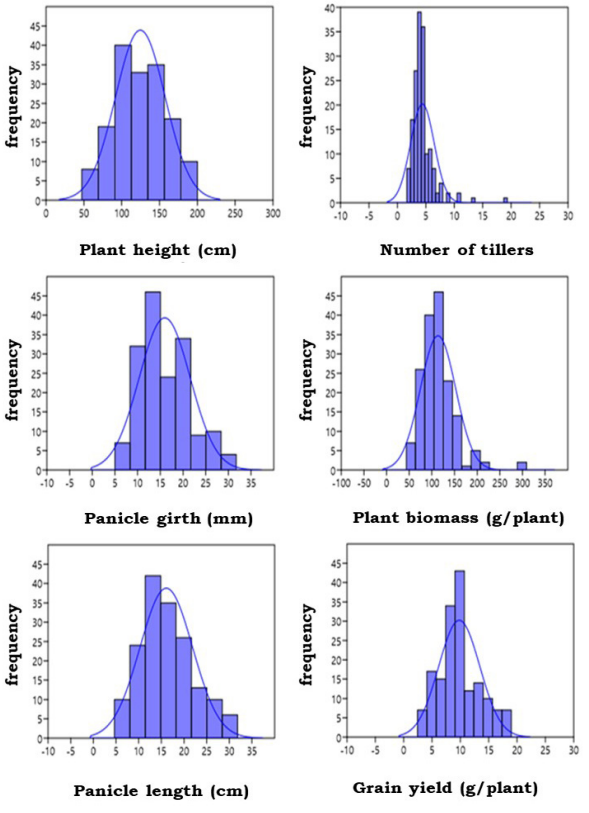


Fig. 1 Frequency distribution of all the studied traits.

Genetic relationship among different genotypes and yield contributing traits of grain amaranth

Amaranth is a promising underutilized crop with huge species diversity and could offer the opportunity to identify superior genotypes for nutritional, yield and related traits for Himachal Pradesh. Therefore, the present study evaluated 67 genotypes from three grain Amaranth species in an augmented design at CSIR-IHBT, Palampur. The analysis of variance was found significant for plant height (cm), leaf length (cm), leaf width (cm), petiole length (cm), day to flowering (days), inflorescence length (cm), lateral spikelet length (cm) and grain yield (g/plant). The result shows that these traits have enormous genetic variation. The cluster analysis partitioned all 67 genotypes in four groups **(Fig. 2)**. The cluster CI had 10 genotypes, CII had 30 genotypes, CIII had 24 genotypes and CIV contained only 3 genotypes.

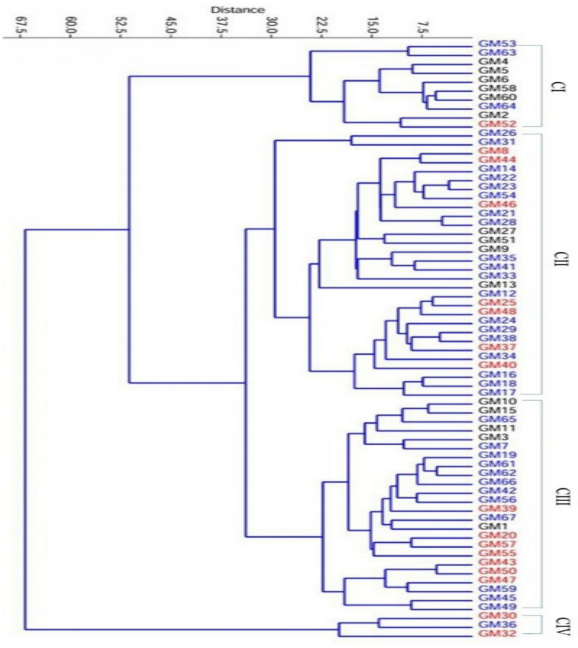


Fig. 2 Genetic kinship among studied genotypes of grain amaranth.

Cluster IV has the highest mean value for leaf length, leaf width, petiole length, inflorescence length, lateral spikelet length, plant height, and yield. Hence, genotypes from Cluster IV ie., GM30 (EC-277971), GM32 (EC-289408), and GM36 (EC-359419) could be promising in future breeding programs for Western Himalayas. All three genotypes in Cluster IV belong to *Amaranthus cruentus* species. Further among traits, inflorescence length and lateral spikelet length were positively associated with grain yield, making them key contributors to productivity **(Fig. 3)**. Plant height positively correlated with several traits, including leaf width, leaf length, and grain yield, suggesting its importance in overall plant performance. These findings suggested that traits like plant height, inflorescence length and lateral spikelet length are critical targets for breeding programs aimed to enhance grain yield.

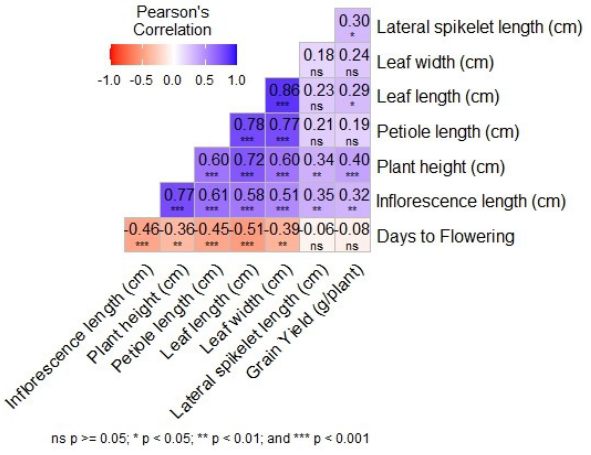


Fig. 3 Genetic association among grain yield and component traits in amaranth.

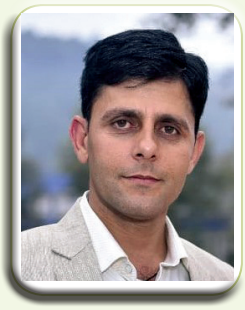
Genetic insights of nutritional traits in pearl millet

Diversity patterns and genome wide association studies (GWAS) for important nutritional and anti-nutritional traits such as protein, amino acids, minerals, phytic acid, lipids and fatty acids were conducted on an international germplasm panel of pearl millet (known as PMiGAP) using a set of 435K SNPs with Aberystwyth University, United Kingdom.

Relevant Publications:

- Food and Energy Security. (2024), 13:565.
- Planta. (2024), 260:63.
- Journal of Food Composition and Analysis. (2024), 134:106557.

Research group: Navjot Kaur, Asmita Saini, Pratibha Pandey, Hari Sharan, Pitrush Dhruwey, Garima Thakur, Shubham Verma and Ajeta Katoch.



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Agronomy

Our research group is focused on the development of agrotechnologies for *Salvia sclarea, Inula racemosa, Cinnamomum verum, Curcuma caesia, Ferula assa-foetida,* and *Dracocephalum heterophyllum.* We are also involved in the introduction and area expansion of *F. assa-foetida* and *C. verum* in the non-traditional areas of Himachal Pradesh.

Effect of agronomic factors on essential oil yield and compostion of Pushkarmool

Pushkarmool (*Inula racemosa* Hook. f.) is a critically endangered medicinal herb known for its rejuvenating and immunomodulatory properties. It also exhibits hypoglycemic, cardioprotective, antimutagenic, antiapoptotic and antianginal properties. A field experiment was conducted in the Lahaul valley to standardize the planting geometry and nutrient dose to get a high essential oil (EO) yield with targeted marker compound. No significant differences were observed in EO content with planting geometry; however, the highest nutrient dose (150:90:50 kg ha^{-1}) produced a higher oil content than other doses. Similarly, planting geometry of 30×45 cm resulted in the highest EO yield than other. In case of nutrient dose, 150:90:50 kg ha^{-1} produced the highest EO yield, which was 125.4% higher than that of control. However, the percent increase from 90:60:30 kg ha^{-1} to 120:75:40 kg ha^{-1} was higher than that of 120:75:40 kg ha^{-1} to 150:90:50 kg ha^{-1}. The major essential oil constituents alantolactone, isoalantolactone, and β-elemene ranged from 59.44–63.65, 31.38–34.68 and 0.24–0.33%, respectively **(Fig. 1)**.

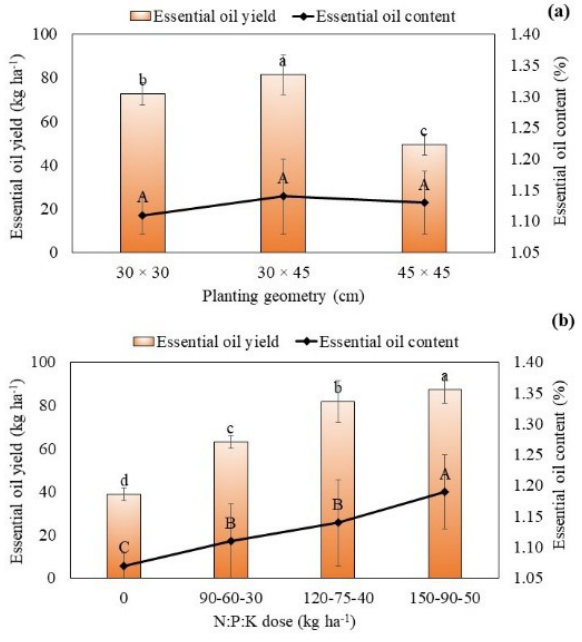


Fig. 1 Effect of planting geometry (a) and nutrient dose (b) on essential oil content and yield of *I. racemose*.

Synergistic effect of mulch and nitrogen management on EO content and composition of clary sage

Balanced plant nutrition and optimal micro-climate are critical factors for achieving higher production sustainably. Substituting mineral fertilizers with organic amendments under water-conserving strategies like mulch can enhance the yield and quality. An experiment was conducted to examine the synergistic effects of mulch and reducing inorganic fertilizers and partially substituting organic amendments on EO content and composition of clary sage (*Salvia sclarea).* Applying mulch significantly increased the concentration of sclareol (7.07%) over no mulch conditions; however, linalool (22.80%) and linalool acetate (29.16%) were maximum under no-mulch conditions. Among nitrogen (N) management practices, 100% N through chemical fertilizer (CF) outperformed for EO content i.e. 42.46% higher over control. While, linalool (23.52%), linalool acetate (29.41%) were accumulated maximum under control. Similarly, sclareol (7.80%) was recorded

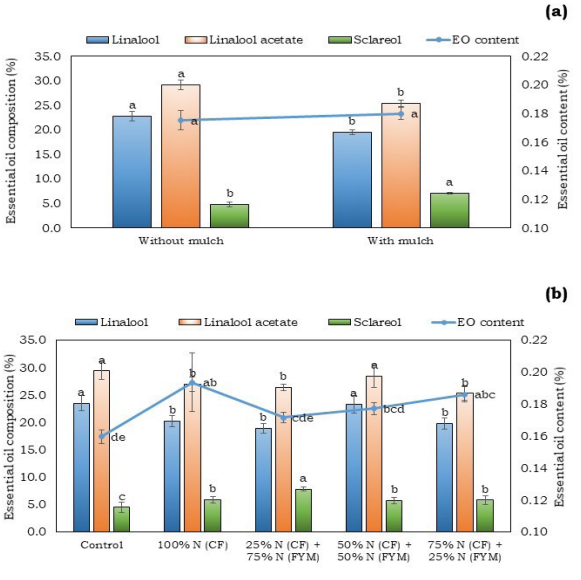


Fig. 2 Effect of mulch (a) and N management (b) on EO content and composition of clary sage.

significantly highest in treatment with 25% N through CF+75% N through FYM compared to control **(Fig. 2)**.

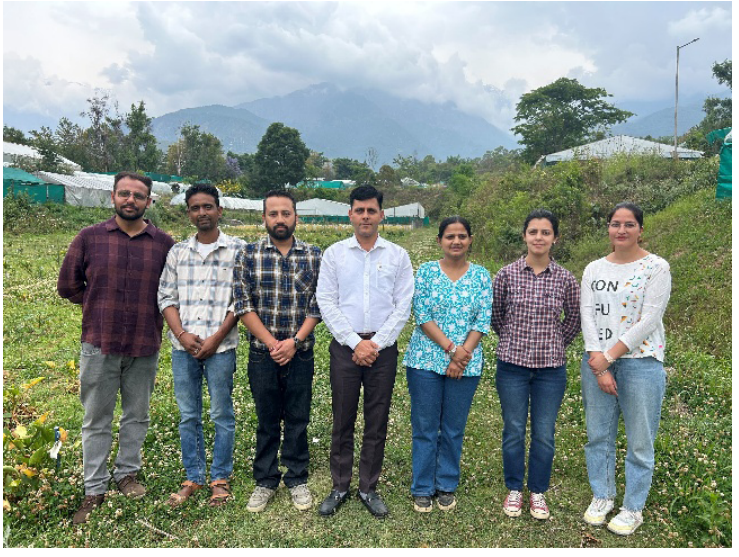
Area expansion under Heeng cultivation

In continuation with the area expansion under Heeng cultivation, 11,964 plants have been distributed during 2024-25 to the farmers of Distt. Kinnaur, Chamba, Kullu, Mandi and Lahaul & Spiti of Himachal Pradesh to cover an area of about 4.42 Acre. Besides this, more than 20,000 plants have been generated for distribution in the next year. Under this program, thirteen (13) on-farm training programs were conducted, and 190 farmers, including officers of State Departments, were trained.

Relevant Publications:

- Scientific Reports. (2024), 14: 32075.
- Scientia Horticulturae. (2024), 338: 113740.

Research group: Diksha Dhiman, Tamanna Bhalla, Mohit, Varun Parmar, Gaytri Hetta.



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Field/plantation crops, Rhizosphere management

Our research group is focused on the introduction of fruit crops like dragon fruit and avocado in non-traditional areas of Himachal Pradesh. Our approach is focusing on the rhizospheric interventions and plant functional traits-based strategies to establish these fruit plants and other commercially important plants for their conservation, characterization, development of agrotechnology and postharvest technology. The initial trials are being undertaken to develop agro-technologies for these fruits and other commercially important plants in the western Himalayan region.

Artificial light at night (ALAN) interaction with seaweed and GA3 for improving growth and productivity by modulating the plant functional traits in Gladiolus

In this experiment, different treatment combinations of seaweed and GA3 *viz.*, GA3 @ 100 ppm, 200 ppm, 300 ppm, 400 ppm, seaweed @ 5%, 10%, 15%, GA3-100 ppm+ seaweed-10%, GA3-200 ppm+ seaweed-10%, GA3-300 ppm+ seaweed-10% and GA3-400 ppm+ seaweed-10% were given in two conditions i.e. artificial light at night (ALAN) and natural condition **(Fig. 1)**. The morphological, physiological and leaf spectral indices of gladiolus were measured to see the effect of artificial light on plant growth. The result showed that the highest physiological traits like photosynthesis rate, stomatal conductance, and transpiration rate were significantly influenced by the combined doses of GA3 (200 ppm) and seaweed-10% in artificial light condition. The rate of photosynthesis, transpiration and stomatal conductance in GA3 (200 ppm) and seaweed-10% treated soil were 11.48 µmol CO_2 m^{-2} s^{-1}, 6.58 mmol H_2O m^{-2} s^{-1} and 0.616 mol H_2O m^{-2} s^{-1}, respectively. However, the highest (1.75) water use efficiency was recorded in seaweed @ 5%. The GA3 and seaweed concentrations also significantly influenced the reflectance vegetation indices. The Triangular Vegetation Index (TVI), Photochemical Reflectance Index (PRI), Carotenoid Reflectance Index (CRI), Water Band Index (WBI) and Normalized Difference Vegetation Index (NDVI) were highly influenced by the light condition as compared to natural condition. Among the different treatments, the highest TVI, CRI, WBI and NDVI were observed in combined doses of GA3 (200 ppm) and seaweed-10%. On comparing both conditions, the highest growth rate and net productivity was observed in ALAN than natural condition **(Fig. 2)**. The maximum growth rate (1.05 cm $day^{-1,}$ after 60 days of sowing) was observed in the combined doses of GA3 (200 ppm) and seaweed-10% **(Fig. 3)**. Similarly, the net primary productivity (7.37 µmol CO_2 m^{-2} s^{-1}) was also highest in the combined application of GA3 (200 ppm) and seaweed-10% **(Fig. 4)**.

Fig. 1 Experimental setup under artificial night light conditions.

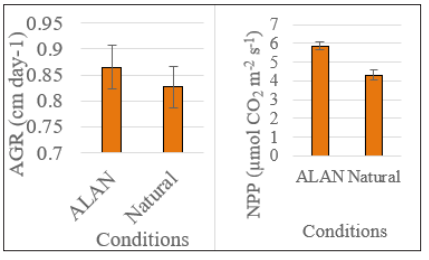

Fig. 2 Absolute growth rate and net primary productivity under artificial light at night (ALAN) and natural conditions.

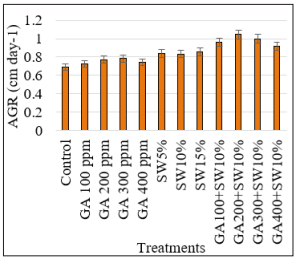

Fig. 3 Effect of different treatment combinations on absolute growth rate of gladiolus.

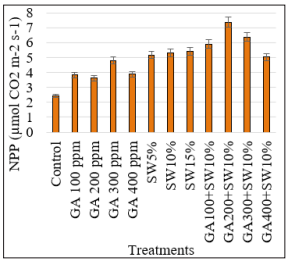

Fig. 4 Effect of different treatment combinations on net primary productivity of gladiolus.

BIOTECHNOLOGY DIVISION

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Waste Managementt

In an agro-industrial waste valorisation study, around 155 bacterial isolates were identified, and 25 potential bacteria were selected for further studies based on hydrolytic and plant growth-promoting potential at 10˚C, followed by their molecular characterisation using 16S rRNA gene sequencing. To assess the safety issue, pathogenicity screening was done using the blood agar spotting method and were found to be non-pathogenic. Subsequently, growth profile experiments were conducted to determine the optimal growth conditions. Whole-genome sequencing was carried out for four potent strains—PHP05:09, CHP03:05, CHP07:08, and CHP07:10—to uncover genomic insights and functional capabilities. The genome analysis of PHP05:09 has led to constructing a draft genome with 3554789 bp, having the largest contig size of 1463185 bp, and 59.64 GC%. The genome blast against the CAZy database revealed 25 genes which encode enzymes for lignocellulosic biomass degradation, and against the PlaBase database deciphered its plant growth-promoting potential with Phosphate and potassium solubilisation, Fe acquisition, N acquisition, and S assimilation.

Sampling and bacterial isolation were conducted from the Darjeeling sites to investigate the landfill microbiome. The comprehensive screening for hydrolytic activity, plastic degradation (including LDPE, PET, and PVC), and pine needle degradation was carried out. Three strains with high LDPE-degrading potential and strong candidates for PET and PVC degradation were identified. Hydrolytic bacteria capable of utilising pine needles as the sole carbon source were also isolated. The16S rRNA-based identification of the most promising strains were done, and the whole genome of a *Bacillus licheniformis* isolate was successfully assembled. The quantitative screening was completed, and future studies on pine needle degradation will be carried out.

Multi-hydrolytic anaerobic bacteria were used to check the degradation of organic waste at 20 ℃, in an anaerobic digestion batch-scale reactor. The experiment was performed in four reactors, i.e. control (C1): Kitchen waste + cow dung (1:1), Test (T1): Kitchen waste + cow dung (1:1) +10% microbial consortia, control (C2): Cow dung, test (T2): Cow dung + 10% consortia. This experiment revealed that adding a microbial consortium significantly improved the anaerobic digestion process in both food waste–cow dung and cow dung-only setups, enhancing the overall efficiency of organic waste conversion and biogas generation. Further, the effect of various anaerobic digestates was checked on wheat (*Triticum aestivum* L.) after growing for 30 days, in selected treatments i.e. Sample control 1 (Kitchen waste + cow dung (1:1)), Sample test 1 (Kitchen waste + cow dung (1:1) +10% microbial consortia), Sample control 2 (Cow dung), Sample test 2 (Cow dung + 10% consortia). All the digestate samples were used in different concentrations, i.e. 100%, 75%, 50%, and 25%, significant differences in shoot and root growth in the pots supplemented with digestate were observed.

Plant Growth Promotion

Continuing further work on PGPR, a field trial was laid at GNDU Amritsar, to evaluate the effect of selected PGPR in combination with mycorrhizal fungi on baby corn cultivation, and it was found that the bioinoculants exhibited a strong synergistic effect, significantly enhancing plant vigour and productivity. Further, effect of PGPR and mycorrhiza were also assessed in field on saffron at Palampur (H.P). The combined formulation significantly increased the flowering in Saffron and encouraging leads are observed on corm production.

Fig. 1 Baby corn field trial at GNDU, Amritsar. Visualised below the first picture s the corresponding Mycorrhizal infection in treated baby corn plants (20 X, Nikon).

Fig. 2 Saffron field trial at Palampur.

The heavy metal tolerance was evaluated of previously isolated PGPRs and unrestingly some of the isolates were found to tolerate high concentration of several heavy metals like lead, chromium and cadmium (Cd). Moreover, the strains accumulated approximately more than 90% of Pb, Cr, and Cd. The AAS and TEM/EDX studies confirms this bioaccumulation. Whole-genome analysis of selected strains revealed the presence of key genes involved in heavy metal uptake, including different types of P-type transporters, cation diffusion facilitator family, efflux RND transporter, which helps explore the mechanism of heavy metal uptake by PGPRS. Notably, the selected PGPR strains demonstrated significant potential for the bioremediation of heavy metal-contaminated water by actively sequestering toxic metals. Furthermore, irrigation of plants with PGPR-treated water also positively influenced plant growth parameters (shoot length, root length, and total roots) under heavy metal stress, enhancing biomass accumulation, nutrient profiling, and reducing oxidative damage.

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Plant Microbe Interaction involving viral pathogens

The lab works in the area of plant microbe interaction involving viral and viroid pathogens.

Cucumis sativus glycine rich protein interacts with cucumber mosaic virus 2b protein

The development of plant stress tolerance is critical in agriculture and horticulture. During viral infection (biotic stress), various plant host factors engage in interactions with viral proteins leading to gene expression dynamics, differential complex formation, signaling, and metabolite production and subsequent tolerance/ resistance or susceptibility. It was found that during cucumber mosaic virus (CMV) infection in Cucumis sativus, glycine-rich protein (CsGRP) associates with the CMV 2b protein, using yeast two-hybrid assay, validation using in planta bimolecular fluorescence complementation (BiFC) and in vivo far western blotting assays. In BiFC, the bimo-lecular complex of CsGRP and 2b was observed as punctate spots in *Nicotiana benthamiana* epidermal cells. In the localization and colocalization studies, CsGRP and the bimolecular complex of the CsGRP-2b protein were found to be localized in the cell wall region. Phylogenetic analysis and domain architecture studies revealed that the interacting CsGRP belongs to the class II of GRPs, and are characterized by signal peptide, glycine-rich, and cysteine-rich regions. After CMV infection, the expression of the CsGRP transcript was significantly upregulated at 7 and 14 days' post virus inoculation. These findings shed light on the molecular connections that establish plant-virus interactions and highlight the potential role of CsGRP in CMV-induced disease development (**Fig. 1**).

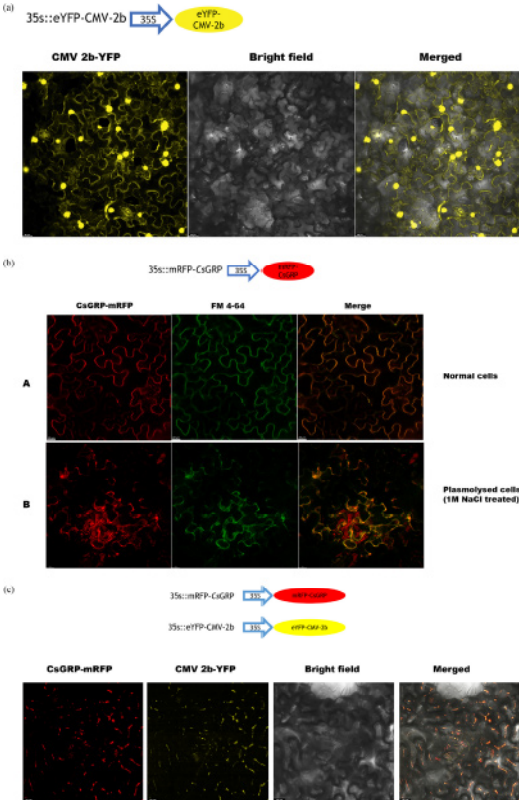

Fig. 1 The CMV 2b protein colocalizes with CsGRP in the cell wall region. (a) Subcellular localization of CMV 2b and protein observed under a confocal microscope. Fluorescence signal observation of *N. benthamiana* leaves transiently expressing 35S::CMV 2b:YFP in the nucleus and cytoplasm. (b) Subcellular localization of CsGRP and protein observed under a confocal microscope. Fluorescence signal of *N. benthamiana* leaves transiently expressing 35S::CsGRP:RFP along with FM464 at the cell wall in normal cells (A) as well as in 1 M NaCl-treated plasmolysed cells (B), (c) colocalization of the CsGRP and CMV-2b proteins observed under a confocal microscope. Fluorescence signal observation of *N. benthamiana* leaves transiently coexpressing 35S::CsGRP:RFP and 35S::CMV-2b:YFP at the cell wall as puncta; bright field and merged images of signals in *N. benthamiana* epidermal cells were compared. Bar, 20 mm.

A rapid pipeline for qualitative profiling of free amino acids in plant tissues using Liquid Chromatography- Mass Spectrometry in conjunction with MS- DIAL

The estimation of relative levels of amino acids is crucial for understanding various biological processes in plants, including photosynthesis, stress tolerance, and the uptake and translocation of nutrients. A wide range of liquid chromatography (LC; HPLC/UHPLC)-based methods are available for measuring the quantity of amino acids in plants. Additionally, the coupling of LC with mass spectrometry (MS) significantly enhances the robustness of existing chromatographic methods used for amino acid quantification. However, accurate annotation and integration of mass peaks can be challenging for plant biologists with limited expe-rience in analyzing MS data, especially in studies involving large datasets with multiple treatments and replicates. The present protocol provides a detailed LC–MS method for obtaining a qualitative amino acids profile using MS- DIAL, a versatile and user-friendly program for processing MS data. Free amino acids were extracted from the leaves of control and Tomato leaf curl Palampur virus (ToLCPalV)- infected *Nicotiana benthamiana* plants. Extracted amino acids were derivatized and separated using UHPLC- QTOF, with each amino acid subsequently identified by aligning mass data with a custom text library created in MS- DIAL. Further, MS- DIAL was employed for internal standard- based normalization to obtain a qualitative profile of 15 amino acids in control and virus- infected plants. The outlined method aims to simplify the processing of MS data to quickly assess any modulation in amino acid levels in plants with a higher degree of confidence.

Relevant Publications:

- South African Journal of Botany. (2024), 17: 67-76.
- Journal of Mass Spectometry. (2024), 59(10): e5094.

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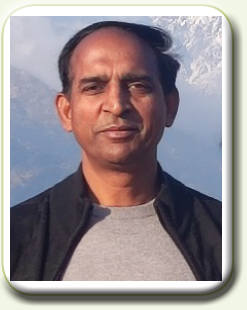

Our group utilize Molecular Genetics and Genomics approaches for harnessing natural diversity for genetic improvement of Himalayan plant genetic resources and commercial important plant species. I am the Key Investigator of CSIR Aroma Mission, CSIR Mission on Genome Editing for Crop improvement and various projects sponsored by DBT. In continuation of the previous reports, the group made following significant achievements during the period under report.

High-quality haplotype-resolved whole genome sequencing of *Stevia rebaudiana* Bertoni: Evolutionary and targeted steviol glycosides (SGs) biosynthesis insights

Recent research evidences support that the consumption of high-calorie sugar-rich diets can lead to several metabolic disorders, such as type 2 diabetes mellitus (T2DM) and obesity. To cater this, plant-derived low/no-calorie natural sweeteners (LNCSs) are gaining global attention due to their low glycaemic effects. *Stevia rebaudiana* Bertoni (2n = 22) accumulates ent-kaurene diterpenoid glycosides collectively referred to as steviol glycosides (SGs), and have been commercially exploited as a potential source of plant-derived natural LNCSs. Nevertheless, genetic predisposition for targeted biosynthesis of SGs is complex due to multi-substrate functionality of key uridine diphosphate glycosyltransferases (UGTs). The high-quality haplotype-resolved chromosome level genome assembly could provide critical information on allelic variations with evolutionary insights and their meaningful biological impacts. Therefore, during the year, a high-quality monoploid assembly of 1.34 Gb was created with N50 value of 110 Mb, and 55 551 predicted protein-coding genes in Rebaudioside-A (Reb-A) enriched cultivar of *S. rebaudiana* **(Fig. 1)**.

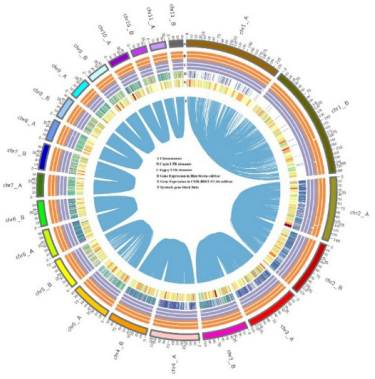

Fig. 1 Genome characteristics representing the distribution of genomic features in the haplotype-resolved genome of *S. rebaudiana*. From outside to inside; (A) Chromosome number, (B) Copia elements distribution, (C) Gypsy element distribution, (D–F) Gene expression and the links in the centre connect syntenic gene blocks.

Additionally, a haplotype-based chromosome assembly consisting of haplotype A and haplotype B with an overall genome size of 2.33Gb was resolved, harbouring 639 634 variants including single nucleotide polymorphisms (SNPs), indels and structural variants (SVs). We discovered ~80% of repetitive sequences in stevia genome, wherein, LTR transposons account for approximately 70%. Furthermore, we found a higher number of intact LTR-RTs (23 388) than in the previous assembly, with intact Ty1-copia (5380) and intact Ty3-gypsy (14 181). Furthermore, a lineage-specific whole genome duplication analysis revealed that gene families encoding UGTs and Cytochrome-P450 (CYPs) were tandemly duplicated **(Fig. 2)**.

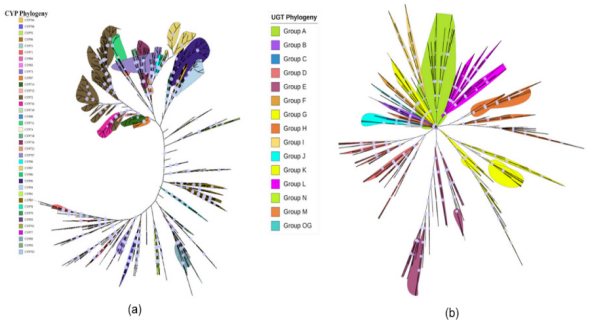

Fig. 2 Characterization of CYPs and UGTs in the haplotype-resolved genome of *S. rebaudiana*. (a) Phylogenetic tree of Cytochrome P450 (CYP) gene family. (b) Phylogenetic tree of the Uridine diphosphate glycosyl transferase (UGTs) gene family.

Additionally, expression analysis revealed five tandemly duplicated gene copies of UGT76G1 having significant correlations with Reb-A content, and identified key residue (leu200val) in the glycosylation of Reb-A (**Fig. 3**).

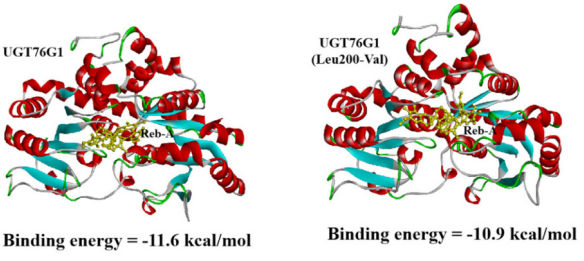

Fig. 3 Molecular docking analysis of UGT76G1 with Reb-A in genome of *S. rebaudiana*.

Furthermore, missense variations identified in the acceptor region of UGT76G1 in haplotype resolve genome, transcriptional and molecular docking analysis were confirmed with resequencing of 10 diverse stevia genotypes (~25X). Gene regulatory network analysis identified key transcription factors (MYB, bHLH, bZIP and AP2-ERF) as potential regulators of SG biosynthesis. Overall, this study provides haplotype-resolved chromosome-level genome assembly for genome editing and enhancing breeding efforts for targeted biosynthesis of SGs in *S. rebaudiana*. ***(Masand, M. – Sharma, R.K. et al. (2024) Plant Biotechnol. J, 22: 3262-3277. https://doi.org/10.1111/pbi.14446)***

Microsatellite marker resource creation and genetic diversity in *Valeriana jatamansi* Jones

Medicinal aromatic plants (MAPs) being a repository of enormous bioactive specialized metabolites, have been used to cure a variety of human ailments since millennia, and provide raw materials for pharmaceutical and aroma industries. Among 16 species found in India, *Valeriana jatamans*i Jones (synonymous: V. wallichii DC; family Caprifoliaceae; common name: Indian valerian, Muskbala, Tagar) is a perennial polyploid herb with a haploid genome size of 1.5 Gb having global significance in the pharmaceutical and aromatic industries. *Valeriana jatamansi* Jones, a potential ethno-medicinal herb of global importance faced an unprecedented threat of its habitat loss due to burgeoning global demand. Genome-wide microsatellites or simple sequence repeats (SSRs) marker resources are advantageous, unfortunately, such larger resources have not been explored for genetic improvement in *V. jatamansi*. In the present study, transcriptome-derived functionally relevant microsatellite marker resources comprising 7957 SSR markers with significant homology (66.3 %) with public functional databases were created. Interestingly, 103 putative functional SSR markers derived from unigenes exhibited substantial annotations with secondary metabolite biosynthesis, transcription factors, and transporters were synthesized and experimentally validated in diverse genotypes (**Fig. 4**).

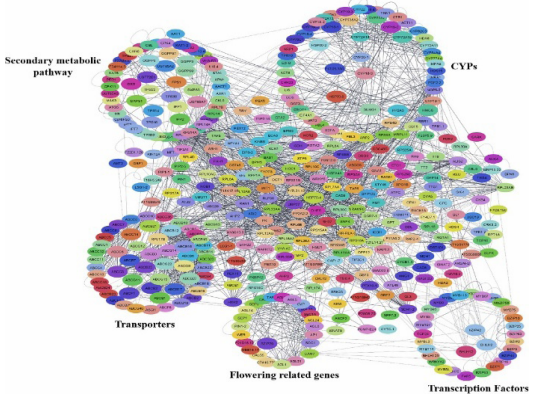

Fig. 4 Protein-Protein Interaction (PPI) network of transcripts harbouring key functionally relevant SSR markers in *Valeriana jatamansi*.

SSR loci with good marker attributes (average alleles/ locus: 7.5; PIC: 0.44; resolving power: 5.25) were successfully utilized for genetic population structure analysis of 525 genotypes representing 29 geographically diverse populations. Despite representing three genetic populations, north-western Indian Himalayan regions (wIHR) exhibited with low genetic diversity (h: 0.22) with moderate gene flow (Nm: 0.97) and high molecular variance (71 %) within population (**Fig. 5**).

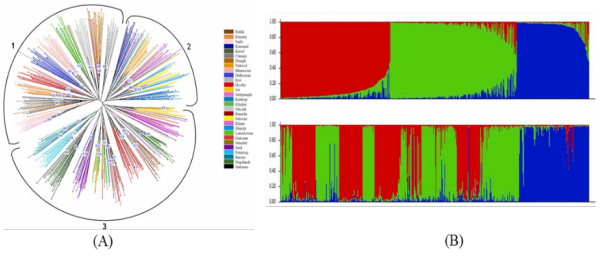

Fig. 5 (A) Neighbor-Joining dendrogram of 525 genotypes (29 populations) of *V. jatamansi* based on genetic distance along with bootstrap values ≥50% (1000 replicates) and (B) Bayesian model of population genetic structure analysis using admixture model showing three clusters.

Moreover, the predicted core of 53 genotypes representing 21 diverse populations was validated successfully using NJ clustering and regression correlation (R2 > 0.85). Additionally, future habitat suitability is predicted to decline in at least 49.89 % habitat area of *V. jatamansi*. Hence, climatic zones with improved suitability can be potential geographical areas for its conservation and sustainable cultivation. The current findings including huge molecular markers resources, diversity inferences, and identification of core collections will facilitate gene bank management, selection of potential parental groups/ cultivars for implementation of molecular breeding strategies, genetic improvement, and sustainable cultivations of *V. jatamansi* for industrial utilization. ***(Devi, A. – Sharma, R.K. et al. (2025) Journal of Applied Research on Medicinal and Aromatic Plants 45: 100616; https://doi.org/10.1016/j.jarmap.2024.100616).***

Relevant Publications:

- Plant Biotechnology Journal. (2024), 22(12): 3262-3277.
- Industrial Crops and Products. (2024), 214: 118504.
- Food Research International. (2025), 209: 116312.

Research group: Dr. M. Saba Rahim; Dr. Amna Devi; Ms. Mamta Masand, Ms. Shikha Sharma;Mr. Balraj Sharma; Ms Palak Sharma; Ms Swati; Ms. Shimran Yadav; Ms. Sangeeta Kumari; Mr. Naveen; Ms Ritisha; Ms. Nidhi; Mr Jatin Kumar.

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Computational Biology

"All things are numbers and mathematical shapes" : Pythagoras

With this philosophy our team approaches the problems in molecular biology where we transform the problems into numbers and mathematical universe. Once the matter is transformed into numbers in mathematical shapes, it naturally becomes computable. What it takes to solves years by experiments, and that too in reductionist manner, the findings and solutions made by computational biology are much faster and grossly universal. Though it takes a lots of efforts to recognize and find out the suitable mathematical system for any given problem. Our problems comes from genomics, epigenomics, regulomics, systems biology, and interactomics.

Plant transcription factors binding discovery

We all know the every biological entity is the resultant of time and space specific expression of genes, their symphony. This symphony decides the fate and look of the organism in any given situation and time. This symphony is orchestrated by regulators which basically work at two levels: Transcriptional and post-transcriptional. Transcription factors are transcriptional regulators.

In plants, finding their binding at DNA has been marred with wrong age old practises. Models from other plant species are used to decode them, while fact is that plants display enormous variability across species. So far, there was no universal model to decode plant TF:DNA interactions, forcing biologists to use Arabidopsis like model organisms information to find TFs and their binding sites in newly sequenced genomes, which in turn generated lots of false results and information.

For the first time, we have developed an AI based universal solution, PTFSpot, where the founding hypothesis was that the functionality and shapes are related. If one learns the transitions of these associations for TF structures and their binding preferences from already available binding experimental data, it becomes feasible to bring out a universal model of TF:DNA interactions which can work with consistent and high accuracy even for completely newly sequenced genomes and unannotated ones, besides disclosing first time the different binding preferences for the splice variants within the same organism.

PTFSpot was evaluated across trans species experimental binding data for >150 transcription factors and multiple plant species. Across all of them, it maintained a consistent performance of >90% accuracy, while taking lead of >30% from the second best performing software which failed terribly in cross-species applications. With our developed approach now one can perfectly carry out discovery of TF binding across any species. PTFSpot also bypasses the need of costly DAP-seq like experiments, savings large amount of money and time (**Fig. 1**).

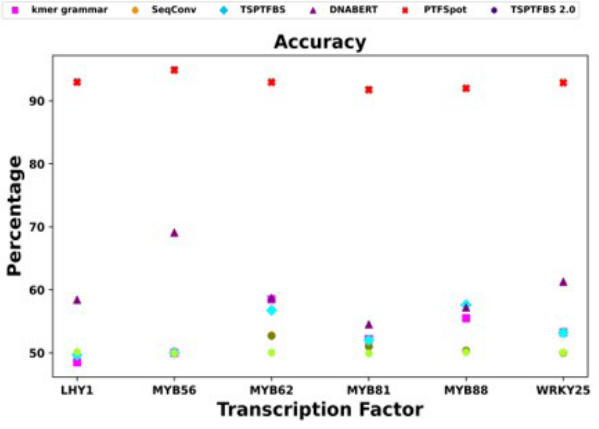

Fig. 1 Performance of PTFSpot in detecting the TF binding region accurately, while outperforming existing tools by at least 30% lead. PTFSpot maintained at least 91% accuracy for any given TF and plant species, even for completely new species/ genome/TF.

Evaluation of software tools in plant TF interaction studies

This year has also seen a highly comprehensive evaluation study to set-up a guideline towards approaching various stages in plant TF and DNA interactions studies. In doing so more than 25 state-of-art software tools and algorithms have been evaluated.

We started with evaluation of tools involved in detecting the TF binding peaks from binding experiments like ChIP-seq. These tools are fundamentals for generating the binding experiment outcomes by detecting the peaks. Any flaw at this stage generates false binding experiment data. We found that MACS2, LanceOtron and PeakRanger were most credible tools for this job.

Next stage was evaluation of algorithms for Transcription factor binding regions (TFBR) discovery. It was found that barring PTFSpot, no other existing tools for plant was reliable for such discovery. Deep-learning based algorithms usually scored high. And, a very interesting thing was noted, the algorithms developed for animals, if were trained on plants specific data, outperformed most of the existing tools developed for plants, except PTFSpot which our group has developed. **Fig. 2** below illustrates this all.

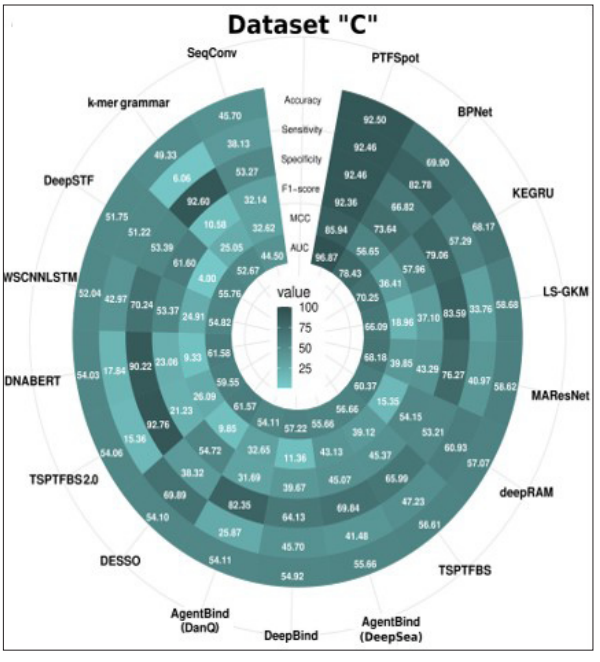

Fig. 2 Performance of TFBR discovery tools.

Decoding the microbiome of Himalayan dairy product Chhurpe

In collaboration with our neutraceutical group, we carried out metagenomic analysis of various dairy products and decoded the metagenomic profile of a high-altitude dairy product Chhurpe, a fermented cheese. Chhurpe was found rich in lactobacillus genera with *Lactobacillus*, *Leuconostoc*, *Lactococcus*, and *Streptococcus* followed by acetic acid bacteria, mainly *Acetobacter*. Species diversity was significantly higher in Chhurpe prepared from *Zomo milk*. Probiotic bacterial strains such as *Lactobacillus helveticus, L. delbrueckii, L. brevis, and Leuconostoc mesenteroides* were identified in the Zomo Chhurpe indicating their superior quality, as also displayed by **Fig. 3** below.

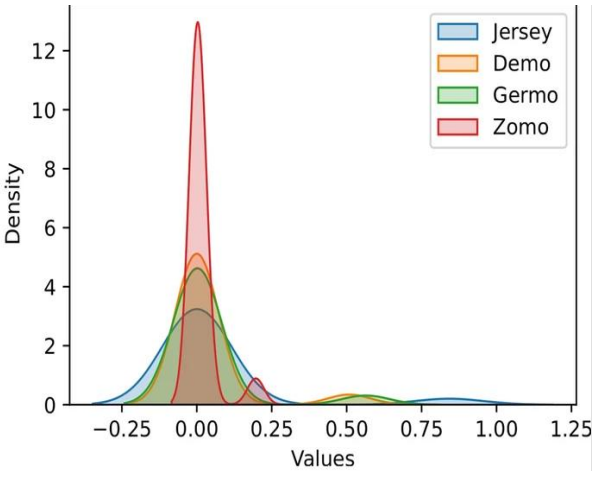

Fig. 3 Microbial diversity was observed high in Zomo chhurpe at species level.

Genome-wide identification of WUSCHEL-like transcription factor in *Picrorhiza kurrooa*.

In another collaborative study with our tissue culture group, we studied *WUSCHEL-related homeobox* (*WOX*) genes which are plant-specific homeobox transcription factors and are known to play a key role during *in vitro* embryogenesis and organogenesis. To decipher the structural basis and genetic diversification of *WOX* family genes, this study performed a genome-wide analysis in Plantaginaceae. Five *WOX* and one *WUS* members were identified in the *P. kurrooa* genome. The WOX genes promoters were specifically enriched for AP2, bHLH, bZIP, Dof, and Myb/SANT. Total 124 binding regions in the 2KB upstream promoter regions of WOX genes were found by PTFSpot. The most abundant binding regions were found for ABI3, HY5, and cDOF2. On co-expression analysis, all these TFs displayed very strong correlation with corresponding target WOX genes, confirming their regulatory stakes in WOX gene regulation in *Picrorhiza kurrooa*.

Relevant Publications:

- Heliyon. (2024), 10(20): e39140.
- In Vitro Cellular & Developmental Biology – Plant. (2024), 60(4): 439-455.
- Briefings in Bioinformatics. (2024), 25(4).

Research group: Sagar Gupta, Jyoti, Veerbhan Kesarwani, Umesh Bhati, Komal, Akanksha Sharma, and Anchit Rana.

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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: -

Genome derived L-asparaginase from eurypsychrophilic *Iodobacter* sp. PCH194 for therapeutic and food applications: L-asparaginase (EC 3.5.1.1) is an important enzyme, primarily used to treat acute lymphoblastic leukaemia (ALL) and lymphoblastic lymphoma, besides its applications in acrylamide mitigation in foods. L-asparaginases are classified into type 1 (cytoplasmic) and type 2 (periplasmic) based on their location in the cell. The bacterial type-II L-asparaginases are medically important owing to their higher substrate affinity towards L-asparagine. It hydrolyses the blood L-asparagine leading to nutrient deficiency that eventually results in the apoptosis of cancerous cells, which lack L-asparagine synthetase. The normal cells are capable of re-synthesizing L-asparagine. L-asparaginases are also used to reduce acrylamide in foodstuffs which are rich in carbohydrates and amino acids.

Our quest is to better understand L-asparaginase's structural and functional relationship for developing an efficient therapeutic drug. During the current period, a genome mining of L-asparaginase from a unique bacterium, *Iodobacter* sp. PCH194, isolated from the high-altitude Himalayan niches by our research group, was done. The sequence-based novelty, the phylogenetic, and in silico relatedness of the protein with commercial L-asparaginases (**Fig. 1**) intrigued us to express, purify, and further characterize it to explore its cytotoxic vis-a-vis acrylamide mitigating potential.

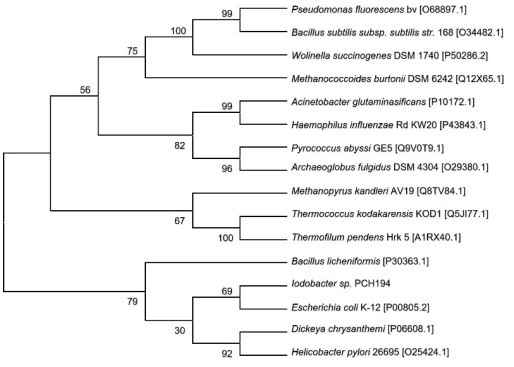

Fig. 1 Neighbor-joining phylogenetic tree based on protein sequences (retrieved from Uniprot/Swissprot database) showing the identity of Id-ASNase II with related genera (accession number in parenthesis). Bootstrap values (expressed as percentages of 1000 replicates) are shown at the branch points.

Iodobacter sp. PCH194 genome was mined for new L-asparaginase (Id-ASNase II). In silico analysis revealed its sequence-based novelty and phylogenetic closeness, including amino acid composition and pI to the commercial bacterial L-asparaginases. Subsequently, the gene was successfully cloned and overexpressed in *Escherichia coli* (*E. coli* BL21 DE3). The monomeric molecular weight of Id-ASNase II was 38 kDa with a native size of 150 kDa. Maximum L-asparaginase activity (80 U mg-1) was achieved in 25 mM Tris-HCl buffer (pH 8.2) at 37 °C after 10 min of incubation (**Fig. 2**).

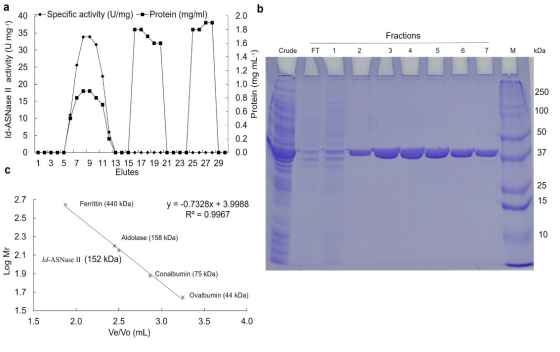

Fig. 2 Purification and molecular weight analysis of recombinant Id-ASNase II. a) Purification profile using Q-Sepharose anion exchange chromatography. b) SDS-PAGE (10%) analysis of recombinant Id-ASNase II. Lane 1 (from left) is total cell lysate (crude); lane 2 is flow-through (FT); lane 3-7 eluted fractions; and M is the protein molecular weight marker. c) Determination of the molecular mass of the native protein by Gel filtration chromatography (Superdex 200 (10/300 GL) column. The arrow indicates the log Mr of the Id-ASNase II. Ferritin, aldolase, conalbumin, and ovalbumin were used as molecular weight standards. Ve and Vo indicate for elution volume of each protein and void volume, respectively.

The enzyme was active in wide pH (5.0-11.0) and temperature ranges (4-70 °C). The half-life (t1/2) of the enzyme at 37 °C was 13.54 h, whereas Km, Vmax, kcat, and kcat/Km were 1.2 mM, 128 µmoles min-1, 82 sec-1, and 63.1 sec-1 mM-1, respectively. Id-ASNase II exhibited cytotoxicity against cell line K562 (IC50 value 0.4 U mL-1) leading to cell cycle arrest in the G2/M phase after treatment.

In conclusion, a new L-asparaginase Id-ASNase II was explored by mining the genome of *Iodobacter* sp. PCH194. Id-ASNase II was successfully expressed, purified, and characterized. The enzyme had a low protein similarity to commercial L-asparaginases but had comparable kinetic parameters suggesting its novelty (**Fig. 3**).

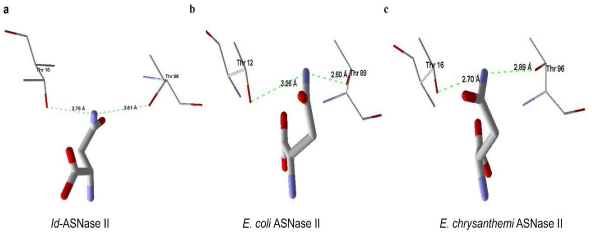

Fig. 3 Docking of L-asparaginases with L-asparagine. Interaction of amino group of L-asparagine with the hydroxyl group of a) Thr16 and Thr96 of Id-ASNase II. b) Thr12 and Thr89 of E. coli ASNase II. c) Thr16, and Thr96 of E. chrysanthemi ASNase II.

The thermostability analysis showed that the enzyme was stable at 50 °C and exhibited prolonged stability at 20 °C and 37 °C. Id-ASNase II demonstrated cytotoxic potential against leukemic and breast cancer cell lines. The cell cycle assessment indicated maximum cytotoxicity in the G2/M phase. The enzyme also displayed potential in reducing acrylamide formation in foods. In-silico characterization showed that the catalytic center was made of Thr16 and Thr96. Owing to the novelty and potential cytotoxicity of Id-ASNase II against cancerous cell lines, future studies will be directed towards understanding the behavior of the protein in the animal model system. The site-directed mutagenesis can be considered to obtain mutants with a high affinity for L-asparagine.

Himalayan bacteria producing biofuelic enzymes and its applications in agro-wastes utilization

We have bioprospected novel bacteria-producing biofuelic enzymes such as processive endoglucanase, xylanase, glucosidase, and laccase. The enzymes have unique properties of broad pH and temperature functionality, multi-substrate specificity, and a higher enzyme activity than commercial wild-type isolates. We developed the bacterial consortia for the substrate-specific (rice straw, wheat straw, and sugar cane bagasse) for the catalysis of natural agro-waste substrates and characterised the chemicals produced. In addition, whole genome sequencing of three potential isolates has been done to reveal their enzymatic and catalytic potential. In another study, an efficient β-glucosidase enzyme from the Himalayan bacteria has been identified. The specific activity of 560 IU/mg after partial purification of wild-type protein was obtained, which is comparatively far better than the reported enzyme activity in the literature. Such work is important for the utilization of agro-wastes for biomass degradation and valorization to generate bioeconomy.

PHA-based bioplastics and pigment biomolecule: For bioplastic, we have mutated the *Iodobacter* strain to raise its optimum temperature from 20°C to 26°C, resulting in rapid growth, reducing the total time period, while increasing biomass and producing a few novel metabolites of pharmaceutical importance. The outcome of this study will lead to the technology development, wherein improved version of bioplastic producing strain along with industrially important metabolites production will the unique features of a mutant *Iodobacter* strain.

Relevant Publications:

- Biologia. (2024), 79: 1525–1537.
- Archives of Microbiology. (2024), 206, 254.
- Journal of Biomaterials Science, Polymer Edition. (2024), 35: 1892-1921.

Research group (From left to right): Sneha, Tamanna, Shamli Chandel, Dr. Dharam Singh, Arushi Katoch, Paridhi Shrivas, Shubam Thakur.

Back row: Matruprasad Mohanty, Samiksha Rana, Bhavna Soni.

Rituraj Purohit, Senior Principal Scientist
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Biotechnology (Bioinformatics)

Our research is focused on evaluating the effectiveness of Himalayan bioactive compounds against a wide range of molecular targets, including phosphodiesterases utilizing advanced biophysical techniques. However, these compounds, known for their polyphenolic nature, often suffer from poor water solubility. Consequently, we are systematically investigating cyclodextrin-based host-guest inclusion complexes to improve the aqueous solubility and stability of biologically important molecules. Our ongoing studies in this academic term have generated valuable insights, demonstrating the potential of our methods in addressing key challenges in drug discovery and formulation.

Identification and evaluation of olefinated benzosuberene analogue as a phosphodiesterase-4D inhibitor with efficacy in a zebrafish larva model of pentylenetetrazole-induced seizures

Phosphodiesterase-4D (PDE4D) is a promising target for neurological disorders, but clinical use of PDE4 inhibitors is limited by side effects. This study identifies compound **5h**, a 1,2,3-triazole-assisted benzosuberene analogue, as a selective PDE4D inhibitor. Computational screening, molecular dynamics, and Replica Exchange MD confirmed **5h'**s stable interaction with the Phe-599 residue, suggesting allosteric inhibition. In a zebrafish seizure model, **5h** delayed seizure onset, reduced hyperactivity, and downregulated c-fos and PDE4D expression. It also modulated the CREB–BDNF pathway. These findings highlight 5h as a potent and selective PDE4D inhibitor with therapeutic potential in epilepsy and related neurological disorders (**Fig. 1**).

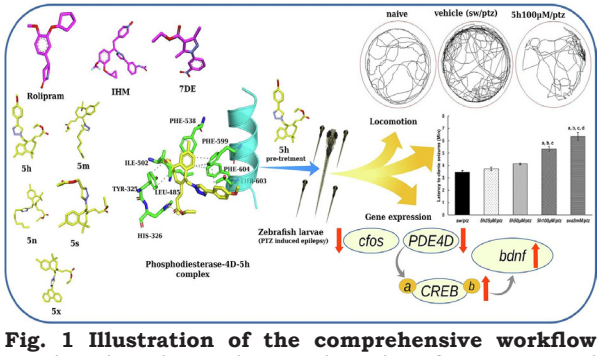

Fig. 1 Illustration of the comprehensive workflow employed in the study aimed at identifying potential inhibitors targeting PDE4D.

A multi-faceted computational and in-vitro analysis to identify potential inhibitors against phosphodiesterase-8A for neurological diseases

Phosphodiesterase-8A (PDE8A), a cAMP-specific enzyme, is a key target in neurological disorders like vascular dementia. This study screened semi-synthesized olefinated benzosuberene analogues to identify PDE8A inhibitors. Compounds AMKPD-48 and AMKPD-39 showed strong binding affinity and stability through molecular docking and dynamics, interacting consistently with Tyr-748, suggesting subtype selectivity. Umbrella sampling and pulling simulations confirmed favorable binding, particularly for AMKPD-48. In vitro assays validated its superior potency. These findings highlight AMKPD-48 and AMKPD-39 as promising leads for PDE8A-targeted therapies aimed at cognitive impairment, supporting further preclinical evaluation for treating neurovascular and cognitive disorders (**Fig. 2**).

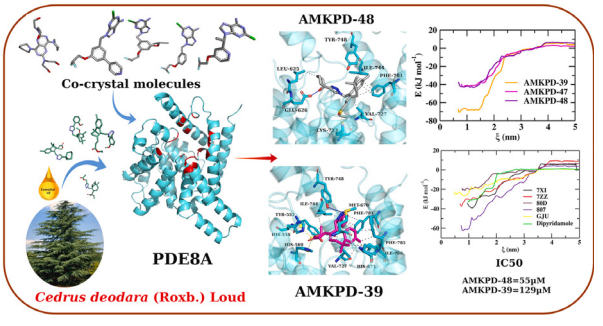

Fig. 2 Graphical representation of PDE8A inhibition by benzosuberene analogues.

Driving forces and large scale affinity calculations for piperine/γ-cyclodxetrin complexes: Mechanistic insights from umbrella sampling simulation and DFT calculations

This study investigates the encapsulation of poorly soluble piperine (PiP) using γ-cyclodextrin (γ-CD) and its derivatives: HP-γ-CD and Octakis-S-γ-CD. Molecular dynamics simulations and umbrella sampling revealed that only Octakis-S-γ-CD and HP-γ-CD retained PiP stably, with Octakis-S-γ-CD showing the strongest binding. Quantum mechanical calculations confirmed the Octakis-S-γ-CD/PiP complex had the most favorable complexation energy (-457.05 kJ/mol). Thermodynamic analyses supported

spontaneous, exothermic complex formation. The enhanced performance of Octakis-S-γ-CD is attributed to its sulfo groups, making it a superior carrier for improving solubility and delivery of bioactive compounds like PiP (**Fig. 3**).

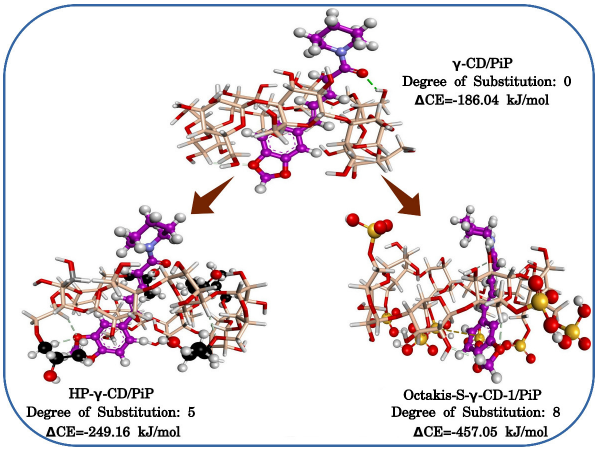

Fig. 3 Molecular dynamics and quantum mechanical analysis-based strategy for selecting optimal CD host to enhance the aqueous solubility of PiP.

Relevant Publications:

- Chemical Engineering Journal. (2025), 507: 160272.
- Materials Today Chemistry. (2024), 42: 102378.
- Carbohydrate Polymers. (2024), 342: 122350.

Research group (From left to right): Pramod Kumar (DBT-SRF), Rahul Singh (ICMR-SRF), Dr. Rituraj Purohit, Dr. Ankita Dhiman, Vidhi Bidaliya (CSIR-GATE), Mukesh Chand Bairwa (NFSC) Amit Daroch (PA), Dr. Ashish Gupta (ICMR-RA), Bhanu Sharma (DBT-SRF).

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Chemical Nanotechnology, Nanobiology and Biomaterials

In our quest to understand how nanomaterials can be used for different healthcare applications, we developed both metal based and polymeric nanoparticles and studied their effect in different cell lines. The outcome of the studies is mentioned below.

Glucosamine-conjugated gold nanoparticles significantly reduce protein aggregation and neuronal cell death by regulating Parkin levels, offering a strong neuroprotective strategy

Recent studies indicate that about 25% of brain glycogen consists of glucosamine (Gln), suggesting its potential role in the nervous system, though its functions are not yet fully understood. This study presents the synthesis and protective effects of glucosamine-conjugated gold nanoparticles (Gln@CA-AuNP) on oligomeric and fibrillar fractions of hen egg white lysozyme (HEWL). Characterized as approximately 30.1±3.7 nm, Gln@CA-AuNP was shown to effectively inhibit HEWL formation and limit protein aggregation nucleation. Experiments with human neuroblastoma cells (SH-SY5Y) demonstrated that Gln@CA-AuNP reduced cell death caused by protein aggregation by inhibiting oligomer formation (by ~2.4 times) and decreasing oxidative stress (by ~3.6 times), improving mitochondrial health. Furthermore, Gln delivery modulated cytosolic Parkin oxidation and restricted autophagic neuronal cell death. Gln@CA-AuNP also enhanced the production of sulfated glycosaminoglycans (sGAGs), suggesting a protective role for the extracellular matrix during protein aggregation toxicity. Notably, neuronal synapses in a *Caenorhabditis elegans* model were preserved after pre-treatment with Gln@CA-AuNP. This research indicates that targeting both early and late aggregates may offer a promising strategy for neurodegenerative disease therapies (**Fig. 1**).

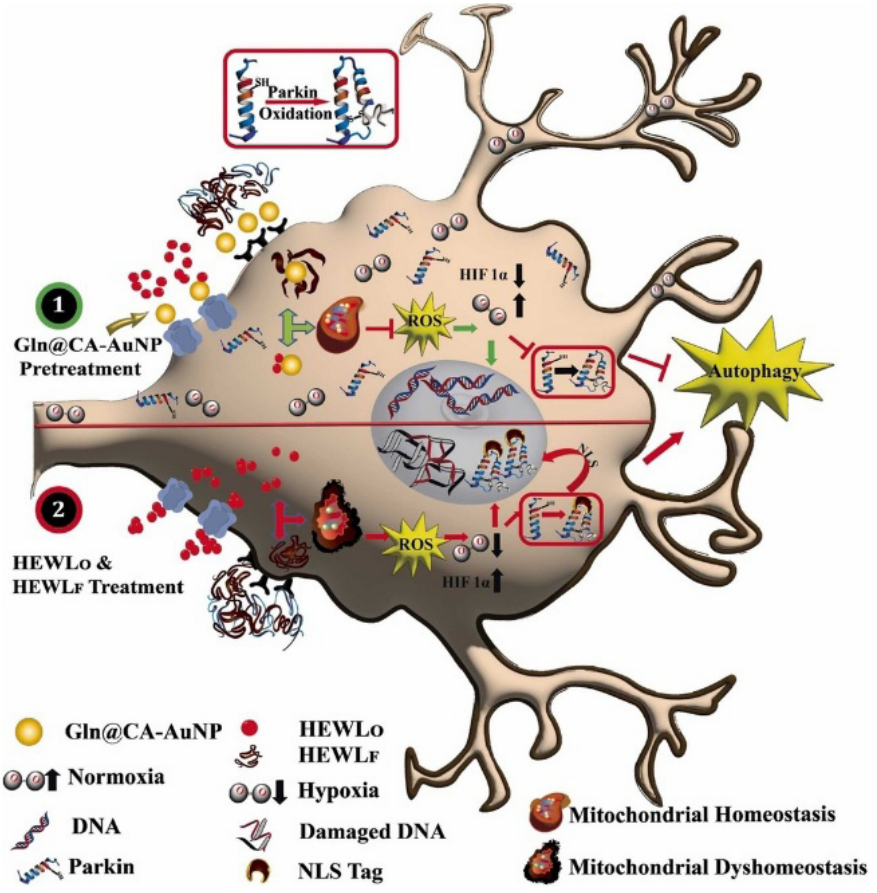

Fig. 1 Glucosamine conjugated gold nanoparticles (Gln@CA-AuNP) inhibits protein aggregation and helps in maintaining neuronal cell health. © Elsevier, 2024.

The transferrin-immobilized graphene oxide nanocomposite offers a promising approach for targeted cancer treatment by effectively increasing intracellular labile Fe2+ concentration, facilitating enhanced chemodynamic therapy

Recent research underscores the importance of regulated cell death (RCD) pathways, including necroptosis, pyroptosis, ferroptosis, and cuproptosis, as promising targets for cancer therapy. In this context, we present the transferrin-immobilized graphene oxide nanocomposite (Tfn@GO_{APTES}) as an innovative treatment option. The study successfully achieved the immobilization of transferrin onto the graphene oxide surface with an efficiency of approximately 74 ± 4%. Tfn@GO_{APTES} demonstrated significant cytotoxic effects on HeLa cells, characterized by increased lipid peroxidation and DNA damage. Furthermore, Western blot analysis revealed decreased acetylation of α-tubulin and increased expression of LC3a/b, suggesting that autophagy plays a central role in the cell death mechanism. This novel approach provides a promising avenue for targeting cancer cells through the enhancement of intracellular iron concentrations (**Fig. 2**).

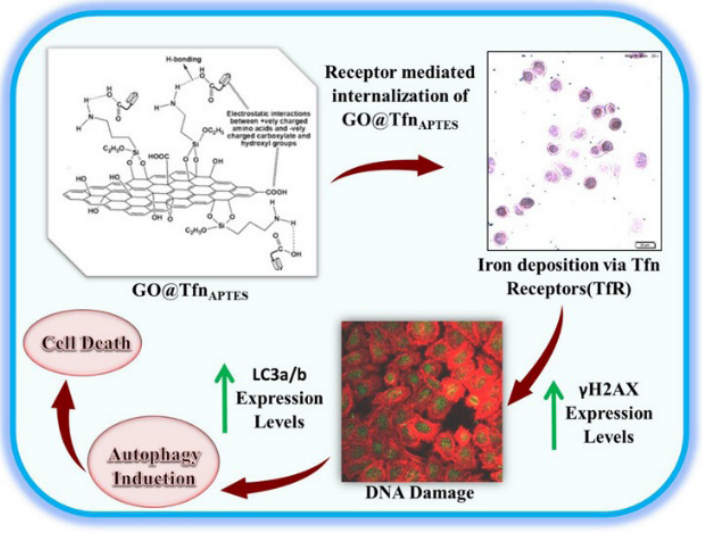

Fig. 2 transferrin immobilized graphene oxide (Tfn@GOAPTES) nanocomposite as a therapeutic strategy toward cancer cell killing. © American Chemical Society, 2024.

Relevant Publications:

- Nano Today. (2024), 56: 102243.
- ACS Applied Bio Materials. (2024), 7: 3649–3659.
- International Journal of Pharmaceutics. (2025), 670: 125142.

Research group (From left to right): Manik, Rahul, Rubina, Anchal, Nandini, Shiwani, Anjali, Harpreet, Tanya, Sanjana, Brijesh and Trilok.

Vishal Acharya, Principal Scientist
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Artificial Intelligence for Computational Biology

Our research areas focus on the major topics: A) Artificial intelligence for host-pathogen interactions & B) Network biology-based algorithms for drug discovery from the Himalayas for human health. Further details are provided with the link: https://fgcsl.ihbt.res.in/fgcsl/research. php.

Computational prediction of host-pathogen protein-protein interactions reveals key virulence factors

To gain a deeper understanding of the molecular responses employed by the host immune system against fungal pathogenicity, investigating host–fungal pathogen protein-protein interactions (HF-PPIs) is essential. Unlike bacterial and viral systems, where well-characterized interaction datasets are widely available, the study of host–fungal interactions remains constrained due to the limited availability of experimentally validated interaction pairs. In this study, we leveraged sequence and domain-based features of known interactions to predict novel and biologically meaningful HF-PPIs. Furthermore, the integration of dual RNA-Seq analysis with computational approaches enables the identification of high-confidence human–fungal protein pairs suitable for downstream experimental validation **(Fig. 1)**.

Candida albicans, a prominent pathobiont, is responsible for approximately 70% of fungal infections globally, largely due to its potent virulence mechanisms contributing to severe outcomes, particularly in clinical settings. The PPIs between *Homo sapiens* and *C. albicans* are critical in determining the course of infection and disease progression. We employed homology- and domain-based computational predictions to systematically explore these interactions, generating a network of 56,515 HF-PPIs involving 6,830 human and 486 *C. albicans* proteins.

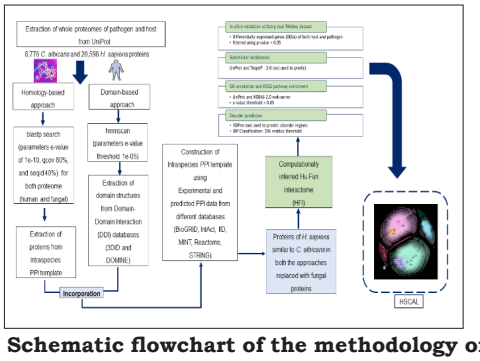

Fig. 1 Schematic flowchart of the methodology of the study.

Among these, we identified 16 key virulence factors of *C. albicans*-including SOD1, ERG10, GFA1, and VPS4-as potential therapeutic targets.

Analysis of dual RNA-Seq data across infection time points (15, 30, 60, 120, and 240 minutes) revealed that these fungal genes interact with downregulated human immunomodulatory genes such as ADRM1, DAXX, RYBP, SGTA, and SRGN. Notably, these human genes exhibit intrinsically disordered regions, making them particularly vulnerable to fungal exploitation.

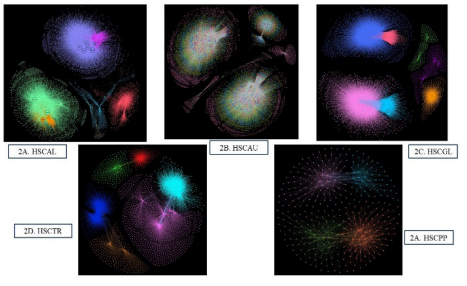

Fig. 2 (A-E) Visualization of the complete HF-PPI for the *Homo sapiens–Candida spp.* interaction system.

Inter-species interactions were predicted between the whole-proteomes of *H. sapiens* and five different species of Candida using sequence-based methods. *HSCAL: *H. sapiens C. albicans,* HSCAU: *H. sapiens C. auris,* HSCGL: *H. sapiens C. glabrata,* HSCTR: *H. sapiens C. tropicalis*, and HSCPP: *H. sapiens C. parapsilosis*

Our study constructs a comprehensive HF-PPI network between H. sapiens and C. albicans by mapping experimentally validated virulence factors and their human interaction partners. The integration of computational predictions with transcriptomic data advances our understanding of host–fungal interactions and supports the development of targeted strategies for the prevention and treatment of fungal infections.

Relevant Publications:

- Archives of Microbiology. (2025), 207: 115.
- Industrial Crops & Products. (2024), 222: 3.

Research group: Aakarshan, Goldie, Ekjot, Kanika, Ruhika, Dipali, Nymphaea, Ravi, Jatin, Kritika.

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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. For example, break of dormancy in *Crocus sativus* corms regulate the flowering bud. Therefore, an understanding of phenological progress of apical bud towards maturing into a flowering bud in a timeline fashion will help in devising a fruitful strategy towards flower inducements or enhancement via chemical priming. Understanding the area of biotic stress to unravel the plant-pathogen interaction mechanism is also a topic of interest.

Multi-year trial show positive effect of chemical regulators on *Crocus sativus* (Saffron) growth and development when treated under dormancy

Stigma produced in flowers of *C. sativus* plants are most valued part due to accumulation of metabolite compound Crocin and Safranal. To find out whether suitable growth regulators could be identified to overcome the inability of small-medium corms towards flowering and check the effect on the plant growth, three set of *Crocus sativus* corms were primed with eight reported chemical regulators, before break of dormancy. The results of three consecutive years trial under rain protected shade net conditions showed significant increment in plant height (**Fig. 1**), total leaf number (based on combined data for apical and lateral buds) and flowering number under different priming agents. The Gibberellin (GA3), $Ca(NO_3)_2$ and KNO_3 treatments improved flowering (**Fig. 2**). The GA3 and $Ca(NO_3)_2$ priming showed positive effect on stigma length. The $AgNO_3$ along with 2,3,5-triiodobenzoic acid (TIBA) also showed increment in few select parameters, albeit, with reduced effectiveness. The Indole-3-acetic acid (IAA) priming improved plant vigour and corm yield. The UPLC analysis on Safranal and Crocin content could not provide conclusive effect and difference between control and treatment was insignificant. This is first report to assess the role of TIBA, IAA, and $Ca(NO_3)_2$ in flowering in *C. sativus*. Multiple year trial validates the priming effectiveness of these growth regulators. Overall, results suggest that GA3 and $Ca(NO_3)_2$ can be utilised for large scale exogenous application in *C. sativus* for increase in growth vigour and flowering yield.

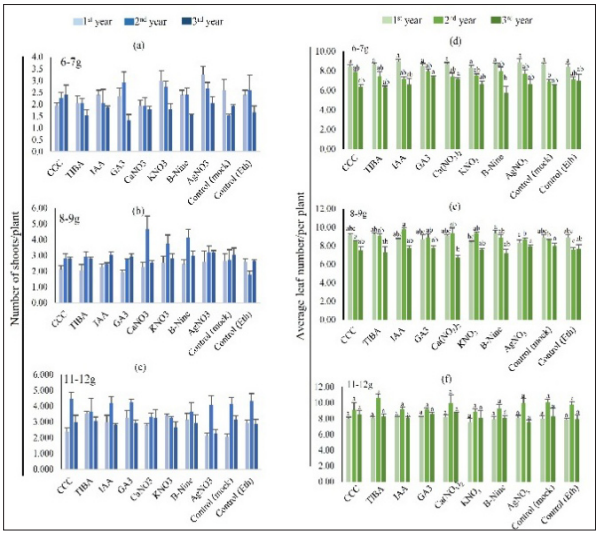

Fig. 1 Effect of the growth modulators application on a) number of shoots per plant and b) total leaf number of saffron. Results are represented as the means of fifteen plants per treatment (n=15) ± SE.

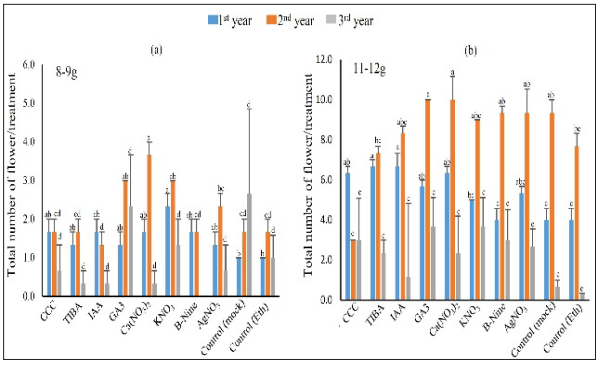

Fig. 2 The GA3, KNO_3, $AgNO_3$ and $Ca(NO_3)_2$ gave best result on flowering under 8-9g corms, considering 2 best years out of three; b) In experimental set of 11-12g, GA3 and $Ca(NO_3)_2$ again provide improved flowering.

Chronological events unfolding the vegetative and floral phenology of apical bud in *Crocus sativus* (Saffron)

Saffron (*C. sativus* L.) is an infertile perennial geophyte considered as the most expensive spice in the world due to low production of stigma as productive part. The stigma being part of the flower, the knowledge of phenotypic transition from dormant apical bud up to flowering is vital, yet, not explored properly. The complexity of flowering in *C. sativus* further accentuates by the lack of clear demarcation

between flowering and non-flowering corms in terms of weight and sizes, as small corms are known to be vegetative only, while large ones produce flower. Therefore, chronological phenotyping on a weekly and quarterly basis of apical shoot (**Fig. 3)** and flowering primordia between June and October was carried out to understand the organogenesis sequentially. In large corms, the stamen was the first floral organ to initiate followed by the formation of tepal from the base of the stamen (**Fig. 4)**. The plants exhibited both synanthous and hysteranthous flowering. Untargeted metabolome analysis of dormant apical bud just before dormancy break from flowering buds from large corms as well as non-flowering buds from small corms identified the presence of many differentially accumulated metabolites including sphingosine and meglutol. The integration of morphological, histological, and metabolomic data offers a comprehensive view of the flowering process that can be utilized in future biotechnological interventions.

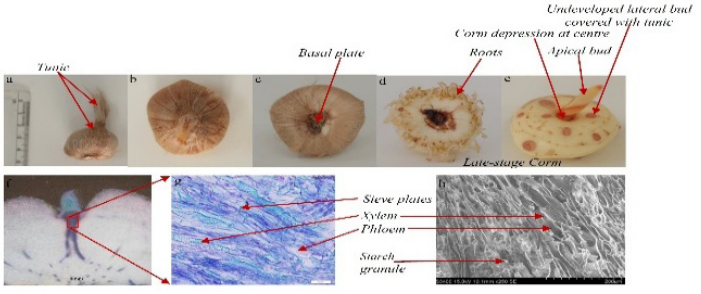

Fig. 3 The general characteristics of the saffron corm before sprouting.

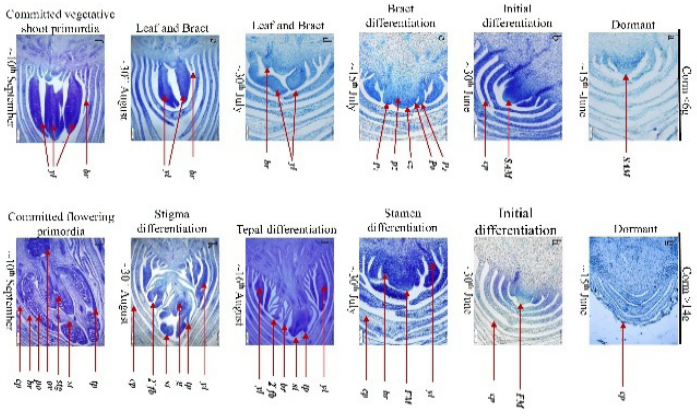

Fig. 4 The microtome sections of the apical bud during the developmental period of small (a-f) and large (g-l) corm from June to September.

Relevant Publications:

- Protoplasma. (2024), 262: 313.
- Russian Journal of Plant Physiology. (2024), 71(6): 214.

Research group: Anjali Chaudhary, Pooja Yadav, Kanchan Yadav, Ruben Ahlawat, Noni Narula.

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Plant Tissue Culture, Stress Physiology

Our group focuses on the development of highly efficient *in vitro* protocols for mass propagation of economically and medicinally important high-altitude plants and study their molecular regulation during *in vitro* organogenesis and abiotic stress regulation.

Unraveling transcription factors and nano-elicited regulation of bamboo growth and climate resilience

Bamboo, belonging to the Poaceae family, is a perennial plant known for its high carbon sequestration potential. However, various abiotic stresses such as waterlogging, soil pH, and salinity affects its growth. The mechanisms underlying abiotic stress tolerance in plants are governed by a complex interplay of physiological, biochemical, and molecular processes. Among the key molecular regulators, transcription factors (TFs) serve as crucial modulators, orchestrating plant responses to diverse environmental challenges. The research focusing on the regulatory roles of TFs and molecular interactions and cross-talk among TFs during abiotic stress responses in bamboo remains limited **(Fig. 1)**.

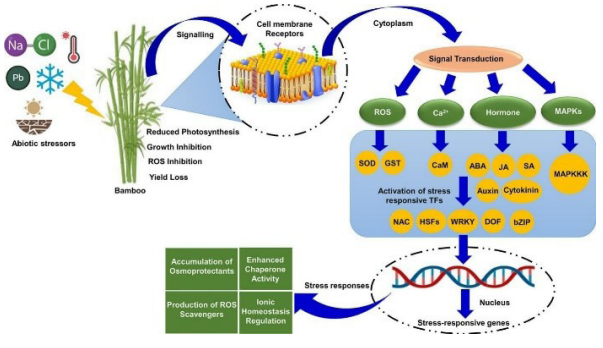

Fig. 1 Role of bamboo transcription factors in abiotic stress signaling.

Bambusa balcooa, a valuable non-timber bamboo species, faces limitations in conventional propagation. Our study explores the effects of citrate- and CTAB-coated gold nanoparticles (AuNPs) on its *in vitro* growth, photosynthetic pigments, and antioxidant activity. Plantlets treated with 400 µM citrate-AuNPs showed enhanced shoot proliferation and physiological performance, while 600 µM CTAB-AuNPs inhibited growth. RNA-seq analysis identified differentially expressed genes (DEGs) involved in stress response and development, including Glyoxalase, Expansin, and ZAT. Gene ontology and KEGG pathway enrichment revealed key molecular pathways regulated by AuNPs, offering novel insights into nano-elicited mechanisms underlying plant regeneration and stress adaptation during micropropagation **(Fig. 2)**.

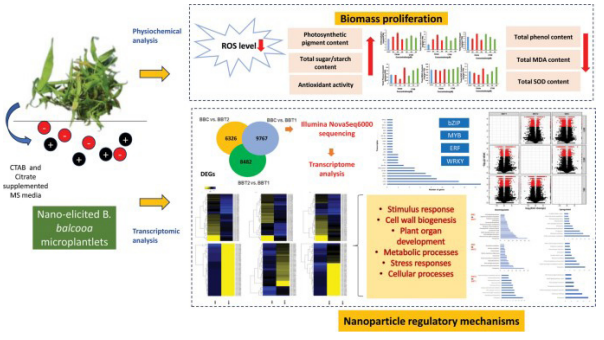

Fig. 2 Effect of *in vitro* nanoelicitation in *Bambusa balcooa*.

Comparative genomic analysis of WOX gene family reveals developmental and stress-responsive roles in *Picrorhiza kurrooa*

WUSCHEL-related homeobox (WOX) genes are key transcription factors involved in plant embryogenesis and organogenesis. Our lab presents a genome-wide analysis of WOX genes in *Picrorhiza kurrooa* and *Antirrhinum majus* (Plantaginaceae). Five WOX and one WUS gene were identified in *P. kurrooa*, and eight WOX and eight WUS genes in *A. majus*. Phylogenetic and synteny analysis revealed close similarity between *P. kurrooa* and *A. majus* WOX/WUS genes. Chromosomal mapping in *A. majus* showed gene distribution across chromosomes 2–7. Expression profiling in *P. kurrooa* showed stage-specific and temperature-responsive patterns, highlighting their potential role in development and abiotic stress adaptation **(Fig. 3)**.

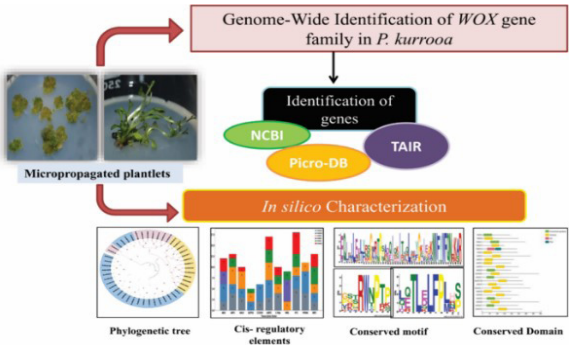

Fig. 3 Genome-wide analysis of WOX family genes in *Picrorhiza kurrooa*.

Unraveling redox signaling and MAPK-mediated mechanisms during abiotic stress response in *Nardostachys jatamansi*

Mitogen-activated protein kinase (MAPK) cascades play essential roles in plant growth, development, and stress responses. We investigated MAPK gene families in *Lonicera japonica* and *Nardostachys jatamansi* (Caprifoliaceae), a high-altitude Himalayan medicinal plant. Twenty MAPKs each were identified from the *L. japonica* genome and *N. jatamansi* transcriptome. *In silico* analyses, including phylogeny, gene structure, subcellular localization, synteny, and cis-element prediction, revealed strong conservation. Promoter regions contained development- and stress-responsive elements. Expression profiling showed tissue-specific and stress-induced MAPK expression in *N. jatamansi*. These findings enhance our understanding of MAPK-mediated regulation of development and abiotic stress adaptation in Caprifoliaceae **(Fig. 4)**.

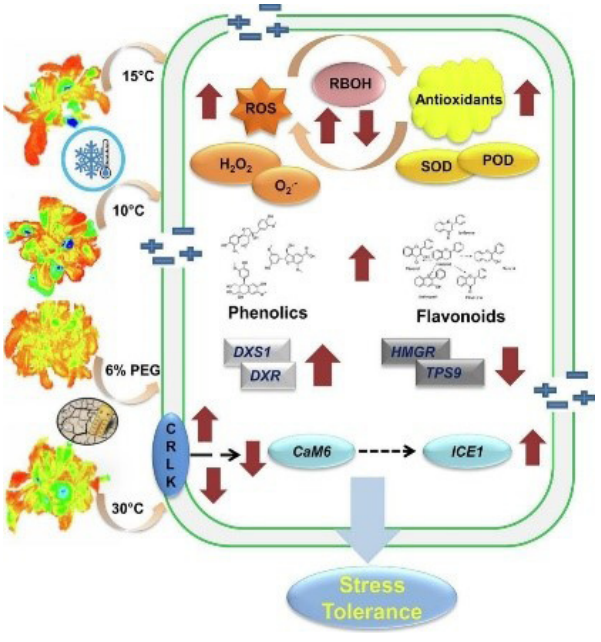

Fig. 4 Redox signaling dynamics in *Nardostachys jatamansi* Wall. ex DC.

Further, our study examines *N. jatamansi* under cold (15 °C and 10 °C), drought (6% PEG), and heat (30 °C) stress. Stress reduced biomass and chlorophyll fluorescence while increasing electrolyte leakage, MDA, and H_2O_2 levels. ROS accumulation was confirmed by DAB/NBT staining and enhanced DPPH and ABTS scavenging activity. Expression of RBOH genes supported ROS production. Key enzymes and transcripts from the MVA (*TPS9, HMGR*) and MEP (*DXS1, DXR*) pathways, along with *CRLK1, CRLK2, CaM6*, and *ICE1*, showed differential regulation, offering insights into stress adaptation and conservation strategies **(Fig. 5)**.

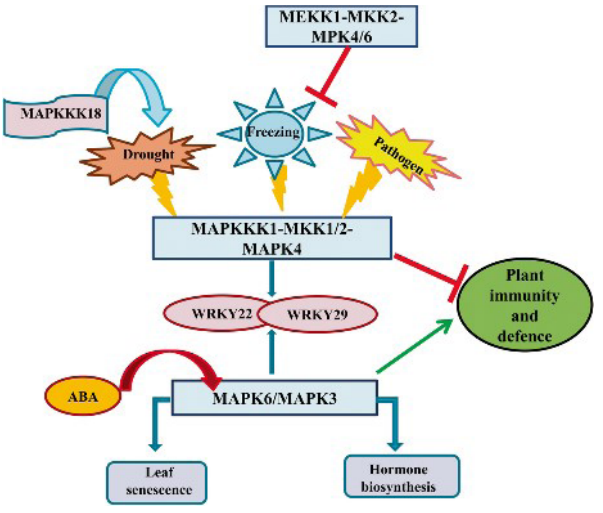

Fig. 5 Role of Mitogen-activated protein kinases (MAPKs) in growth, development as stress response.

***In vitro* assessment of growth, biochemistry, and gene expression in *Crocus sativus* under drought stress**

Our study investigated drought stress in *Crocus sativus* L. (saffron) using PEG 6000 (0%, 5%, 10%) under *in vitro* conditions. Saffron shoots cultured on MS medium with BAP and NAA showed reduced shoot regeneration, increased apical browning, and altered chlorophyll and carotenoid levels under PEG-induced stress. Drought decreased growth, water content, and antioxidant enzyme activity (SOD, POD), while increasing lipid peroxidation, membrane damage, proline content, and non-enzymatic antioxidant activity. Expression of drought-responsive genes (*DREB1/2, AREB1, DHN1, SnRK2*) was elevated at higher PEG levels. Results underscore saffron's drought sensitivity and the need for developing drought-resilient cultivars under changing climates **(Fig. 6)**.

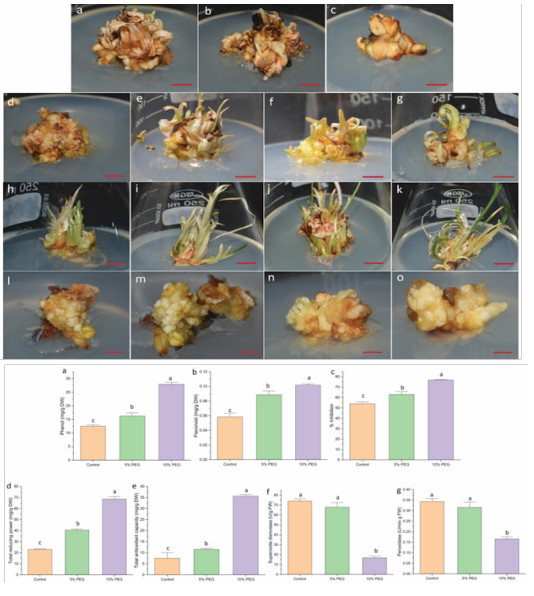

Fig. 6 Effect of PEG induced drought stress in *Crocus sativus*.

Molecular mechanisms, adaptive strategies and genetic engineering approaches to regulate cold stress response and root system architecture in plants

Cold stress is a major abiotic factor in high-altitude regions, severely impacting plant growth and productivity. Plants have developed physiological and molecular adaptations to cope with chilling and freezing stress, including the expression of cold-inducible genes. However, many crops lack sufficient cold acclimatization mechanisms. Traditional breeding has shown limited success in improving cold tolerance. Advanced gene editing technologies now offer precise tools for enhancing stress resistance. This review highlights gene editing approaches—ZFNs, TALENs, CRISPR/Cas9/Cas12a, prime editing, and retron library recombineering—with emphasis on CRISPR/Cas. These tools hold promise for developing cold-tolerant, high-yielding, climate-resilient crops through targeted genome modifications **(Fig. 7)**.

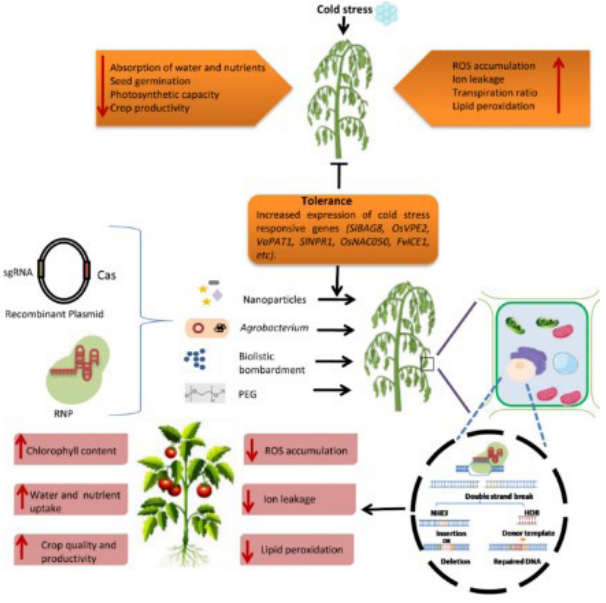

Fig. 7 Schematic representation of cold stress tolerance through the application of CRISPR/Cas9 in plants.

Drought is a critical environmental stress that severely impacts global agriculture, disrupting plant physiology, biochemistry, and gene expression. Roots are central to drought responses, influencing development, anchorage, and rhizosphere interactions through exudation and soil penetration. This review highlights root-mediated adaptations, emphasizing root hydraulic conductivity, root system architecture, and root–soil dynamics. It explores the roles of phytohormones like ABA, auxin, cytokinin, and ethylene, along with transcription factors such as DREB, AREB, MYB, bZIP, and NAC in regulating drought responses. Understanding root signaling and metabolic adjustments under water stress can aid in developing drought-resilient crops with improved yield and stress adaptability **(Fig. 8)**.

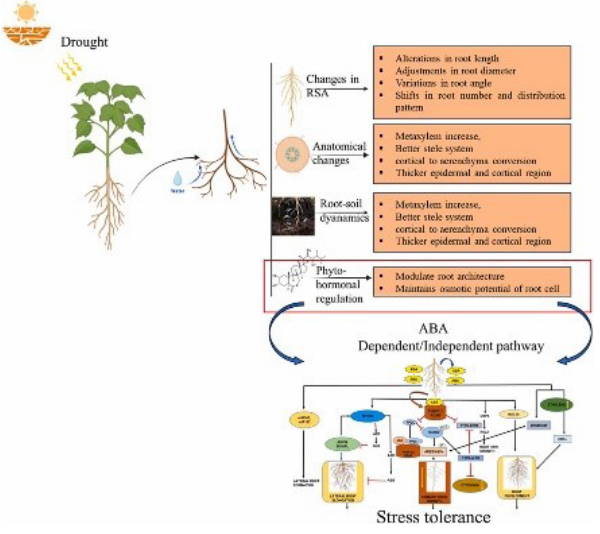

Fig. 8 Schematic representation of root-soil dynamics in the rhizosphere as critical for plant adaptation to drought conditions.

Relevant Publications:

- Biology. (2025), 14(1): 78.
- Planta. (2025), 261: 2.
- Rhizosphere. (2025), 31: 100922.

Research group: Dr Rohit Joshi, Dr. Kiran Devi, Mr. Ajay Kumar, Ms. Anita Kumari, Ms. Jhilmil Nath, Mr. Shubham Joshi, Ms. Suman Gusain, Ms. Khusbu Kumari.

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Plant-Microbe Interaction, Plant Adaptation and Plant Physiology

Our research group focuses on the interactions between Himalayan medicinal plants and their associated microbes specially endophytes. We are particularly interested in exploring endophytic microbes as potential plant probiotics to enhance plant growth, boost secondary metabolite production, and improve stress tolerance of plants. Additionally, we study plant adaptation mechanisms under stressful environmental conditions and are actively working on developing an efficient genome-editing platform for *Camellia sinensis*.

Endomicrobiome of *Podophyllum hexandrum*

Understanding how the cultivation of medicinal plants in non-natural habitats (NNH) affects plant-associated microbial diversity and secondary metabolite biosynthesis is crucial for preserving the therapeutic values of medicinal plants.

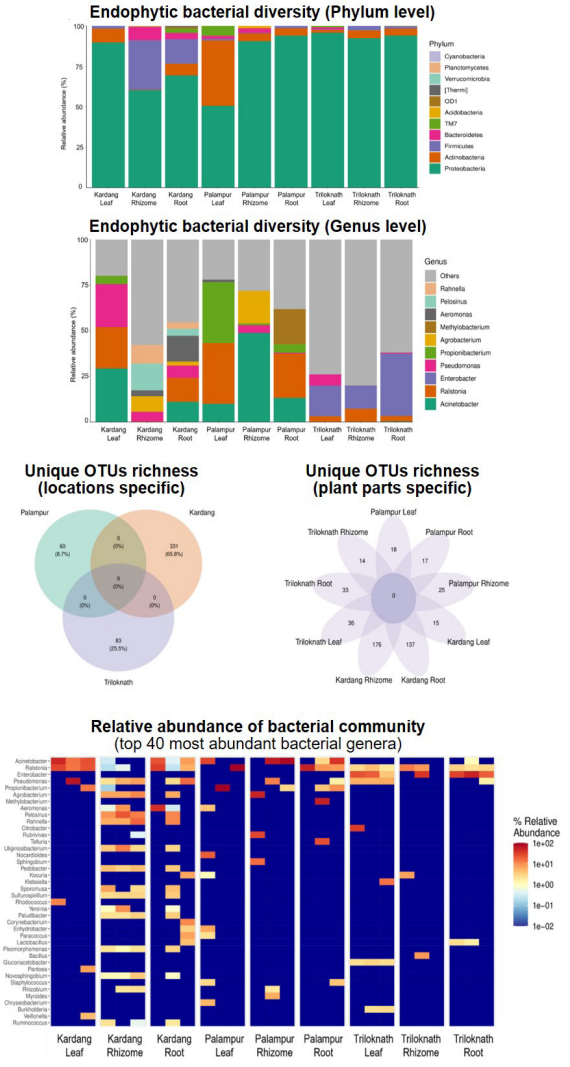

Fig. 1 Endophytic bacterial diversity, location and plant parts specific OTUs richness and abundant bacterial genera of *Podophyllum hexandrum* plants of natural habitats (Kardang and Triloknath) and a non-natural habitat (Palampur location).

We examined the bacterial endomicrobiome of *Podophyllum hexandrum* collected from natural habitats (NH; Kardang and Triloknath locations) and a NNH (Palampur location) to explore its association with podophyllotoxin (PTOX) biosynthesis. The rhizomes—primary sources of PTOX—from NH plants exhibited the highest diversity of endophytic bacteria compared to those from NNH. Distinct and shared microbial taxa were identified across different plant tissues and locations, highlighting plant-location and tissue-specific microbial signatures **(Fig. 1)**. Core bacterial genera such as *Acinetobacter*, *Ralstonia*, and *Pseudomonas* were consistently present in both NH and NNH samples. Functional prediction of the endophytic communities revealed a higher abundance of genes involved in the early steps of PTOX biosynthesis and plant growth promotion in the rhizomes and roots from Kardang. Moreover, significantly higher levels of secondary metabolites—including PTOX (2.78- and 2.11-fold in Kardang and Triloknath rhizomes, respectively; 1.48 and 1.71 fold in Kardang and Triloknath roots, respectively), Picropodophyllotoxin (3.08 fold in Kardang rhizomes), Quercetin (1.65 fold in Kardang and 1.32 fold in Triloknath rhizomes; 3.07-fold in Kardang and 1.60 fold in Triloknath roots) and Kaempferol (1.66 and 1.24-fold in Kardang and Triloknath rhizomes, respectively; 2.91 and 1.94-fold in Kardang and Triloknath roots, respectively)—were detected in NH plants compared to NNH. These findings provide novel insights into the relationship between habitat-driven shifts in endomicrobiome composition and secondary metabolite production, offering valuable considerations for the sustainable cultivation of medicinal plants with microbial interventions.

Endophyte-based fungal elicitors for leaf cell suspension cultures of *Valeriana jatamansi*

Valeriana jatamansi is highly valued for its therapeutic properties, primarily due to the presence of bioactive secondary metabolites such as valepotriates and sesquiterpenoids.

However, overharvesting from wild habitats has led to a significant decline in its natural populations, necessitating alternative strategies for sustainable production of these metabolites. This work aimed to evaluate the potential of endophytic fungi isolated from *V. jatamansi* rhizomes to enhance secondary metabolite production in leaf-cell suspension (LCS) cultures. A total of 11 fungal endophytes were isolated, representing the phyla Ascomycota, Basidiomycota, and Mucoromycota **(Fig. 2)**. Supplementation of LCS cultures with extracts from *Phaeosphaeriaceae* sp. VRzFB, *Mucor griseocyanus* VRzFD, *Penicillium raistrickii* VRzFK, and *Penicillium sajarovii* VRzFL significantly increased fresh cell biomass by 19.6%–39.1% and dry biomass by 23.4%–37.8%. Most endophytic extracts also enhanced the accumulation of key secondary metabolites—valepotriates (valtrate: 26.5%–76.5%; acevaltrate: 40.5%–77.9%) and sesquiterpenoids (hydroxyl valerenic acid: 19.9%–61.1%). Notably, only *Irpex lacteus* VRzFI and *Fusarium oxysporum* VRzFF were effective in increasing the levels of acetoxy valerenic acid (36.9%–55.3%). In contrast, certain endophyte extracts had either negligible or negative effects on biomass and metabolite content. The observed enhancement in metabolite production correlated with the upregulation of iridoid biosynthesis genes in LCS cultures. Furthermore, variations in hydrogen peroxide generation and lipid peroxidation across treatments indicated that different endophyte extracts modulate cellular oxidative stress responses. Overall, this work highlights the distinct influence of individual fungal endophyte extracts and supports their role as biotic elicitors to boost secondary metabolite production in plant *in-vitro* culture systems.

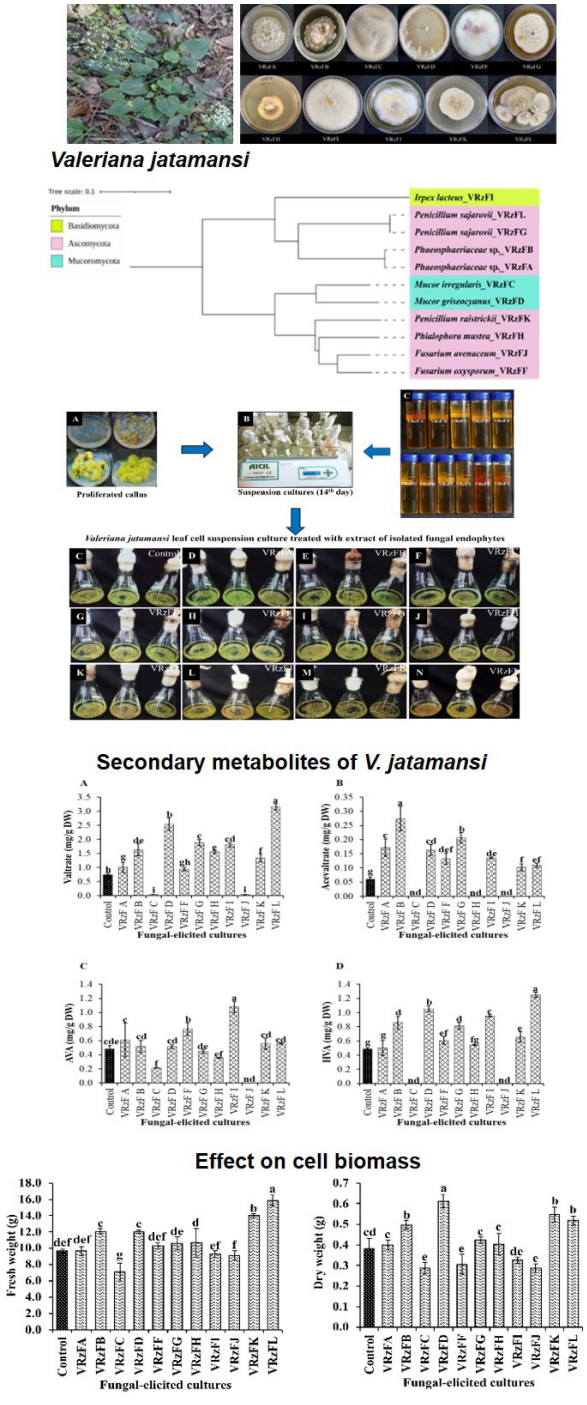

Fig. 2 Fungal endophytes isolated from the rhizome of *V. jatamansi* plants and their phylogenetic relation. Treatment of leaf cell suspension culture of *V. jatamansi* with extracts of isolated fungal endophytes. Effect of endophyte extract treatment on secondary metabolites and cell biomass of leaf cell suspension culture of *V. jatamansi*.

Under genome editing of *Camellia sinensis*, efforts are made to optimize the RNP-mediated editing of protoplast of *C. sinensis*, which is in progress.

Relevant Publications:

- Journal of Applied Microbiology. (2024), lxae242.
- World Journal of Microbiology and Biotechnology. (2025) 41: 38.

Research group: Manju Kumari, Ankita Thakur, Mamta, Priyanka Bhardwaj, Jyoti Sharma, Nikhil Rawat, Vanshika Thakur, Aditi Sharma.

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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.

Pathway precursor feeding enhanced the picrosides content in cell suspension culture of *Picrorhiza kurroa*

The study reports the impact of precursor treatment on picrosides (P-I, P-II, P-III) enrichment in the cell culture of *Picrorhiza kurroa* **(Fig. 1)**. Exogenously, vanillic acid (VA), phenylalanine (PAL), and trans-cinnamic acid (TCNA) precursors were used at 50-150 mg/L concentrations to leaf and rhizome cell suspension of *P. kurroa*. In leaf suspension culture, the content of P-I, P-II, and P-III was found 0.99, 1.01, and 1.05 fold higher, respectively, in the VA 150 mg/L treatment compared to the 50 and 100 mg/L treatments. In rhizome suspension culture, P-I and P-II levels were approximately 1 fold higher, while P-III was 1.17 fold higher in the 150 mg/L VA treatment compared to the other concentrations. The results concluded that VA (150 mg/L) is most suitable for picrosides enrichment in the cell culture of *P. kurroa.*

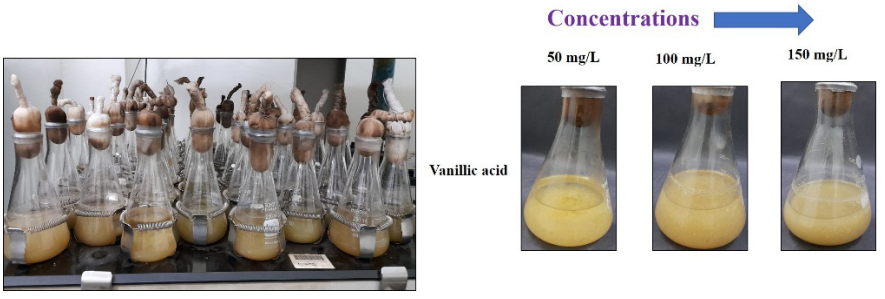

Fig. 1 Precursor feeding in leaf and rhizome cell suspension culture of *P. kurroa* treated with different concentrations (50–150 mg/L) of precursors (vanillic acid (VA).

Methyl jasmonate enhanced the picrosides in Cell Culture of *Picrorhiza kurroa*

The elicitor-mediated responses in plant cell to increase specialized metabolites has attracted a lot of scientific and industrial interest. The present study investigated the impact of elicitor on the augmentation of picrosides (P-I, P-II, P-III) content in *Picrorhiza kurroa* cell suspension cultures **(Fig. 2)**. Methyl jasmonate (MeJA; 50–150µM) were applied to leaf (LFSC) and rhizome (RHSC) cell suspensions on the 21st day of culture and incubated up to 192 h. In LFSC, P-I and P-III levels were 1.69- and 1.35-fold higher, respectively, in the MeJA 150 µM treatment, while P-II was maximally enhanced (1.62-fold) at 50 µM. The study indicated that Me-JA is particularly effective in enhancing picrosides accumulation in *P. kurroa* cell cultures. In conclusion, elicitors significantly boost the production of valuable secondary metabolites, particularly in the plant cell culture of *P. kurroa.*

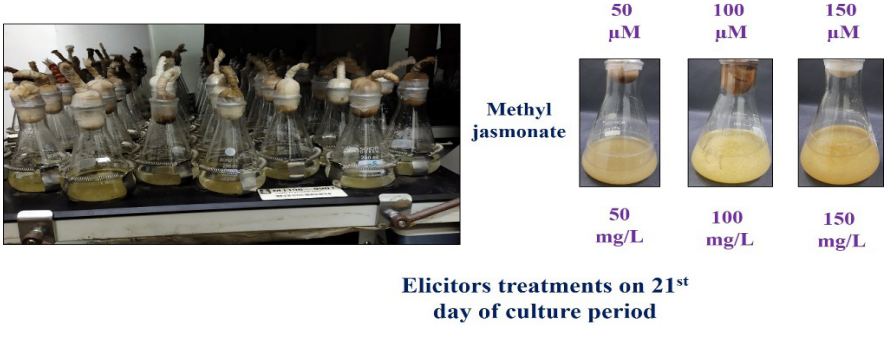

Fig. 2 Optimization of methyl jasmonate and concentrations and their exposure duration for the treatment in leaf and rhizome-raised cell suspension culture of *P. kurroa*.

Evaluation of Morphological, Biomass, and Secondary Metabolite Profiles of *Morus alba* under Hydroponic Cultivation

Morus alba, a species of significant medicinal, economic, and ecological value, is widely cultivated across temperate regions. Its leaves are particularly vital in sericulture as the primary diet of *Bombyx mori* larvae. In this study, *M. alba* stem cuttings were propagated under controlled hydroponic conditions **(Fig. 3a, b)**. Maximum observed values included plant height (110 cm), number of leaves (53), leaf length (19.2 cm), leaf width (14 cm), and root length (56 cm), representing a 10-15-fold increase over *in vitro* plants. Result shows that there is a 2- to 3-fold increase in the levels of these metabolites during the second year of hydroponic cultivation compared to the first year, indicating a positive correlation between prolonged cultivation duration and enhanced secondary metabolite biosynthesis. These findings highlight the potential of hydroponic systems to significantly improve morphological development, biomass production, and phytochemical content in *Morus alba*.

Fig. 3a & b) *Morus alba* plants cultivated under hydroponic conditions.

An efficient clonal propagation method of *Dactylorhiza hatagirea* D.Don Soo, using shoot meristem culture and genetic fidelity analysis

Dactylorhiza hatagirea, a medicinal orchid endemic to the Hindu-Kush Himalayas, is valued for its aphrodisiac and therapeutic properties. Marketed as Salam Panja, it has high demand, and poor propagation methods have led to overharvesting. This study successfully demonstrated *in vitro* propagation of *D. hatagirea* using shoot tip meristems (0.3-0.5 cm) on half-strength modified MS medium **(Fig. 4)**. Of 25 primers tested, 13 produced clear, reproducible bands and were selected for fingerprinting of randomly chosen regenerates and the mother plant. The plantlets showed a 65% survival rate during *ex-vitro* transfer to natural conditions. *In vitro* micropropagation protocol using shoot meristem culture presently developed for *D. hatagirea* may prove useful for mass propagation and conservation of other related medicinal Himalayan herbs as well.

Fig. 4 *In vitro* propagation of *D. hatagirea* assessing regeneration using shoot apical meristem culture.

Relevant Publications:

- Biocatalysis and Agricultural Biotechnology. (2025), 64, 103501.
- Journal of Plant Growth Regulation. (2025), 44: 247-265;
- Plant Cell, Tissue and Organ Culture (PCTOC). (2025), 160: 20.

Research group: Kanika, Amit Kumar, Shashi Rani, Seema Devi, Praveen Kumar, Manish Kumar.

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Stress biology and Proteomics

Research in our lab explores medicinal plants' adaptation potential at high-altitude environmental conditions. The high-altitude alpine environment is an extreme environment with unique combinations of abiotic stresses. Despite progress in plant response to individual abiotic stress in controlled conditions, our knowledge of plant adaptation to multifactorial stress combinations that typically occur in alpine environments is limiting. Understanding the stress tolerance mechanism is crucial for designing new strategies to maintain plant performance under abiotic pressure.

In the present study, we used the complex regulatory architecture of *P. kurroa* to dissect plant response to environmental stress gradient associated with high-altitude at transcriptional level with experimental design to know (1) whether *P. kurroa* acquire unique or shared response to multifactorial stress gradient of high altitude, (2) what are the regulatory networks and biological pathways responding to multifactorial stress combinations in *P. kurroa* along high altitude gradient, (3) to explore the core regulatory genes utilized by *P. kurroa* that can be imported to other plants for developing climate-resilience and resource-efficiency, and (4) to integrate our RNA-seq data with proteomics data previously reported from the same samples along the high-altitudinal gradient, which will uncover highly correlated transcriptional and translational signatures of high-altitudinal alpine plant adaptations.

These findings recognize an array of new candidate genes for climate resilience, which would contribute to further our research on high-altitude alpine plant adaptations.

P. kurroa acquires unique responses to multifactorial stress gradient at high altitude

We first analyzed the expression pattern of 24 stress marker genes of cold (*PkCBF1, PkRAV, PkHSFC1*, and *PkCBF3*), drought (*PkDREB2a, PkRD26,* and *PkABF4*), heat (*PkHSFA1* and *PkHSFA2)*, salinity (*PkP5CS1*, *PkRD20* and *PkAREB1*) high light (*PkELIP/SEP* and *PkAPX)*, UV (*PkHY5*, *PkPDX1.3, PkUVR8*, and *PkMEB5.2*), hypoxia (*PkHRE, Pk*RAP2.2 and *PkADH)*, and heavy metal stress (*pkgstu* and *PkAR781, PkPCS)*. Changes in marker transcript levels revealed an inconsistent pattern of expression with high-altitude gradient **(Fig. 1)**. On the whole, this reflects the unique or common response of *P. kurroa* to environmental variables associated with high-altitude irrespective of the individual stress factors reported under controlled conditions and suggested further transcriptome profiling to uncover the molecular basis underlying *P. kurroa* adaptation along the environmental gradient.

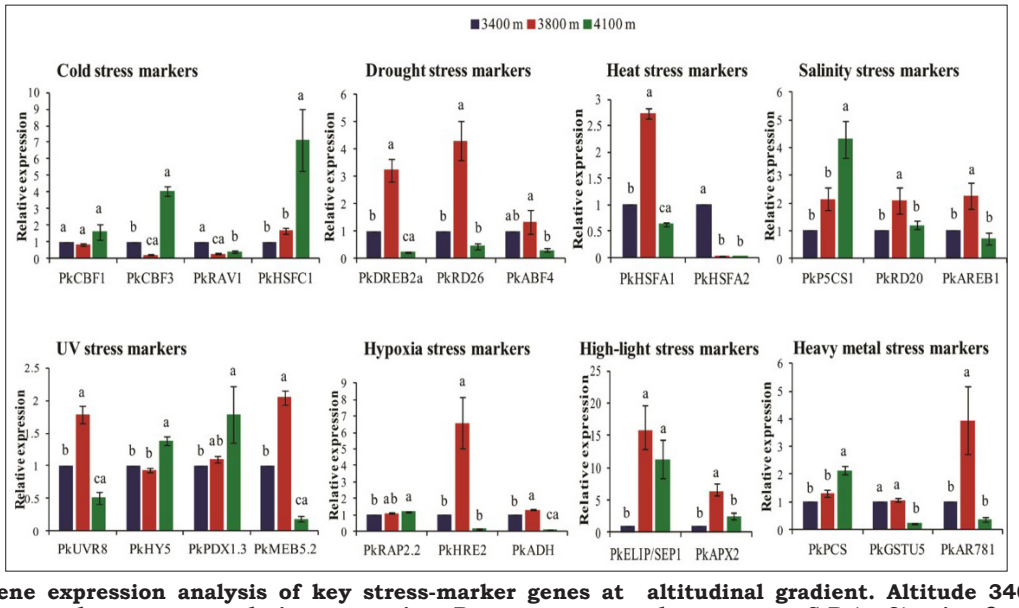

Fig. 1 Gene expression analysis of key stress-marker genes at altitudinal gradient. Altitude 3400 m was taken as control to measure relative expression. Data are presented as means ± S.D (n=3) using β-actin as an endogenous control in qRT-PCR. Different letters indicate statistically significant differences analyzed using ANOVA followed by Tukey-HSD post-hoc test ($p < 0.05$) in R v. 4.3.1.

Leaf transcriptional dynamics highlights unique gene expression pattern to multifactorial stress gradient of high-altitude

To gain molecular insights into *P. kurroa* response to multifactorial stress combinations along high-altitude, *de-novo* transcriptome sequencing was performed. We identified 7,388 (5,132 up-regulated and 4,004 down-regulated) differentially expressed unigenes (DEGs; Abs. $\log_2$ fold change > 2; $p \leq 0.05$) in pairwise comparisons of three altitudes *viz.* 3800*vs*3400 m, 4100*vs*3400 m and 4100*vs*3800 m. In detail, there were 4,176 DEGs (1,876 up-regulated and 2,300 down-regulated) for 3800*vs*3400 m, 3,349 DEGs (2,137 up-regulated and 1,212 down-regulated) for 4100*vs*3400 m, and 4,120 DEGs (2,710 upregulated and 1,410 down-regulated) for 4100*vs*3800 m **(Fig. 2)**. A principal component analysis (PCA) visualizes a high similarity among the replicates within each high-altitude; however, the three different high-altitudes clustered away from each other, indicating altitude is a major factor that affects gene expression. Interestingly, 3800 m and 4100 m altitudes diverged and were in stark contrast to 3400 m altitude. Further, the impacted transcript lists were not so similar for 3800 m and 4100 m when compared with 3400 m, with a weak correlation of 0.38 between these datasets, suggesting more unique molecular response to the multifactorial complex environment of each high-altitude. GO enrichment analysis of DEGs revealed the most enriched terms are 'secondary metabolite biosynthetic process', 'single organism reproductive process', 'response to biotic and abiotic stimulus', and 'cell wall organization or biogenesis' and 'reproductive structure development'. Among 1,616 TF (21.87 % of the DEGs) bHLH (10.2 %), NAC (7.79 %), and ERF (7.42 %) were representing the top three TF families. These TFs families were considered important in regulating biological processes involved in plant adaptation to multifactorial stress combinations at high-altitude; however, further experimental studies would be required. Global gene expression analysis suggests signaling cascade including Ca^{2+}, ROS, and 14-3-3, cross-talk between phytohormone providing a unique molecular response by reprogramming, remodeling or reconfiguring unigenes associated with secondary metabolite biosynthesis, multiple stress response, as well as cellular and developmental processes.

Identification of core unigenes involved in *P. kurroa* adaptation to multifactorial stress gradient of high-altitude

We found 253 core set of unigenes involved in *P. kurroa* adaptation to multifactorial stress gradient of high-altitude and visualization of their expression using heat map **(Fig. 3A & B)**. Next, we constructed a co-expression network of the 253 common DEGs that were clustered into three significant modules **(Fig. 3C & D)**. According to module membership, ascorbate oxidase and pectinesterase were found to be highly correlated. Next, the obtained network was filtered based on absolute correlation > 0.9 and adjusted *p*-value < 0.01 resulting 239 unigenes interconnected by 12,252 edges (Fig. 3E). The top three intra-modular hub genes in the

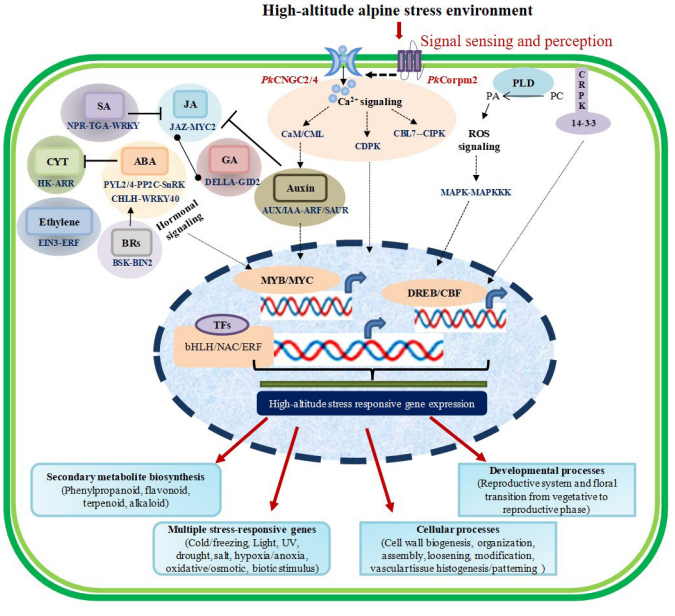

Fig. 2 Hypothetical model depicting the transcriptional response of P. kurroa to high-altitude alpine environmental stress.

largest module that had the highest degree (154 connections) in the co-expression network were PLAT domain-containing protein, GATA transcription factor and WRKY transcription factor. In addition, various hypothetical/uncharacterized proteins and serine/threonine protein kinases also had similar connections. Further, four key genes were selected for validation by real-time PCR that showed similar responses for almost all transcripts (Fig. 3F). All these hub genes were co-expressed with the aforementioned stress-responsive genes, suggesting their importance as multifactorial stress response regulators and are potential candidate for functional characterization in future studies.

Integration of transcriptomic and proteomic

We exploited transcriptomic and proteomic data in the same high-altitude leaf samples (Kumari and Kumar, 2024). Only 18 proteins (13.6 %) followed the positive correlation between mRNA and corresponding protein levels. Overall, most of the proteins showed dissimilar expression patterns across high-altitude gradient at the transcriptional and translational levels, which is in agreement with previous reports revealing a weak correlation between gene expression and corresponding protein accumulation, suggesting the regulation of the high-altitude stress-responsive proteins primarily did not occur at the level of transcription rather than underlying different post-transcriptional/ translational level.

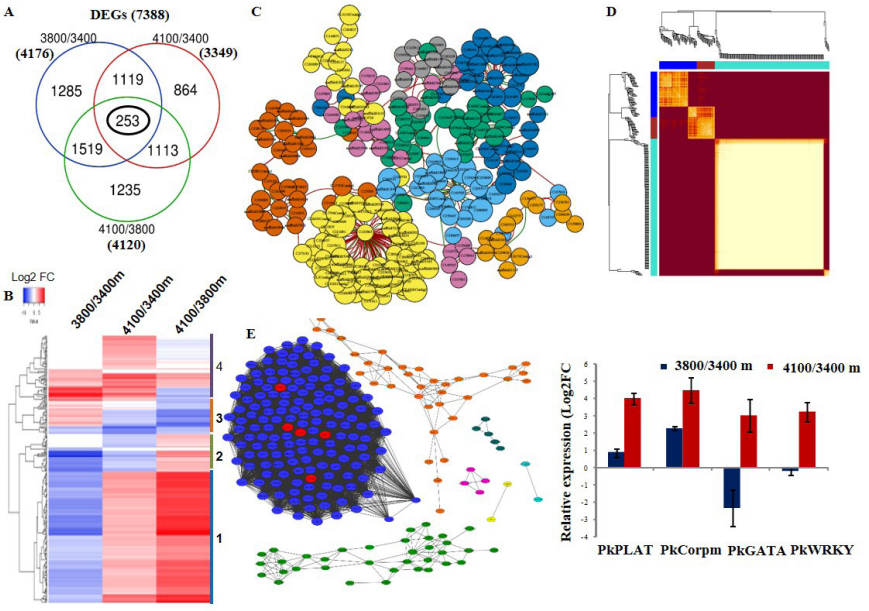

Fig. 3 Analysis of 253 common DEGs. (A) Venn diagram displays the overlap of DEGs across all three altitudes, (B) their heatmap, (C, D) Weighted gene co-expression network of the core set of genes with three significant modules, (E) The significant co-expression network (absolute correlation > 0.9 and adjusted p-value < 0.01) highlighted the major hub genes, and (F) qRT-PCR relative expression of the selected key hub genes normalized to 3400 m. Data is expressed as means ± SD.

Relevant Publications:

➢ Industrial crops and products. (2024), 222, 119855.

Research group: Dr. Paramdeep Kumar, Pallavi Anand, Suparna Mandal, Dr. Rajiv kumar, Ashwani Punia, Monika Chauhan, Amit Chauhan, Vishal Saini.

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Molecular Biology and Biochemistry

The research interests and long-term goals of our lab are to identify enzymes with novel functions for the healthcare and agriculture industries. In line with these goals, we are currently focusing on the following projects.

Chitin and cellulose active lytic polysaccharide monooxygenases (LPMO) from *Trichoderma harzianum*

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. Ongoing studies in our lab identified T*richoderma harzianum* to encode potential LPMOs. One of the LPMOs referred to as ThAA11A was successfully cloned and expressed in *E. coli* BL21 cells. The purified ThAA11A exhibited monooxygenase activity and had a pH and temperature optima of 7.0 and 50°C, respectively. The enzyme resulted in oxidative cleavage of chitin and PASC (Phosphoric acid swollen cellulose; **(Fig.1)**. The detailed characterization of the enzyme is under progress.

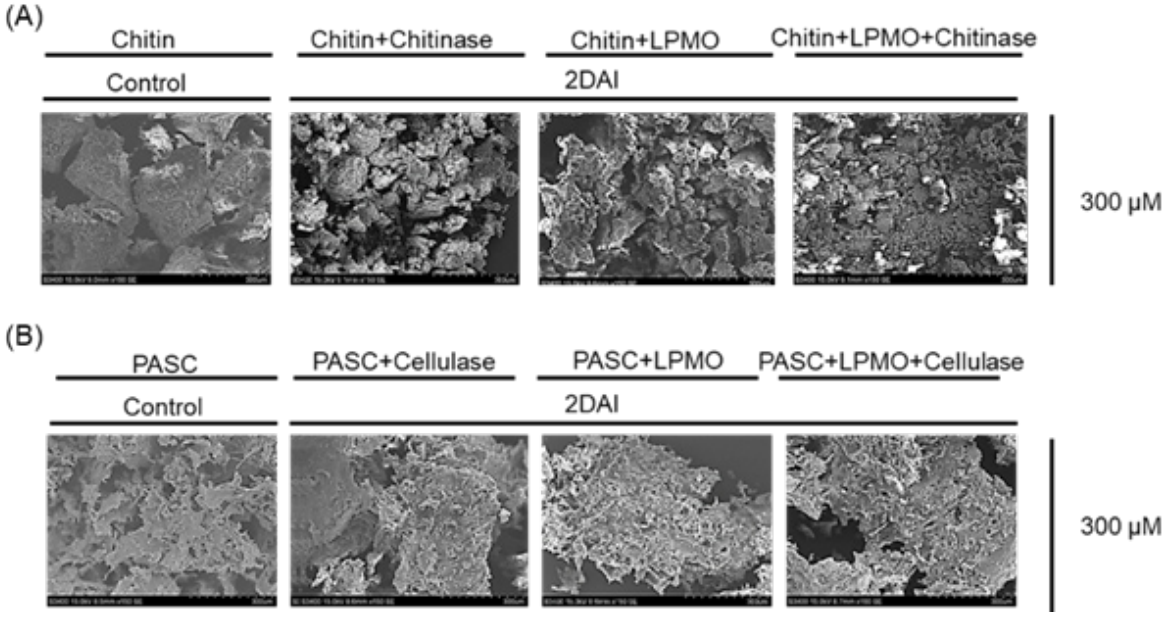

Fig. 1 SEM analysis of ThAA11A-treated substrates. Surface morphology of (A) chitin and (B) PASC oxidized by ThAA11A. DAI: days after incubation.

Augmenting Serratiopeptidase (SPEP) Resilience in Acidic Environments

Serratiopeptidase (SPEP), a metalloprotease renowned for its anti-inflammatory, analgesic, and anti-atherosclerotic effects, is hindered by its instability in extreme pH environments, which limits its therapeutic and industrial applications. With the aim to improve the pH tolerance of SPEP, we engineered it by introducing an N412D mutation in the polypeptide backbone. Following purification, we evaluated the stability and activity of the WT and mutated enzymes across a wide pH range, specifically at acidic (pH, 3) and alkaline (pH 10.8) conditions **(Fig. 2)**. Our findings reveal that the N412D mutation significantly improves the stability of SPEP in acidic environments, allowing it to maintain therapeutic efficacy at lower dosages, which could reduce treatment costs and enhance its applicability in various medical treatments.

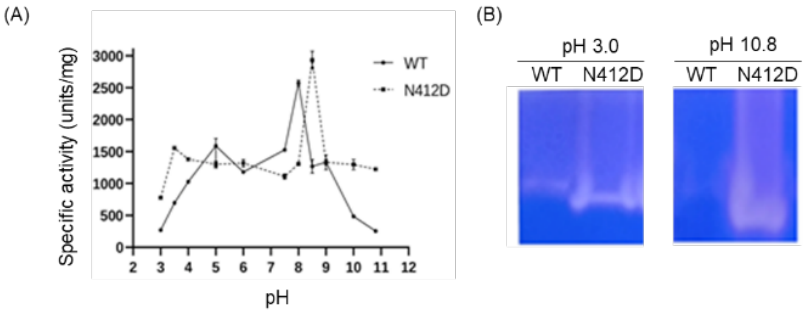

Fig. 2 Augmented activity of N412D mutant of SPEP under pH extremes. (A) the comparative specific activity of WT vs N412 over a pH range (B) Zymogram analysis at two pH extremes.

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*. The purified protein exhibited a low Michaelis-Menten constant (Km) of 0.025 µM and a maximum velocity (V_{max}) of 256.14 Units/mg, and was functional at a broad pH (5.0-9.0) and temperature range (4-70 °C). 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), astonishingly stable to varying concentrations of denaturants, inhibitors and reducing agents, confirming its structural robustness **(Fig. 3)**. Such thermostable and chemically resistant properties render *Lc*MnSOD a strong candidate for various industrial and biotechnological applications.

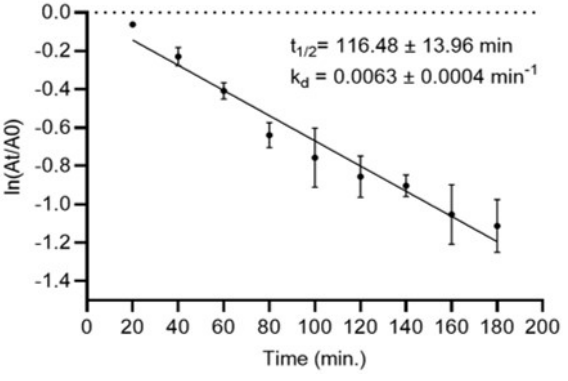

Fig. 3 Thermal inactivation kinetics of recombinant *Lc*MnSOD at 80 °C.

Relevant Publications:

- Journal of Molecular Structure. (2025), 1322: 140460.

Research group (From left to right): Akshita Goel, Dr. Kavita Rana, Asheesh Kumar, Dr. Arun Kumar, Dr. Neha Kumari, Sunanda Jassal, Mahima Chauhan, Himanshu, Naveen Kumar.

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Plant Molecular Biology

Research interests and long-term goals of our lab are (i) decoding stress-induced and chloroplast-triggered retrograde signaling activating the cognate responses; (ii) understanding the adaptive mechanisms in high-altitude plants; (iii) deciphering the epidermal cell differentiation mechanisms promoting the formation of outgrowth and secondary metabolite accumulation. In line with these goals, we are currently working on the following projects:

Decoding stress-induced and chloroplast-triggered retrograde signaling activating acclimation and cell death

Various stress factors directly affect the photosynthetic electron transport chain and generating reactive oxygen species (ROS). The ROS, thus generated, primarily targets photosynthetic machinery, leading to reduced efficiency. Chloroplast activates distinct retrograde signaling pathways, using ROS *per se*, ROS-oxidized derivatives, ROS-generated metabolites activate signaling to deal with elevated ROS and its impacts. We are elucidating the precise oxidative damage, identifying molecules relaying retrograde signalings, and utilizing the findings to engineer or develop damage-resilience in plants of economic importance.

Despite several studies, the precise damage caused by ROS to photosynthetic machinery and other chloroplast proteins remains unknown. Our investigations on the model plant, *Arabidopsis thaliana* were subjected to high light/cold and high temperature, mapped specific proteome changes and oxidative posttranslational modifications. These findings were further explored in the high-altitude plant *Picrorhiza kurroa*. Using the findings earlier, we unveiled the specific damage in photosystem II protein D1, which marks the PSII damage and repair process. We have now unveiled the relevance of oxidative modifications on an important chloroplast chaperone protein involved in the activation of Rubisco for efficient CO_2 fixation and protecting PSII reaction center proteins under temperature and light stress to ensure efficient photosynthesis (*Under review; presented at EMBO-HEPACC conference, India*). The findings of specific oxidations in light-harvesting complex (LHC) proteins allowed us to reveal the precise mechanism of the turnover of LHC proteins and LHC-bound pigments and turnover (*In communication; presented at Gordon Research Conference on Chloroplast Biotechnology, Italy).*

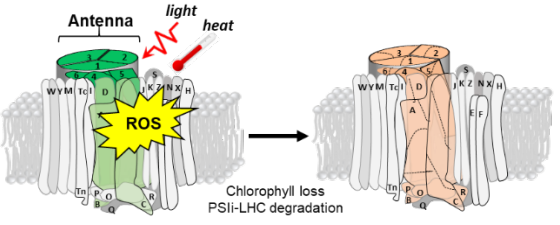

Fig. 1 Oxidative stress damages proteins and protein-bound pigments in the photosynthetic apparatus (*Unpublished*, 2025).

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 (***Plant Physiology and Biochemistry, 2025***). The sub-lethal stresses induce plant growth inhibition by arresting chloroplast division, 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.

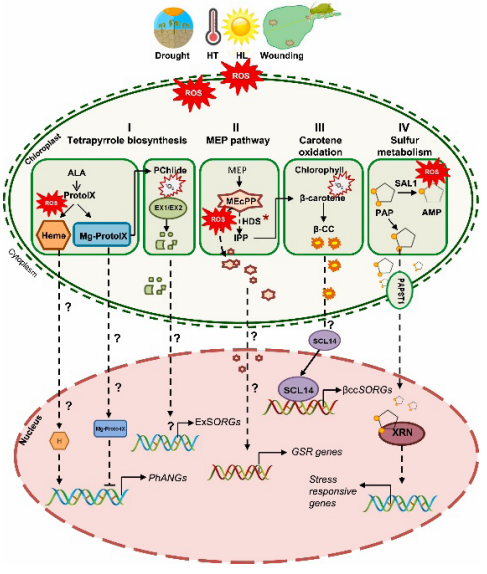

Fig. 2 Chloroplast-to-nucleus retrograde signaling pathways in plants. (*Plant Physiology and Biochemistry*, 2025).

PPO, a copper-containing chloroplast thylakoid-localized enzyme, catalyzes the oxidation of phenols. In tea, PPO converts catechins into brown pigments, theaflavins, during the processing of green tea into black tea. We recently revealed that PPO undergoes stress-induced proteolysis and subsequent activation. Activation of PPO leads to the accumulation of theaflavins, which act as signaling molecules, triggering an ER-stress-like response. This ER-stress-like signaling activates a programmed cell death, an essential phenomenon to sustain stress conditions. Silencing of PPO attenuated the accumulation of theaflavins and resulted in repression of theaflavins-mediated signaling and cognate stress responses. The role of PPO was further reinforced in tomato and wheat subjected to drought, indicating the crucial biological relevance of this evolutionarily conserved enzyme. The impact of theaflavins was further reinforced in the pharmacological treatment of *A. thaliana,* where theaflavins were revealed to modulate ER-specific HSP90 protein. And activating a bZIP60-dependent canonical EER-stress response. This work unveiled the role of PPO in triggering a novel inter-organelle communication activating stress responses in tea and other plants (*In revision; presented at Gordon Research Conference on Chloroplast Biotechnology, Italy*).

The molecules in tea extracts and the novel oxylipins identified showed potential for growth promotion and eliciting defense/secondary metabolite accumulation. This potential is being harnessed to develop technologies around these novel molecules.

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), high-intensity radiations such as UV-B, low partial pressure of gases, and inadequate availability of water and nutrients, high-altitude plants sustain and complete their life cycle. Deciphering the mechanisms by which these plants deal with these cues is essential for understanding the adaptability of these extremophiles. Our screening on Foxtail germplasm revealed resilience and adaptation to photoinhibitory stress (high light/cold) in landraces inhabiting high altitudes. The resilient genotypes possess lesser chlorophyll contents, better non-photochemical quenching, and a comparatively shorter life cycle (*In communication*; *presented at EMBO-HEPACC, CSIR-IHBT*). The nutritional aspects of resilient genotypes are being studied further.

Deciphering the relevance of glandular prickles in Rose

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 such an epidermal differentiation process are not clear. Earlier, we deduced a transcriptional module that plays a role in prickle morphogenesis and secondary metabolite accumulation. Recently, we characterized the glandular prickles and discovered these glandular structures accumulate specific sesquiterpene hydrocarbons possessing insect attractants and insecticidal potentials. Experimental results showed that glandular prickles protect floral buds from aphid pests (manuscript submitted after minor revisions).

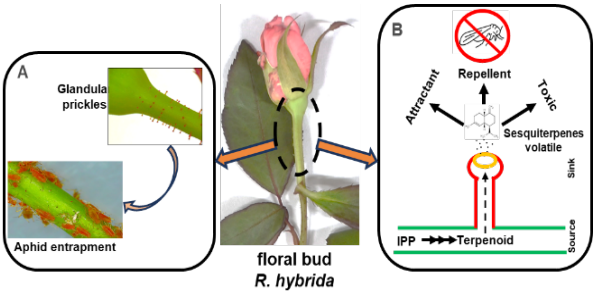

Fig. 3 Glandular prickles-mediated defense mechanism against aphid herbivores in the rose plant. (*Communicated*, 2025).

Relevant Publications:

- Plant Physiology and Biochemistry. (2025), 109747.
- Metalloids in Biology. (2025), Taylor & Francis Group, 318.

Research group (From left to right): Ritu Godara (UGC-SRF), Kajal Thakur (PAT-I), Dipanshu Ghosh (UGC-SRF), Vivek Dogra (Sr. Scientist), Rajvir Singh (SPA), Twinkle (CSIR-SRF), S. Vaishnavi (PAT-I), Sapna Thakur (SPA), Sumanta Mohapatra (UGC-SRF), Shagun Bali (DBT-RA-III).

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Adaptation, Climate change, Genomics/Epigenomics

The Integrative Plant AdaptOmics Laboratory (iPAL) investigates the molecular and physiological responses of plants to environmental stressors associated with global climate change, including elevated atmospheric CO_2, rising temperatures, and drought. Also, we are looking at the nutritional aspects of plants. We aim to elucidate the genetic and biochemical bases of plant resilience and nutritional dynamics to inform sustainable agriculture in changing climates.

HSFA1s integrate warm and heat signals in plants

Global climate change poses a serious threat to plant productivity. Two facets of ongoing climate change are the rise in global average temperatures (warming) and the increase in the intensity and frequency of extreme heat (heating) events. As Earth warms and heatwaves intensify, understanding how plants respond to temperature is critical. While warm temperatures trigger growth-related changes like stem elongation, extreme heat leads to stress responses that protect plant cells.

We highlighted that how a family of proteins called Heat Shock Factors A1s (HSFA1s) act as central regulators, integrating both warm and heat signals in plants. HSFA1s not only stabilize the growth regulator PIF4 during warmth but also activate HSFA2, a key gene for heat tolerance **(Fig. 1)**. This shows that plants don't treat warmth and heat separately—they use shared players to balance growth and survival. These insights deepen our understanding of how plants adapt to rising temperatures and may help develop crops better suited to a warming world.

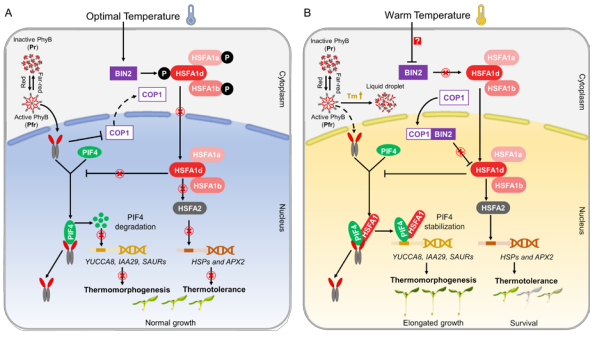

Fig. 1 HSFA1s integrate thermomorphogenesis and thermotolerance pathways. (A) At optimal temperatures, active PhyB inhibits COP1 and degrades PIF4, while BIN2 blocks HSFA1d nuclear entry, suppressing thermomorphogenesis. (B) Warm temperatures induce PhyB phase separation and COP1-mediated BIN2 inhibition, enabling HSFA1d nuclear localization. HSFA1d stabilizes PIF4 and activates HSFA2, coordinating growth and heat stress responses.

Nutritional dynamics in Quinoa (C3) and Amaranth (C4)

Intensifying threats of malnutrition and climate change call for climate-resilient, nutrient-rich crops. Quinoa (C3) and Amaranth (C4), pseudocereals of the Amaranthaceae family, have emerged as promising alternatives due to their adaptability and nutritional quality.

We compared diverse germplasms of both crops under four environments: control, heat, rain shelter, and field **(Fig. 2)**. Growth, yield, nutritional, and metabolic traits were assessed. Environmental conditions significantly affected both species. Quinoa showed a higher harvest index and elevated levels of flavonoids, phenolics, saponins, and iron. Amaranth had greater protein, starch, potassium, and amino acids like glycine and aspartate, along with higher phytic acid.

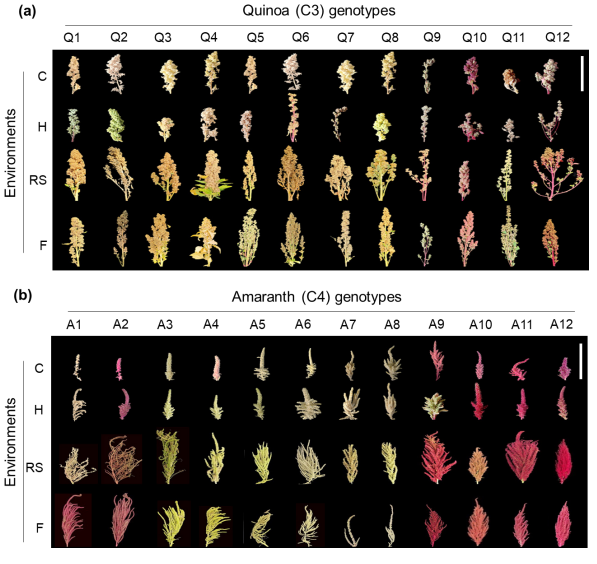

Fig. 2 Phenotypic variation in panicle morphology among diverse genotypes of quinoa and amaranth grown across four distinct environments.

Overall, our findings offer key insights into nutritional trait diversity, supporting the selection and breeding of resilient genotypes to improve food and nutritional security under future climate stress.

Microtubers – a system to explore potato biology

Potato (*Solanum tuberosum* L.), a staple food crop, produces underground tubers rich in carbohydrates, proteins, and micronutrients, essential for food and nutritional security. Tuberization—the transformation of stolons into tubers—is a complex process regulated by genetic, epigenetic, and environmental cues. Soil-based studies are limited by the invisibility of below-ground development. In contrast, in-vitro microtuberization enables precise observation under controlled, soil-less conditions. Microtubers form in response to internal factors like genotype and explant type, and external stimuli including photoperiod, temperature, light quality, plant growth regulators, sucrose, and synthetic compounds (**Fig. 3**). Morphologically and physiologically similar to field-grown tubers, microtubers offer a tractable model for dissecting the molecular mechanisms underlying tuberization. We highlight regulatory factors influencing microtuberization and its applications in seed production, germplasm conservation, molecular farming, genetic engineering, and stress adaptation.

Critically, the utility of microtubers as a model system advances our understanding of tuber development and supports innovation in potato research.

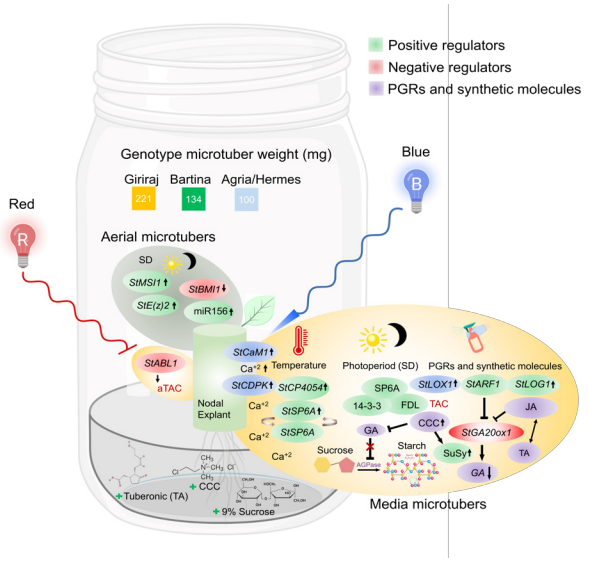

Fig. 3 Factors regulating microtuberization. Microtuberization is controlled by genotype, explant type, hormones, light, temperature, and synthetic molecules.

Relevant Publications:

- Plant Cell Reports. (2025), doi:10.1080/07388551.2025.2490957.
- Critical Reviews in Biotechnology. (2025), doi:10.1007/s00299-025-03483-0.
- Trends Plant Science. (2024), 29:885–887.

Research group: Dr. Avriti Ranjan, Dr. Anuj Choudhary, Dr. Sachin Ashok Tharot, Komal Goel, Pravesh Kundu, Madhushree Dutta, Vidhi Raturi, Surbhi Mali, Kirti Pandey, Sanjeet Kumar, Narender Kumar.

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Plant Adaptation and Developmental Biology

Crocus sativus is a perennial geophyte valued both for its medicinal properties and as the source of the spice saffron. Despite its economic and cultural importance, the molecular mechanisms and metabolic dynamics underlying its floral development remain poorly understood. In our laboratory, we aim to elucidate the temperature-mediated regulation of floral induction in saffron. To this end, we have adopted integrated transcriptomic and metabolomic approaches to investigate how temperature influences the initiation and progression of flowering in *C. sativus.*

Integrated Metabolomics and Transcriptomics Reveal Temperature-Dependent Floral Regulation

Our previous transcriptome-based study suggested that temperature-induced flowering is associated with changes in starch and sucrose metabolism. However, saffron corms contain a diverse array of metabolites, many of which are implicated in flowering across plant species, although their specific roles in *C. sativus* remain unclear.

To explore this further, we performed a comprehensive metabolomic analysis using HPLC-MS/MS, and integrated the results with transcriptomic data to gain deeper insights into the floral transition. Of the 118 metabolites detected, 97 showed differential accumulation across temperature treatments. When compared to 8°C, a total of 60 metabolites were significantly upregulated at 25°C and downregulated at 37°C, suggesting temperature-dependent modulation of metabolic pathways. Notably, metabolites related to raffinose metabolism, terpenoids, and phenylpropanoids, along with their derivatives, were significantly altered between flowering and non-flowering apical buds. These metabolic shifts were strongly supported by transcriptomic data, which revealed differential expression of genes involved in these pathways. Collectively, our results enhance the understanding of temperature-responsive floral induction at both metabolic and molecular levels.

Raffinose may Counteract Sucrose During Floral Transition

Among the metabolites studied, raffinose emerged as a potentially critical regulator of floral induction. Our data suggest that raffinose may play an antagonistic role to sucrose, or alternatively, that the sucrose-to-raffinose ratio may serve as a key determinant of the floral transition. At 8°C, we observed a 4.7-fold upregulation of galactinol synthase (GLOS), a central enzyme in the biosynthesis of raffinose family oligosaccharides (RFOs) (Figure 1). This was consistent with metabolite profiling, which showed a 5.2-fold accumulation of raffinose under the same conditions. RFOs function as carbohydrate reserves and have been widely associated with enhanced stress tolerance, including resistance to cold, drought, salinity, and heat (Elango et al., 2022; Sanyal et al., 2023). Hence, raffinose accumulation may contribute to saffron's resilience at low temperatures.

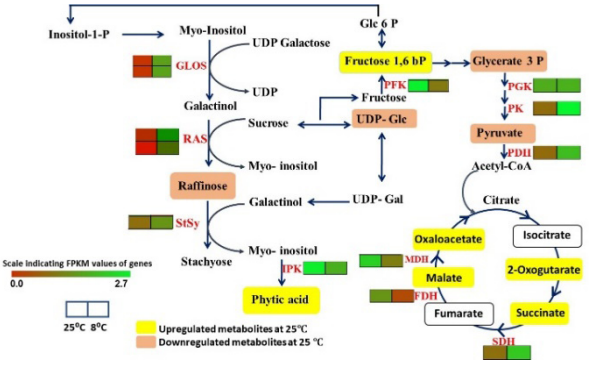

Fig. 1 Alteration in Raffinose family oligosaccharides (RFOs) and other sugar metabolite pathways during floral induction. Transcriptional and metabolomic profiling of DEGs (FPKM values) and DAMs of Raffinose family oligosaccharides (RFOs) and other sugar biosynthetic pathways during floral induction. Galactinol synthase (GLOS), Raffinose synthase (RAS), Stachyose synthase (StSy), Inositol-pentakisphosphate 2-kinase (IPK), Phosphofructokinase (PFK), Phosphoglycerate kinase (PGK), Pyruvate kinase (PK), Malate dehydrogenase (MDH), Fumarate hydratase (FDH), Pyruvate dehydrogenase (PDH), Succinate dehydrogenase (SDH). Yellow boxes represent upregulated metabolites and pink represents downregulated metabolites at 25°C.

Beyond their role in abiotic stress responses, sugars and sugar derivatives also act as signaling molecules that regulate flowering time. In Hemerocallis citrina, RFOs have been reported to play a critical role in floral induction (Li & Cui, 2023). Moreover, studies have shown that loss-of-function mutations in raffinose synthase (RS), a key RFO biosynthesis gene, can lead to early flowering (Praena Tamayo et al., 2022). It has been proposed that reduced RS activity shifts the sugar balance toward mono- and disaccharides, facilitating floral transition through the trehalose-6-phosphate synthase

(TPS) pathway. In our study, elevated GLOS expression and increased raffinose accumulation at 8°C may have shifted the sugar balance toward RFOs, limiting the pool of simple sugars available for metabolic energy—a potential explanation for the delayed flowering observed under cold conditions **(Fig. 1)**. Interestingly, raffinose accumulation has also been noted under warm temperatures in Arabidopsis, where genome-wide association and functional studies revealed a regulatory link between TPS activity and raffinose synthesis (Reichelt et al., 2023). These findings suggest that TPS modulates carbon partitioning and sucrose homeostasis, thereby contributing to thermotolerance. Our data support this model: under floral-inductive conditions, we observed downregulation of GLOS and upregulation of TPS, further indicating that sugar partitioning—and particularly the ratio between simple sugars and RFOs—plays a central role in the timing of floral induction.

Our data, in line with previous studies, suggest that phytohormones such as auxins, jasmonic acid, and gibberellins mediate temperature-induced flowering through components like DELLA, JAZ, and SAUR. Floral regulators including FPF1, PIF, and LHY may also contribute to this process. Metabolomic analysis revealed differential accumulation of metabolites from carotenoid, flavonoid, amino acid, and sugar pathways (excluding starch and sucrose) under inductive and non-inductive conditions. Notably, metabolites and genes related to raffinose metabolism were implicated, suggesting a role in floral induction. Together, these findings propose a network linking hormone signalling, metabolism, and floral regulators in temperature-mediated flowering, warranting further investigation **(Fig. 2)**.

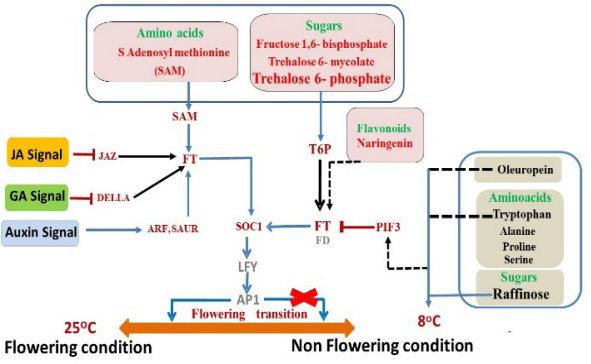

Fig. 2 A Schematic model drawn from integrated transcriptome and metabolomic analysis of flowering in saffron. Metabolites Trehalose 6 phosphate, S Adenosyl methionine and Naringenin upregulates the FT expression which ultimately promotes the expression of downstream genes and regulates floral induction under inductive condition. Whereas Raffinose, Oleuropein and tryptophan downregulates the FT expression and suppresses flowering under non inductive condition. Metabolites in red color indicate upregulated metabolites at flowering inductive condition (25ºC). While metabolites written in black color indicates upregulated metabolites at non-flowering inductive conditions (8ºC). Flowering-related genes present in red font (SAUR, ARF, JAZ, DELLA, PIF3) were supported by the transcriptomic data and other genes in shaded color were not detected in the data but are key genes in regulating the process.

Relevant Publications:

- Physiologia Plantarum. (2024), 176(2): e14285.
- Journal of Experimental Botany. (2024), 75(19): 6125-6141.
- Physiology and Molecular Biology of Plants. (2024), 30(5): 749-755.

Research group: Dr Rajesh Kumar Singh**,** Diksha Kalia, Joel Jose-Santhi, Firdous Rasool Sheikh, Nirupma Kumari, Sonali Kumari Manhas, Jahnvi Singh, Dr. Hrishikesh Mahato, Dr. Upasna, Dr. Keshav Thakur, Arushi Sharma, Sukriti and Varnika (Visiting PhD Student), Avishek and Shiny (Trainee).

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Microalgae biotechnology, Food and nutraceuticals

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

Microalgae *Tetradesmus* sp. as a novel dietary ingredient

We assessed the nutritional and nutraceutical potential of three microalgae strains from the *Tetradesmus* genus (formerly known as Scenedesmus sp.): *T. acutus*, *T. obliquus*, and *T. abundans*. The protein content ranged from 33 to 43 g 100 g^{-1}, primarily comprising alkali-soluble glutelin-like proteins. Tryptophan and sulfur amino acids were the limiting essential amino acids. The Essential Amino Acid scoring indicated that *Tetradesmus* proteins were inferior to conventional sources like eggs and dairy but superior to cereals such as wheat. The lipid composition showed a higher ratio of unsaturated fatty acids, suggesting potential health benefits. Essential micronutrients such as iron and zinc were found in abundance compared to common food products. Lutein was the predominant carotenoid, making up 0.1-0.25% of the total biomass. In vitro simulated gastrointestinal digestion increased the bio accessibility of phenolics in these microalgae. The strong antioxidant activity along with α-amylase inhibitory properties suggest their potential nutraceuticals applications. Among the three strains, *Tetradesmus acutus* possessed optimal growth and nutritional composition, indicating its potential as a novel source of dietary ingredients alongside established microalgae species like *Spirulina, Chlorella,* and *Nannochloropsis*. A graphical representation of the work is summarized in **Fig. 1**.

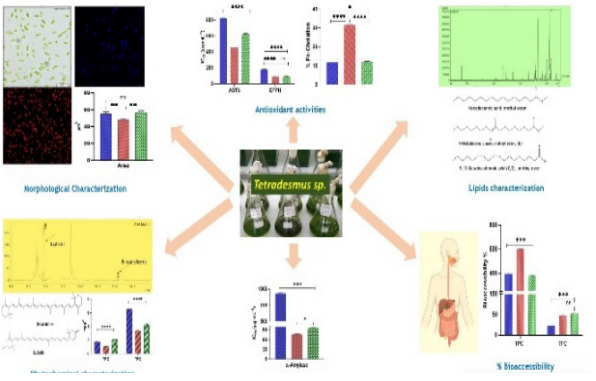

Fig. 1 Nutritional and nutraceutical potential of microalgae *Tetradesmus* sp.

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

We surveyed and identified nearly 100 WEPs were recorded and are consumed in the form of curries, soups, sauces, cordials, and pickles. These WEPs contain myriad bioactive molecules such as carotenoids, phenolic acids, flavonoids, polyunsaturated fatty acids (PUFAs) and terpenoids with therapeutic applications mainly antioxidants and enzyme inhibition activity (Fig. 2). Among the different WEPs, green leafy vegetables (GLVs) possessd higher concentratipons of macronutrients (proteins), micronutrients (iron and zinc), PUFAs, particularly PUFAs, and higher proportions of polyphenols with enhanced bioaccessibility compared to fruits. GLVs such as Amaranthus spinosus, Urtica dioica are promising sources of essential micronutrients particuallry iron and proteins.

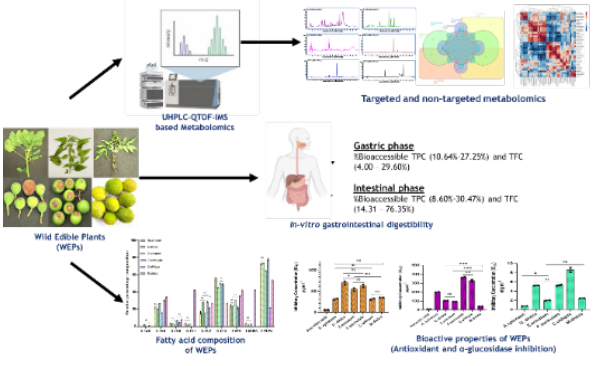

Fig. 2 Evaluating the nutritional properties of Wild edible plants of Western Himalayas.

Valorization of agri-waste for value-added products

Residues and byproducts generated after the extraction of essential oil (EO) from German Chamomile (*Matricaria chamomilla* L.) are often discarded or burnt causing severe resource wastage and pollution. Valorization of these residues and byproducts through a biorefinery approach generates myriad products of high value, leading to resource recovery and enhancement in the sustainability of Chamomile cultivation. In this direction, we comprehensivley

characterized the nutritional and nutraceutcitical profile of Chamomile residues **(Fig. 3)**. The fixed oil of the Chamomile flower (CF) residues contained high concentrations of linoleic acid. The aqueous extracts of the flower residues (CFL) were abundant in polyphenols, specifically *p*-Coumaric acid constituting 50% of the total composition. The CFL extracts exhibited strong antioxidant (IC_{50} 30–50 µg ml^{-1}), and α-glucosidase inhibitory activities (IC_{50} 244.81 µg ml^{-1}). The whole plant residue contained significant quantities of fiber (18.80 g 100 g^{-1}) and protein (14.80 g 100 g^{-1}) with higher concentrations of sulfur amino acids. A functional soup product incorporated with aqueous extracts of Chamomile flower residues was developed and characerize-d for nutraceutical properties, particulalry antioxidant and alpha-glucosidase enzyme activity. The Chamomile residues could be targeted for nutraceutical applications while the unutilized plant parts could be exploited as sources of industrial fibre and proteins that may find application as animal feed. The present work demonstrates the scope for the generation of value-added products from Chamomile waste towards effective resource recovery and enhancement of the sustainability of Chamomile cultivation.

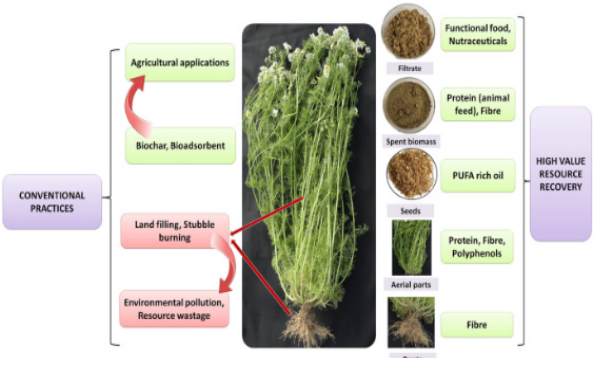

Fig. 3 Valorization of agri-process waste for the production of value added products.

Relevant Publications:

- ACS Food Science & Technology. (2025), https://doi.org/10.1021/acsfoodscitech.4c01032.
- ACS Food Science & Technology. (2024), 4 (11): 2707-2723.
- Waste Biomass Valorization. (2024), https://doi.org/10.1007/s12649-024-02683-1 .

Research group: Raman Kumar, Priyanka Parmar, Sampa Das, Athrinandan S Hegde, Smrit Gupta, Kalit Sharma, Aditi Guleria, Neha, Prajwal Jakhmola.

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Biotechnology

We're dedicated to advancing the understanding of high-altitude plant biology through the development of molecular markers, genetic and epigenetic analyses, and molecular breeding techniques aimed at enhancing key traits.

Insights into the heavy metal associated isoprenylated plant proteins (*HIPP*) gene family via genome-wide analysis in Rose

Roses (*Rosa* spp.) are among the most economically valuable ornamental plants and hold significant value in research due to their adaptability and response to various environmental stresses. Understanding the genetic mechanism underlying these responses is crucial for improving rose breeding and resilience. This study provides a comprehensive genome-wide analysis of the *Heavy Metal-Associated Isoprenylated Plant Protein* (*HIPP*) gene family in rose. In the present study, we identified a total of 67 genes in rose, including 38 *HIPP* and 29 *HPP* genes **(Fig. 1A)**. *RcHIPP* genes were distributed across all chromosomes, with the highest numbers on chromosomes 1 and 4. Phylogenetic analysis grouped *RcHIPPs* into five clades, and motif analysis revealed significant diversity, with *RcHIPP22* carrying the most motifs **(Fig. 1B)**. Further, to explore the regulatory functions of *HIPP* genes, 1619 *cis*-regulatory elements (CREs) were identified across the *RcHIPP* genes, classified into stress, hormone, development, and light-responsive elements. The stress-responsive CAAT-box and hormone-responsive ABRE elements were particularly abundant **(Fig. 1C)**. Next, to explore the expression of *RcHIPP* genes, qPCR analysis of *RcHIPP5* in both prickled and prickle-less genotypes showed differential expression during prickle development. *RcHIPP5* showed a significant upregulation, with a 1.6-fold increase during the mature stage. Conversely, the gene exhibited a 1.2-fold and 3.1-fold increase in the prickle-less genotype during the initial and mature stages (**Fig. 1D**). Overall, these findings highlight the potential roles of *RcHIPP* genes in growth, development, and abiotic stress responses in rose. These findings provide valuable insights into the *RcHIPP* gene family's structure, evolution, and functional relevance in rose adaptation and development.

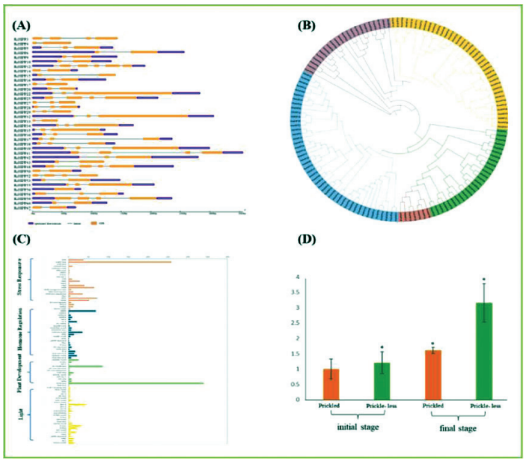

Fig. 1 (A) Gene structure of 38 *RcHIPPs* genes, (B) Phylogenetic relationship among HIPPs gene belonging to the rose, Arabidopsis, and rice, (C) Predicted *cis*-regulatory elements in the promoter regions of *RcHIPP* genes, (D) Expression profile of *RcHIPP5* in stem (where the prickle development initiates) of prickled and prickle-less genotypes at initial and final stage.

Identification of *LOG* genes and their role towards prickle development in rose

The *LOG* (*LONELY GUY*) gene family plays a role in plant cytokinin biosynthesis, converting inactive cytokinin precursors into their active forms. This activation process supports various physiological functions, including cell division, organogenesis, and stress responses, highlighting the gene family and its significance in plant development and adaptation. However, *LOG* genes are unexplored in rose. Eight *LOG* genes (*RcLOG*) were identified in rose, with CDS lengths ranging from 648 to 921 bp, encoding proteins of 215–306 amino acids. Molecular weights of RcLOG proteins varied between 23.52 and 34.20 kDa, with most featuring glycine-rich sequences, except for RcLOG3 and RcLOG4, which contain leucine and serine. These genes are unevenly distributed across three chromosomes (3, 5, and 6) and are classified into three clades. Structural analysis revealed that all *RcLOG* genes have seven exons, except *RcLOG3* and *RcLOG4*. Promoter analysis using PlantCARE found 316 *cis*-acting regulatory elements, mainly stress-responsive, hormone-related, development-associated, and light-responsive elements. GO enrichment analysis indicated *RcLOG's* roles in cytokinin and hormone biosynthesis, amine metabolism, and biological quality regulation. Additionally, qRT-PCR analysis showed varying

expression patterns in prickled and prickle-less genotypes, suggesting that *RcLOG* genes are implicated in prickle development **(Fig. 2)**. These findings provide a foundation for further functional characterization studies on *LOG* genes.

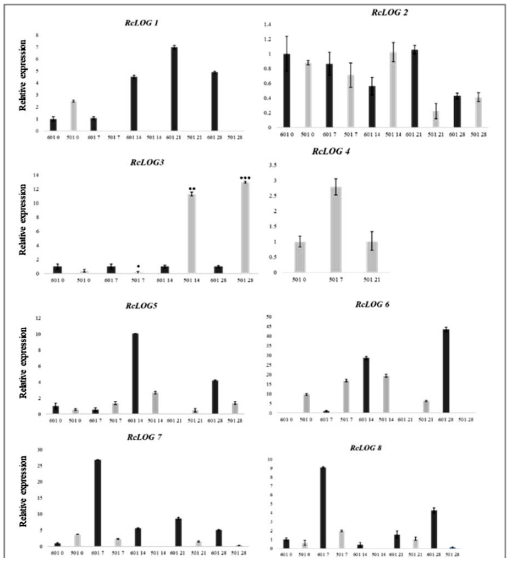

Fig. 2 Expression profile of *RcLOG genes* in the stem (where the prickle development initiates) of prickled and prickle-less genotypes at the initial and final stages.

Micronutrient content variation in buckwheat germplasm

Buckwheat (*Fagopyrum tataricum;* 2n=16) belongs to the Polygonaceae family, is a pseudocereal crop valued for its nutritional benefits, including high-quality protein, fiber, and bioactive compounds. The core set of 192 buckwheat accessions comprising *F. tataricum* (105 accessions) and *F. esculentum* (87 accessions) was procured from different sources (NPBGR Delhi, Kashmir). The field experiments were conducted at four locations at different altitudes of the Himalaya, including CSIR-IHBT: open field and polyhouse (Palampur), Dharamshala, and Keylong to assess the impact of varying temperature regimes on the agronomical performance as well as on the nutritional behaviour of the core set. After harvesting the seeds from different locations, various phenotypic traits, including seed colour, seed shape, seed surface, and 100 seed weight were recorded for each accession with three replicates. The core set was also evaluated for micronutrient content in seeds (Fe, Zn, Cu, Mn, Ca, Ni, K, and Mg) using ICP-MS at NABI, Mohali. The present study found that the mineral elements are highly variable in buckwheat germplasm, emphasizing the strong possibility of getting desirable natural alleles with high micronutrient content.

DNA barcode library for plants from the Western Himalayan Region

The present study focused on developing an efficient DNA barcode library for plant species from the Indian Western Himalayan region. A total of 72 specimens from 30 genera, 23 families, and 17 orders were analyzed. For analysis, we used tree-based, distance-based methods.

Within the ITS phylogenetic tree, dicot species from a number of families, including Ericaceae (3 individuals), Ranunculaceae (4), Boraginaceae (2), Asteraceae (3), Berberidaceae (4), and Crassulaceae (2) showed unique grouping patterns (Figure 4). In comparison, the phylogenetic tree constructed using the rbcL marker exhibited widely scattered clustering among most species, indicating reduced resolution and limited ability to distinguish between species. In case of distance-based method, the highest genetic distances within most genera were greater than the lowest genetic distances between genera, suggesting a lack of a distinct DNA barcoding gap. On the other hand, the ITS barcode exhibited a distinct DNA barcoding gap in eight genera, indicating its higher effectiveness in differentiating species. In conclusion, these results highlight the superior taxonomic resolution of the ITS barcode, particularly in distinguishing relationships between dicot and monocot species **(Fig. 3)**.

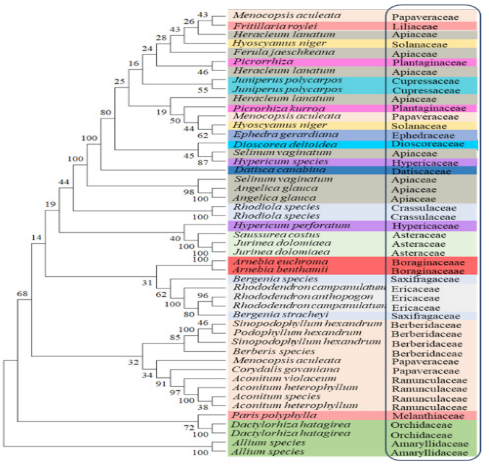

Fig. 3 The neighboring-joining tree was constructed for the plant species present in the Western Himalayan region under the p-distance model using the ITS DNA barcode gene.

Relevant Publications:

- Plant Cell Reports. (2024), 43(1): 1-13.
- Trends in Plant Science. (2025), 30:131-133.
- Plant Cell Reports. (2024), 43:144.

Research group: Dr. Narender Kumar, Priya Kumari, Vishek Choudhary, Himanshi Gangwar, Anita Choudhary, Ankita Sharma and Astha

Sarita Devi, Senior Scientist
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Biotechnology (Microbiology and Fermentation Technology)

The research group of our lab is working on the exploration of diverse microbial resources from ethnic fermented foods and environmental samples from the cold desert regions of Western Indian Himalaya for the identification of microorganisms for the development of probiotics based functional foods and for the production of thermophilic microbial enzymes, etc. These studies significantly impact industry and society through various applications like producing pharmaceuticals, as well as in food production, and disease prevention. Thermostable enzymes have gained interest for their widespread uses in various industries owing to their stability, catalytic activity, and ease of production and optimization than plant and animal enzymes and the probiotic-based nutraceuticals will improve health and combat the malnutrition problem of the local society.

Microbial production of Vitamin B12

The beneficial health effects of probiotics are precise and variation is observed even within different strains of a particular species. The samples of various milk and milk-based fermented products selectively obtained from indigenous cows, yaks and goats and traditional non-diary fermented products collected from different high-altitude regions of Western Himalaya (Lahaul and Spiti of Himachal Pradesh and Ladakh) were collected. These milk and milk-based samples were evaluated for their nutritional and micronutrient profiling i.e. carbohydrates, minerals, vitamins, proteins, and fat contents (AOAC international methods for proximate analysis and FSSAI, 2015. Manual of Methods of Analysis of Foods: Oils and Fats) and compared with the milk and milk-based products obtained from non-indigenous cow's milk. Potential probiotic from these foods were screened using standard protocols and probiotic attributes as described in the guidelines given by World Health Organization (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 vitamin B12 production under standard aerobic conditions. The ability of the microorganisms to produce vitamin B12 were tested qualitatively by growing the organisms in vitamin B12 assay medium (HiMedia) plates. The plates were incubated at 37°C for 24 to 48 h and checked for growth **(Fig. 1)**. The colonies that showed positive result were used for further quantification **(Fig. 2)**.

Fig. 1 Probiotic cultures growing on Vitamin B_{12} assay medium.

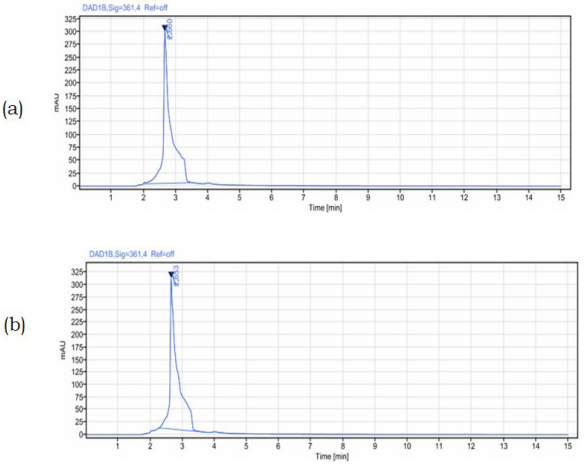

Fig. 2 Chromatogram by HPLC analysis of (a) *Enterococcus* sp. BAM 04 and (b) *Pediococcus* sp. BAM 10 showing vitamin B12 (cyanocobalmin) peak at retention time between 2 and 3.

Thermostable pectinase enzyme from Himalayan Geothermal Belt, Ladakh, India

In the past two decades, a myriad of extreme environments has been extensively studied for their microbial diversity, including hot springs, hydrothermal vents, fumaroles/stream vents, and volcanic soils. Investigations into the microbiological or geomicrobial richness of hot springs have not only produced remarkable scientific breakthroughs but have also enriched our knowledge of life in extreme conditions. So, we have isolated and screened various microorganisms from different water, sediment and soil samples from Panamik Hotspring, Chumathang hotspring, and Puga geothermal geyser, Ladakh for the identification of

microorganisms (bacteria) by culture-dependent methods. A total of 1100 isolates were isolated and screened for pectinase and xylanase enzyme production. The bacteria utilizing natural substrate (lignocellulosic biomass) and high temperature (>50ºC) for the production of pectinase and xylanase enzyme has not been explored yet. Out of 1100 isolates, 428 isolates showed the positive results for the pectinase enzyme activity. After qualitative and quantitative estimation for pectinase enzyme and based on the morphological identification of isolates, 30 potential strains were selected for 16S rDNA gene sequencing for the molecular identification. Some of the identified species were *Anoxybacillus* sp., *Geobacillus* sp., *Flavobacterium* sp., *Aeribacillus* sp., *Parageobacillus* sp. *Bacillus* sp. etc. Techniques like the one-factor-at-a-time (OFAT) approach, along with statistical methods such as Plackett-Burman Design (PBD) and Response Surface Methodology (RSM, **Fig. 3**), increase the pectinase production from a minimum of 3.22 U/mL to a maximum of 18.68 U/mL, which shows its higher value. (i.e. approximately 5.8-fold higher than the initial production (3.22 U/mL).

The final pectinase production medium compositions optimized were as follows: galactose 0.5% (w/v), HM B powder 0.55% (w/v), K_2HPO_4 0.6% (w/v), KH_2PO_4 0.6% (w/v), sodium nitrate 0.5% (w/v), sugarcane bagasse (w/v) 3%), pH (7) for 5 days' incubation period at 65ºC, 150 rpm.

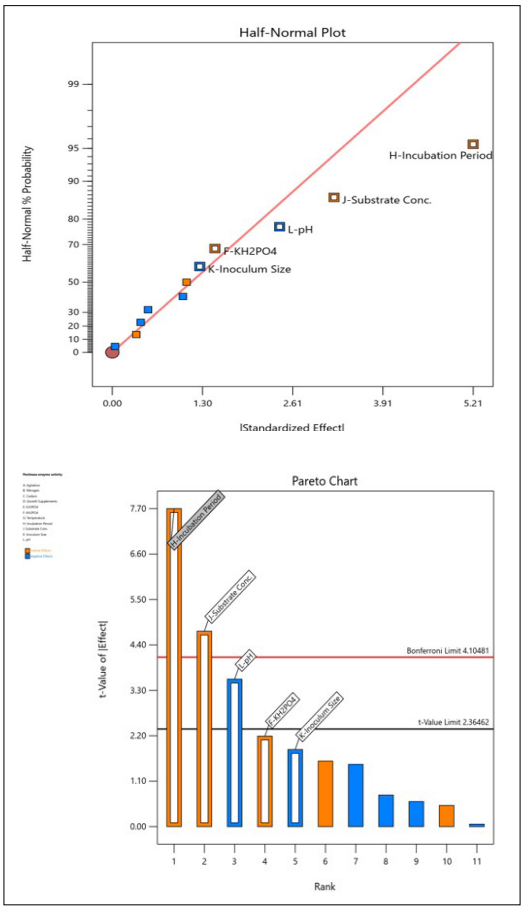

Fig. 3 Construction of (a) Pareto chart and (b) Half-normal plot during the screening of medium component by PBD.

Relevant Publications:

- Brazilian Journal of Microbiology. (2024), 14: 1-4.
- In Recent Advances in Bioprocess Engineering and Bioreactor Design. (2024), 139-169.
- In Antimicrobial Peptides from Lactic Acid Bacteria: Diversity, Biosynthesis and Applications. (2024), 209-246.

Research group (Left to right: Sitting line): Mr. Puneet, Mr Abhishek Kumar and Mr. Rajneesh Kumar

Standing line: Ms. Rashmi Koundal, Kumari Shanu, Ms. Geetanjli Choudhary, Dr Sarita Devi, Ms. Diksha Sood, Ms. Pragya Bardewa, and Ms. Shalini Kumari.

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Plant Tissue Culture, *in vitro* mutagenesis

Our lab is currently focusing on utilization of Plant Tissue Culture interventions for mass propagation of economically important and exotic fruit crops. Additionally, we will be utilizing induced mutagenesis approach for improvement of industrially important medicinal plants of Himalayan region for the development of novel genotypes with enhanced phytocompounds.

Development of a process for mass propagation of Blueberry

Blueberry (*Vaccinium* spp.), an exotic evergreen shrub belonging to the family Ericaceae, is highly valued for its nutrient-rich fruit and increasing consumer demand in India. Often referred to as the "king of berries," blueberries are packed with anthocyanins, polyphenols, and other bioactive compounds that offer numerous health benefits. Despite its adaptability in diverse climatic conditions, quality planting material for commercial cultivation of blueberry is not available.

Traditionally, blueberries are propagated via stem cuttings, but not all cultivars respond well to this method. Moreover, stem cuttings limit the scalability of propagation, making them less suitable for commercial production of new cultivars. Additionally, propagation through cuttings carries the risk of pathogen transmission. Therefore, developing an efficient in vitro propagation system is crucial for the large-scale production of disease-free, high-quality planting material and the successful expansion of blueberry cultivation.

Currently, we are focusing on developing an efficient system for the establishment of aseptic cultures of blueberry **(Fig. 1)**. This process technology will be further utilized by various plant tissue culture facilities for mass propagation of planting material for commercial cultivation in India.

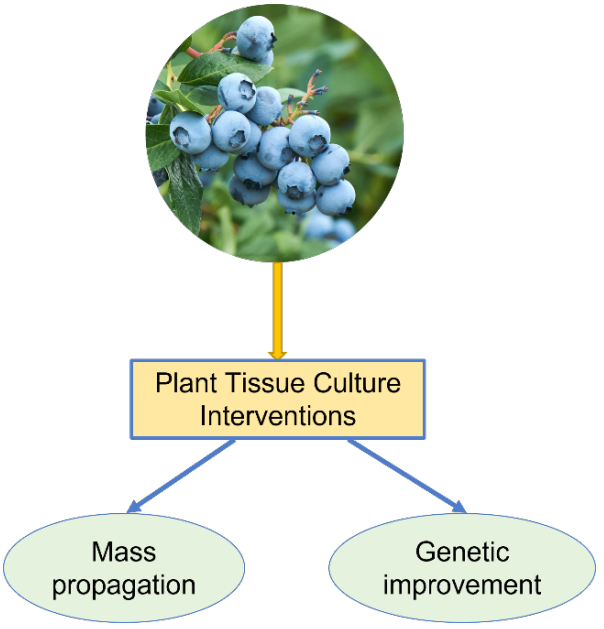

Fig. 1 Overview of workflow for future research plan.

CHEMICAL TECHNOLOGY DIVISION

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Chemical Technology

Our research group has been actively engaged in lignocellulosic biomass valorization to high-value chemicals, semi-synthesis of bioactive molecules from *Cedrus deodara* oil, processing chemistry for the scalable production of 4-alkyl resorcinol, designing visually detectable colorimetric sensors for CO_2 detection and nanocomposite materials development as well as application as catalysts for green and sustainable methodology development.

Lignocellulosic biomass valorization to high-value chemicals

Lignocellulosic biomass is a widely available, low-cost, and sustainable feedstock as a promising alternative to fossil carbon sources, with waste paper as another major contributor. Herein, a simple, sustainable, one-pot, and highly efficient protocol for the synthesis of 5-hydroxymethyl furfural (5-HMF) and furfural from cotton, waste papers such as cardboard, newspaper, tissue paper, white paper, and poly/mono-meric carbohydrates using a hydrothermal reactor system has been demonstrated in a greener solvent media (**Fig. 1a**). Additionally, other one-pot scalable and sustainable approach for 5-HMF and furfural production has been introduced by directly employing de-oiled lemon grass waste as a feedstock. The developed reagent system was also applied in different complex lignocellulosic biomass such as corn-cob, rice-straw, and sugarcane bagasse (**Fig. 1b**). Furthermore, a thermochemically stable furan-based π_{12}[12] cyclic-conjugated color-enriched heterocycle AF-cpdp, has also been synthesized via an energy-barrier-less approach from 2,5-diformylfuran and hydrazine hydrate (**Fig. 1c**).

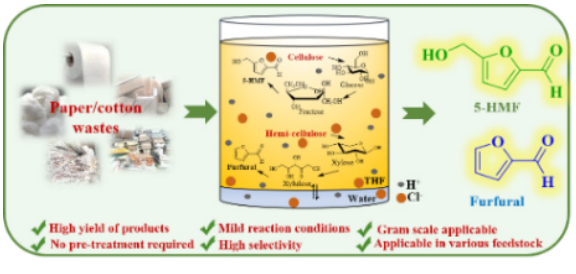

Fig. 1a 5-HMF and furfural synthesis from waste paper, cotton, and poly/monomeric carbohydrates.

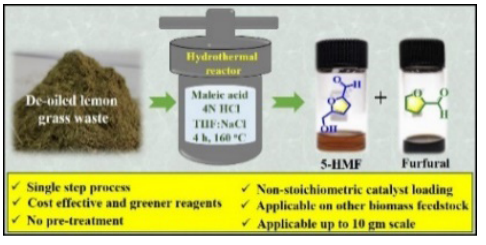

Fig. 1b Conversion of de-oiled lemon grass waste into 5-HMF and furfural.

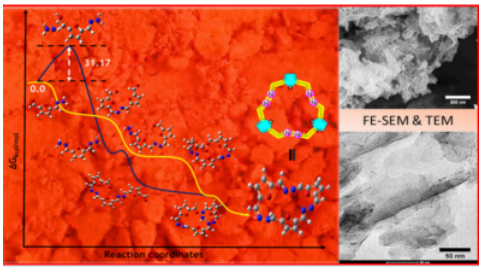

Fig. 1c Energy-barrier-less synthesis of AF-cpdp.

Semi-synthesis of bioactive molecules from *Cedrus deodara* oil

The benzosuberene class of compounds are important scaffolds due to their remarkable biological activities. Herein, a Pd-catalyzed synthesis of a range of benzocyclohepta-quinolinones has been reported from *β*-enaminones and vinyl bromide benzosuberene moieties derived from *Cedrus deodara* Oil (**Fig. 1d**). Furthermore, a Sonogashira coupling at the vinyl bromide position of triazole-bearing benzosuberene has been introduced for the synthesis of different potentially bioactive 1,2,3-triazole and conjugated enynes conatining benzosuberene analogues (**Fig. 1e**). Moreover, a highly efficient Pd-catalyzed synthesis of 1,2,3-triazolo-azepine-fused benzosuberenes has also been developed from vinyl bromide benzosuberene moieties and internal alkynes (**Fig. 1f**)

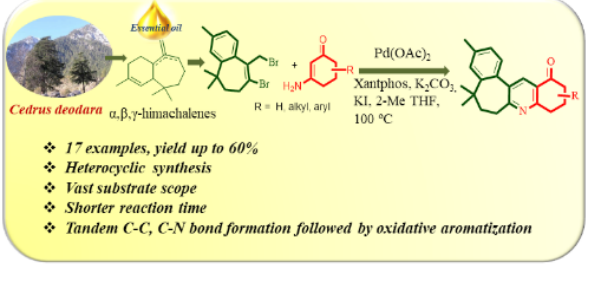

Fig. 1d Pd-catalyzed domino reaction for benzo-cyclohepta-quinolinones synthesis.

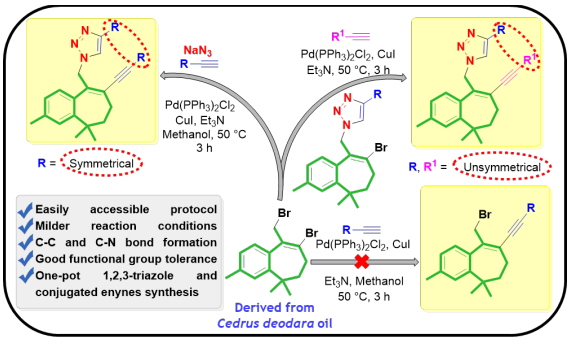

Fig. 1e 1,2,3-Triazole-guided multi-component Sonogashira coupling of substituted Benzosuberenes.

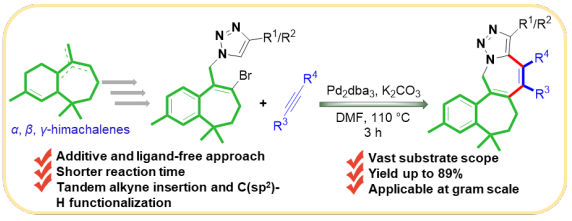

Fig. 1f Pd-catalyzed tandem approach for 1,2,3-triazolo-azepine fused benzosuberenes and 1,2,3-triazolobenzazepines synthesis.

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

Considering the importance of heterogeneous catalysis, a polystyrene-supported Pd nanoparticles catalyzed regioselective synthesis of indenones has been devised from *o*-bromo-chloroaryl iodides and internal alkynes using solid and economical oxalic acid as CO source (**Fig. 1g**). In addition, a Pd-catalyzed four-component dual carbonylative approach for cascade synthesis of 2-aryl quinazolinones has also been developed with ammonium carbamate as an ammonia precursor and oxalic acid as a bifunctional reagent acting as CO and C-atom surrogate (**Fig. 1h**). Further, a highly efficient Pd/C catalytic system has been introduced for regiodivergent hydrocarboxylation of terminal alkynes to selectively afford various acrylic and cinnamic acids employing oxalic acid as a CO source and a promoter for active Pd–H complex formation (**Fig. 1i**).

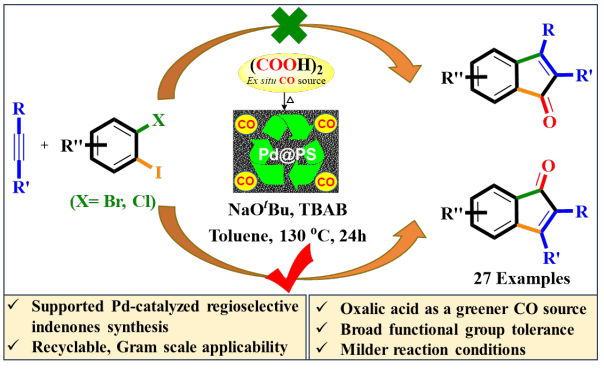

Fig. 1g Pd@PS catalyzed regioselective carbonylative indenones synthesis.

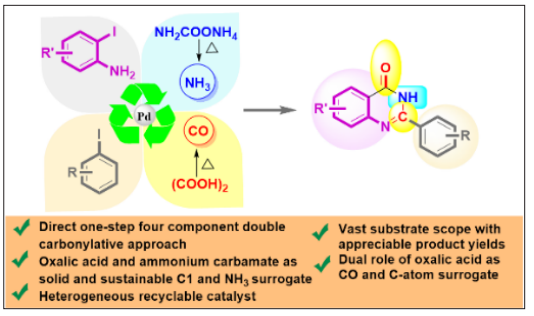

Fig. 1h Pd/C-catalyzed tandem four-component quinazolinone synthesis.

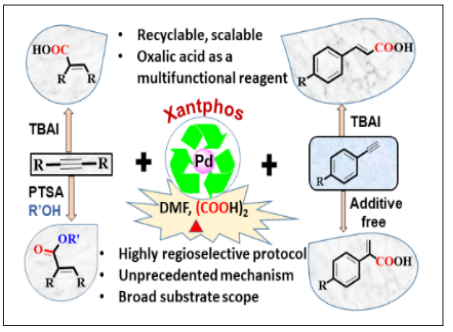

Fig. 1i Pd/C-catalyzed regiodivergent hydrocarboxylation and esterification of alkynes.

Design of visually detectable colorimetric sensors for CO_2 detection

Application of alkanolamines as an optical CO_2-responsive medium in combination with galvinol (GALH) as a reversible quantitative colorimetric sensor is proposed with detection limit for CO_2 gas as low as ~19 ppm (**Fig. 1j**).

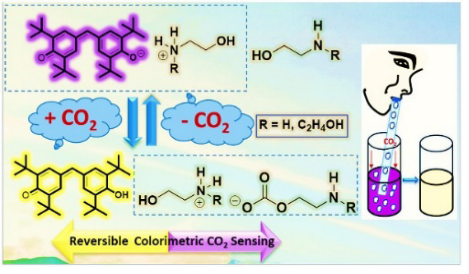

Fig. 1j Application of alkanolamines as an optical CO_2-responsive medium.

Relevant Publications:

- Chemical Science. (2024), 15: 18379.
- Renewable Energy. (2025), 244: 122657.
- Biomass and Bioenergy. (2024), 188: 107314.

Research group: Dr. Sheetal, Ashish Kumar, Pushkar Mehara, Rohit Bains, Poonam Sharma, Mahender Kumar, Naresh Kumar, Ayushi Walia.

Vijai K. Agnihotri, Senior Principal Scientist
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Natural Product Chemistry

Our research group specializes in Natural Products Chemistry, focusing on aromatic and medicinal plants from the Himalayan region. We work on aroma profiling and isolating and characterizing novel bioactive compounds. The therapeutic potential of essential oils and isolated compounds is thoroughly evaluated to identify promising candidates. In addition, we offer training programs on quality control, standardization, and botanical aspects of electrohomeopathic medicines to support practitioners in this field.

A new iridoid from the roots of *Valeriana jatamansi* Jones

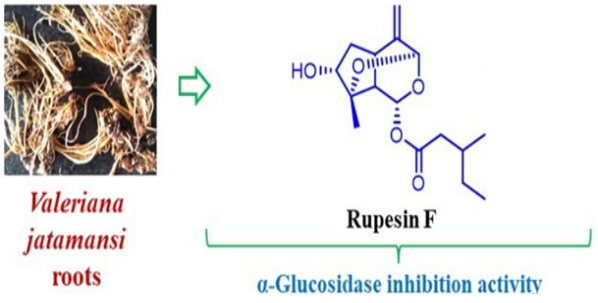

Fig. 1 *Valeriana jatamansi* Jones.

Valeriana jatamansi Jones (Valerianaceae) is a widespread perennial herb, distributed at altitudes of 1000–3300 m asl (above sea level). This species is a well-accepted aromatic and medicinal herb in Ayurveda. This study reports the isolation of one new iridoid compound, rupesin F, along with four known ones (rupesin E, valerianoside A, 8,9-didhydro-7-hydroxydolichodial and sucrose) from the roots of *Valeriana jatamansi* Jones. The structures were elucidated through detailed spectroscopic analysis, including ^{1}D- and ^{2}D-NMR techniques (HSQC, HMBC, COSY, and NOESY), and confirmed by comparison with existing literature data. Among the isolated compounds, rupesin F and valerianoside A demonstrated significant α-glucosidase inhibitory activity, with IC_{50} values of 10.13±0.11 and 9.13±0.03 µg/mL, respectively. These findings enhance the known chemical diversity of *Valeriana jatamansi* and highlight its potential as a source for developing antidiabetic agents.

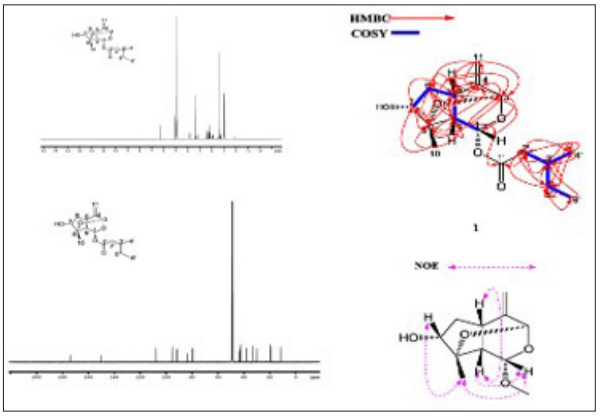

Fig. 2 NMR spectra of Rupesin F.

Rupesin F: Yellowish color oil; [α] +9.0 (c 0.1, MeOH); IR (ZnSe) ν_{max} cm^{-1} 3433, 1735, 1672; ^{1}H NMR (CD_3OD, 600 MHz): 6.33 (d, 3.3, H-1), 5.08 (s, H-3), 3.17 (t, 6.1, H-5), 2.14 & 1.93 (m, H-6), 3.84 (dd, 3.1, 7.2, H-7), 2.41 (t, 3.6, H-9), 1.42 (s, H-10), 4.94 & 4.87 (s, H-11), 2.31 (dd, 6.4, 14.7, 1H-2'), 2.20 (m, 1H-2'), 1.88 (m, H-3'), 0.97 (d, 6.7, H-4'), 1.43 (m, 1H-5') 1.28 (m, 1H-5'), 0.94 (t, 7.4, H-6'); ^{13}C NMR (CD_3OD, 150 MHz): 91.5 (C-1), 95.1(C-3), 150.4(C-4), 38.0 (C-5), 43.4 (C-6), 79.5 (C-7), 83.6 (C-8), 43.0 (C-9), 19.1 (C-10), 108.0 (C-11), 173.8 (C-1'), 42.3 (C-2'), 33.2 (C-3'), 19.5 (C-4'), 30.1 (C-5'), 11.9 (C-6'); HRESIMS m/z 319.1519 $[M + Na]^+$ (calcd for $C_{16}H_{24}O_5Na$, 319.1516).

Chemical profiling of *Cyclospermum leptophyllum* essential oil and evaluation of their biological properties

Cyclospermum leptophyllum grows wild in Himachal Pradesh, Haryana, Kerala, and Uttarakhand, and is cultivated for medicinal use in Andhra Pradesh, Gujarat, and Madhya Pradesh. This work describes the comparative chemical profiling of *C. leptophyllum* essential oil extracted from its aerial, fruits, leaves, and stem parts. The EOs extracted from different parts had variation in the yield (0.45–0.65 % v/w), and in composition thymohydroquinone dimethyl ether is identified as a major EO constituent having abundance in aerial parts (37.91%), stem (48.75%), leaves (39.33%) and fruit (67.94%).

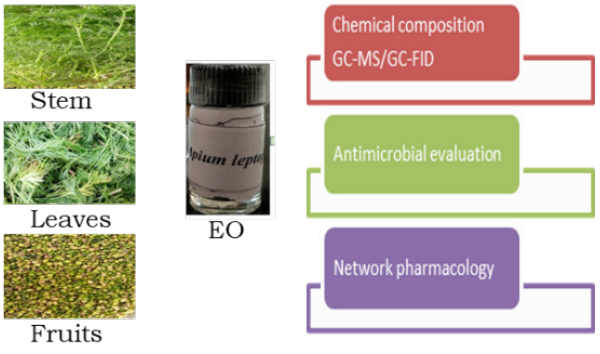

Fig. 3 Extraction of essential oil.

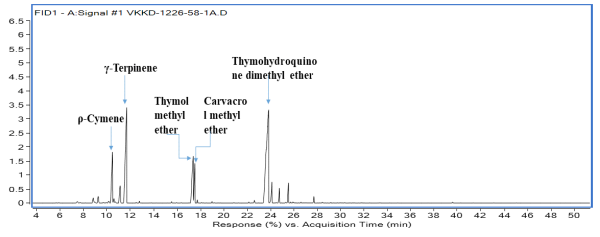

Fig. 4 GC-FID Chromatogram.

Other major constituents of EOs were γ-terpinene (3.94%–22.08%), thymol methyl ether (10.38%–14.09%), ρ-cymene (4.08%–12.3%), and carvacrol methyl ether (5.12-6.89%).

Unveiling the microbiome and metabolites of traditional dairy and alcoholic products from North-western Himalayan region

People in the Indian North-western Himalayas consume traditional fermented foods that may support a healthy lifestyle, but the region's probiotic diversity remains underexplored. This study examined fermented dairy products and alcoholic beverages using culture-based and sequencing methods and metabolite analysis.

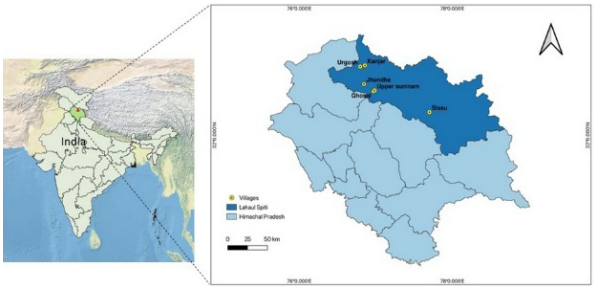

Fig. 5 Sampling site location from different regions of North-western Himalayas.

Probiotic genera like *Levilactobacillus*, *Lactiplantibacillus*, and others were identified, with dairy products showing greater diversity than alcoholic beverages. GC-MS detected high levels of methyl hexadecanoate and methyl linoleate. Functional predictions showed anabolic pathways dominated in dairy, while catabolic pathways were prominent in alcoholic samples. Fermented dairy products offer superior probiotic and nutritional value, making them promising functional foods.

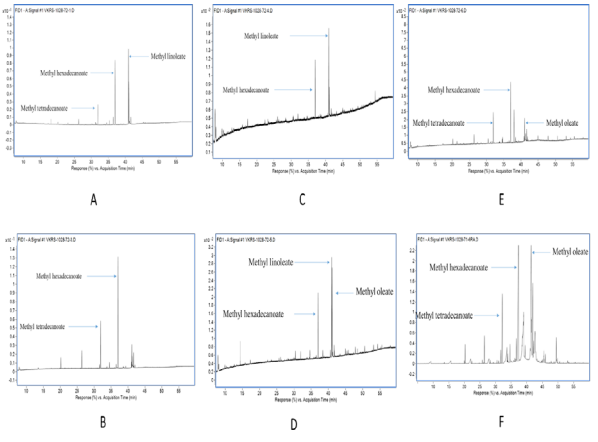

Fig. 6. Chromatograms of diffrenet samples

Six traditional fermented food samples were analyzed by GC-MS and quantified by GC-FID, identifying seven compounds. Methyl hexadecanoate was dominant in dairy samples like milk sisso (25.79 g/100g), wet churpi (39.59 g/100g), and curd cow (26.22 g/100g), while methyl linoleate was most abundant in alcoholic samples like lugri rice (27.93 g/100g), wheat (31.16 g/100g), and barley (36.75 g/100g). This chemical profiling, combined with microbial and metabolic analysis, highlights the nutritional and probiotic potential of Lahaul Valley's traditional fermented foods.

Relevant Publications:

- Natural Product research. (2024), 38(14): 2505–2510.
- Journal of Food Composition and Analysis. (2024), 136: 106833.

Research group: Ritesh Sharma, Rishabh Bhardwaj, Dr. Vijaikant Agnihotri and Kapil Dev.

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Chemical Technology Division

Our group focus is on development, design and up scaling of improved technologies for processing of 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.

Experimental Study on Natural deep eutectic solvents-based concurrent approach for qualitative and quantitative enhancement of *Rosa damascena* (Damask rose) essential oil and recovery of phenolic from distilled rose petals:

In pursuit of adopting environment friendly methodologies to amplify essential oil (EO) yield of industrially important aromatic plants, enrichment of bioactive content in distillation waste, and to establish the recovery process for the enriched product; this study employed natural deep eutectic solvents (NADESs) as cosolvent in the conventional hydro distillation method using *Rosa damascena* Mill L (Damask rose) petals as biomass. *R. damascena* is one of the most important species of Rosaceae family known for producing high-valued rose EO [often termed as "liquid gold"] but with very low yield. Herein, nine NADESs were used as cosolvent along with conventional hydro distillation method which led to 1.7 times EO yield enhancement (retention of EO quality as

per ISO guidelines) using NADES-4 [choline chloride: glycerol (1:1)] as cosolvent. Further, to sustainably utilize the residue (otherwise waste) left after hydro distillation, hydrolate (aqueous part left in the flask) and spent (dried solid waste) were analysed with UHPLC to determine targeted phenolics compounds. All the samples (EO, dried hydrolate, and spent) were also evaluated for in-vitro antioxidant activity using DPPH-radical scavenging assay, which revealed that hydrolate obtained by using NADES-5 [choline chloride: glucose (5:1)] showed the highest activity (IC50 0.85 µg/mL) as compared to ascorbic acid (IC50 5.40 µg/mL). Hence, the present study provides a green protocol for enhancing rose EO yield with phenolics-enriched antioxidant by-products. **(Fig. 1)**

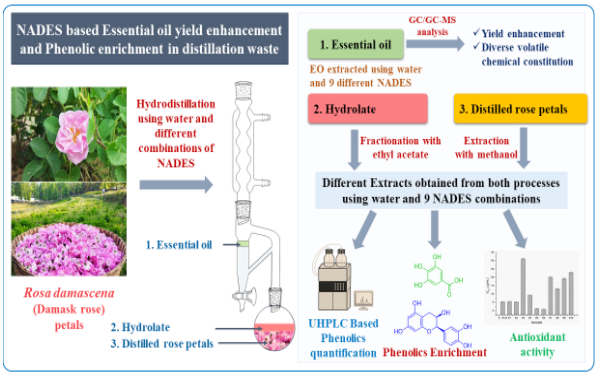

Fig. 1 NADES based essential oil yield enhancement and phenolic enrichment in distillation waste.

Experimental study on *Elwendia persica* (Boiss.) Pimenov & Kljuykov (Kala Zeera) from Indian Western Himalaya: impact of geographical locations on essential oil yield, chemical diversity, antibacterial, anti-diabetic and anti-oxidant activities

The present study investigated the effect of different geographical locations on the seeds of *Elwendia persica* (Boiss.) Pimenov & Kljuykov essential oil (EO) yield, chemical profile and their anti-bacterial, anti-oxidant and anti-diabetic potentials. The samples collected from three locations in Lahaul and Spiti regions, *viz.* Tindi (AC-209), Udaipur (AC-207) and Gondhala (AC-208) showed highest EO yields, 9.1%, 8.4%, and 8.7%, respectively. GC analysis revealed *p*-cymene, γ-terpinene, cumin aldehyde, and γ-terpinen-7-al as major constituents with AC-208 having the highest content of *p*-cymene (49.33%) and cumin aldehyde (41.33%). All samples showed significant inhibition (6h) against *Bacillus subtilis* MTCC121, *Staphylococcus aureus* MTCC96, *Salmonella typhimurium* MTCC733, and *Escherichia coli* MTCC43, with AC-203 showing the highest inhibition (≥98.8%) against all bacterial strains. *a*-glucosidase inhibition assay revealed significant inhibition by all samples (IC50 0.50– 0.88 mg/mL) compared to acarbose (IC50 0.29 mg/mL). Most of the samples showed moderate activity against DPPH radical inhibition. However, AC-203, –207 and –208 showed comparatively good activity against ABTS radicals with IC50 ≤ 0.55 mg/mL. This study highlights the use of *E. persica* from the Indian western Himalayas as an effective anti-bacterial and anti-diabetic

agent along with potential anti-oxidant activity and lays the groundwork for developing its superior varieties. **(Fig. 2)**

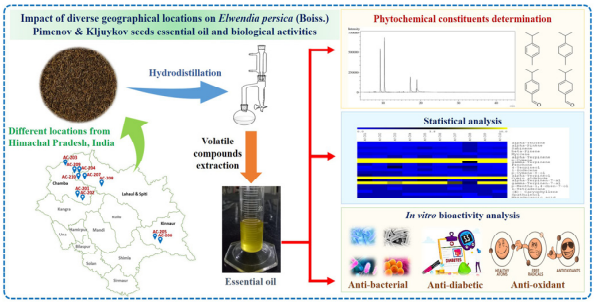

Fig. 2 Impact of diverse geographical locations on *Elwendia persica* (Boiss.) Pimenov & Kljuykov (Kala Zeera) seeds essential oil composition and its biological effects.

Design, fabrication and setting up of distillation units and catalyzing setting up of farmer's cooperatives for marketing of the produce: (HCP-0007) Mission Aroma phase-III

To enable farmers to distill the oil from their crop four improved multipurpose essential oil distillation units were designed, fabricated, installed commissioned at Meghalaya & Himachal Pradesh to registered society under Mission Aroma Phase-III

Design of solar hybrid essential oil distillation unit: A prototype was designed using solar energy as a renewable, sustainable and clean source for extracting essential oil. The unit is designed at a capacity of 50 kg per batch biomass processing capacity and installed at CeHAB Ribling, Lahaul & Spitti (**Fig. 3**)

Fig. 3 Installation of solar hybrid distillation units at CeHAB Ribling under Mission Aroma Phase-III.

Stevia Processing Plant installation at M/s RJ saints, Haroli, Una HP

Demonstration of technology and technical discussion regarding process flow, process design for extraction of steviol glycosides from *Stevia rebaudiana* were held with representative of M/s RJ Saints, HP. The pre installation visit was done at the site. Finally, the plant was inaugurated by DG, CSIR in presence of Director, CSIR-IHBT and staff **(Fig. 4)**

Fig. 4 Installation & inauguration of Stevia Processing Plant at M/s RJ saints, Haroli, Una HP.

Processing of Damask rose flowers on pilot plant: Fresh damask rose flowers were processed on pilot plant. Total 525 kg rose flowers were distilled to produce 250 liters rose water for sale and complimentary samples.

Relevant Publications:

- Separation and Purification Technology. (2025), 354: 128699.
- Natural Product Research. (2025), 1-10.

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

Upendra Sharma, Principal Scientist
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Catalysis; C-H Activation; Natural Product Chemistry; Analytical Chemistry

Phytochemical Investigation of Medicinal Plants

Our lab focuses on phytochemical investigations of medicinal plants with an emphasis on: (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*. The innovative green extraction techniques are utilized using Natural Deep Eutectic Solvents (NADES) for extraction 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 eight new and more than twenty-five known compounds from *Achyranthes bidentata, Aconitum heterophyllum Ageratum conyzoides, Cissampelos pareira, Cocculus hirsutus, Cyperus rotundus, Fritillaria cirrhosa,* and *Trillium govanianum*. Additionally, we've scientifically validated 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 seven new molecules.

Biochemometrics-A blend of untargeted metabolomics with biological activity: Plant extracts consist of a complex mixture of diverse phytometabolites, making it challenging to identify the specific compound responsible for a particular biological effect. Biochemometrics integrates untargeted metabolomics with bioactivity data through multivariate statistical methods to profile the entire metabolome and identify potential marker compounds contributing to the observed biological activity. We have developed biochemometrics models to pinpoint chemical markers responsible for the inhibition of acetylcholinesterase of *F. cirrhosa* (**Fig. 1**). Further three previously undescribed and two known isosteroidal alkaloids were isolated and characterized as acetylcholinesterase (AChE) inhibitors from the bulbs of *F. cirrhosa*.

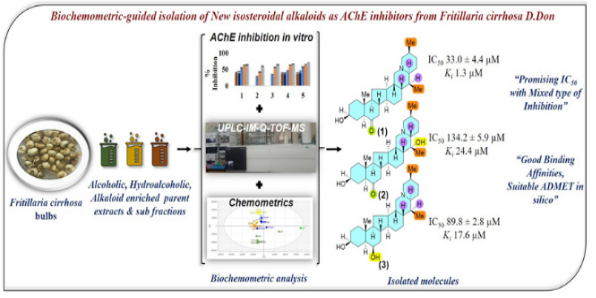

Fig. 1 UPLC-IM-Q-TOF-MS-based biochemometric approach: Isolation and characterization of new steroidal alkaloids from *F. cirrhosa*.

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

UHPLC-ELSD-based quantification of fourteen specialized metabolites from *Trillium govanianum* Wall. ex D.Don: The current study targeted the development of an easy and reliable UHPLC-ELSD-based quality assessment method for the simultaneous quantification of fourteen specialized metabolites in *T. govanianum*. The developed method was validated as per ICH guidelines for linearity, precision, and recovery studies. Furthermore, the developed method was applied for the recovery enhancement study of targeted specialized metabolites using NADES-assisted extraction in five geographically varied *T. govanianum* rhizome samples (**Fig. 2**).

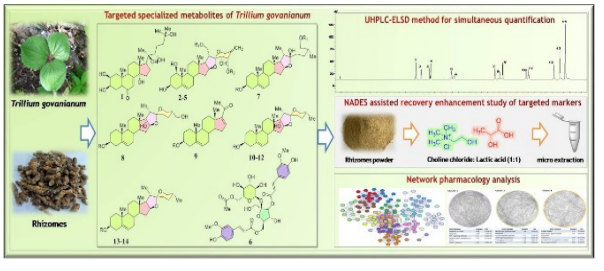

Fig. 2 UHPLC-ELSD-based simulatenous quantification, of fourteen specialized metabolites in *T. govanianum*.

NADES as green solvents

Our group have made a significant contribution towards the exploration of NADES' as green solvent in the MAPs extraction processes, emphasizing

their significant advantages in terms of eco-friendliness, targeted extraction, sustainability, enhanced selectivity, and higher extraction yields over conventional organic solvents (**Fig. 3**). This further aids in the scale-up isolation of targeted phytochemicals.

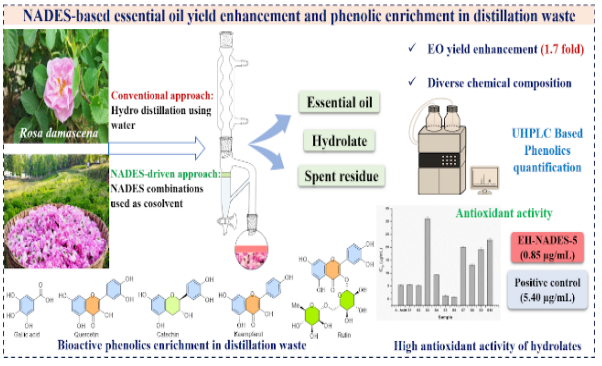

Fig. 3 Efficacy of natural deep eutectic solvents for extracting plant metabolites.

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

Construction of Stereogenic Nitrogen Compounds: Emerging Chemistry: Controlling chiral architecture is a fundamental yet elusive challenge in organic synthesis. Although the generation of point chirality at carbon centers is well-established, nitrogen stereocenter generation is particularly challenging, and underdeveloped. However, recent advancements in the field present promising solutions for the construction of these underexplored chiral nitrogen centers (**Fig. 4**).

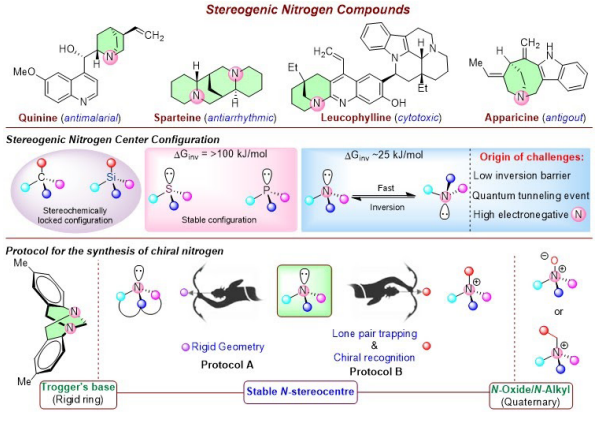

Fig. 4 Approaches for the construction of Stereogenic Nitrogen Compounds.

Synthesis of Axially Chiral Biaryls via Pd(II)-Catalysed Direct C(sp2)-H Arylation: Herein, a concise protocol for the construction of axially chiral biaryls via Pd-catalyzed direct C-H arylation of 1-arylisoquinoline N-oxides through kinetic resolution using commercially available, cost-effective, and bench-stable chiral mono-protected amino acid have been uncovered. The high conformational stability of the axially chiral products in different solvents and at high temperatures, as observed from the experimental studies and DFT calculations, shows their excellent stability (**Fig. 5**).

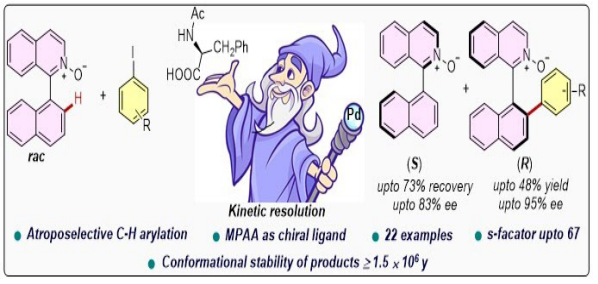

Fig. 5 Synthesis of Axially Chiral Biaryls via Pd(II)-Catalysed Direct C(sp2)-H Arylation.

Photocatalytic Synthesis of unsymmetrical Bis-*N*-Heterocycles: In this study, a sustainable approach has been revealed for the synthesis of bis-N-heteroaryl motifs comprising an indole and an isoquinoline/quinoline moieties. A novel photolabile phthalimide reagent based on indole was specifically designed to facilitate its coupling with medicinally valuable quinoline and isoquinoline motifs in the Minisci-type reaction. Indomethacin and ibuprofen-based biologically important motifs were also coupled with isoquinolines to generate a unique chemical space for further exploration in drug discovery research. Detailed experimental and theoretical studies were conducted to understand the mechanism of the developed protocol. This protocol can be a green tool for integrating drug molecules to discover new therapeutic leads (**Fig. 6**).

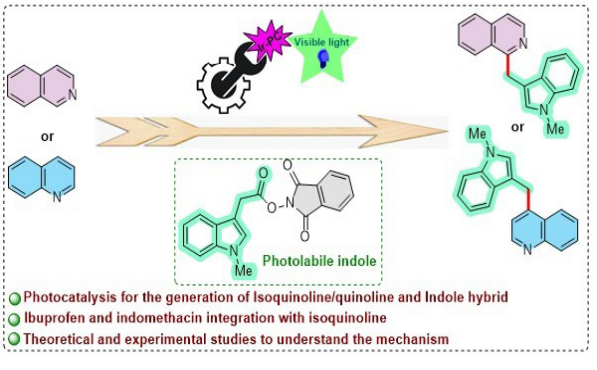

Fig. 6 Photocatalytic Synthesis of unsymmetrical Bis-N-Heterocycles.

Co (III)-Catalysed Regioselective Functionalization of Isoquinolones with Naphthoquinones: A strategy for Co(III)-catalyzed C(sp2)-H alkenylation of *N*-protected isoquinolones with 1,4-naphthoquinones has been disclosed. The developed protocol was efficiently applied for diversely substituted isoquinolones. Preliminary mechanistic experiments revealed the involvement of a five-membered cobaltacycle as an intermediate. Deuterium labeling experiments suggested the reversible nature of the C-H activation step. The scale-up reaction was also carried out, and the product was utilized as a chemosensor to detect Fe3+ ions (**Fig. 7**).

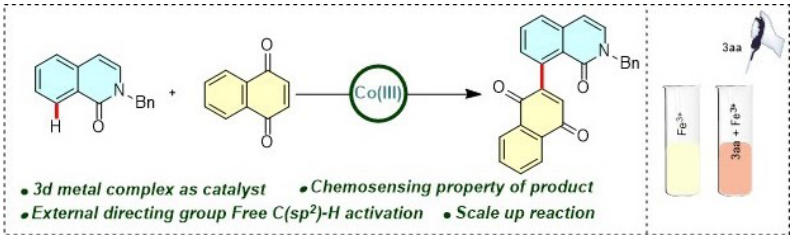

Fig. 7 Co(III)-Catalysed Regioselective Functionalization of Isoquinolones with Naphthoquinones.

Relevant Publications:

- Separation and Purification Technology. (2025), 354, 128699.
- Fitoterapia. (2025), 180, 106279.
- Microchemical Journal. (2025), 208, 112620.
- Phytochemical Analysis. (2024), 35, 1265.
- Trends in Chemistry. (2024), 6, 705.
- Organic Chemistry Frontiers. (2024), 11, 4986.
- Journal of Catalysis. (2024), 438, 115673.
- Organic Letters. (2024), 26, 8515.
- Organic Letters. (2024), 26, 5027.

Research group: Aadarsh Shrivastav, Dr. Anmol, Aryan Bhardwaj, Gaurav Aggarwal, Mehak Sharma, Prateek Singh Bora, Raman Singh, Ritika Sharma, Sachin, Sahil Awasthi, Sarthi, Shivani, Shivani Puri, Shourabh Rav and Tamanna Sharma.

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Natural Product Chemistry; Natural colors/dyes

In Natural Product Chemistry, this year we have studied the chemical constituents variation in different samples of *Rhododenron arboreum* collected from different regions of Himachal Pradesh and Uttrakhand. A total of 150 metabolites were detected through database and were categorized as terpenoids, fatty acid and their derivatives, amino acids, nucleosides, alkaloids, tannins, quinones, and polyphenols.

Rhododendron arboreum Sm. (Buransh) is an evergreen wild flowering tree found in high altitude temperate topography across India, Bhutan, Nepal, China and Pakistan at 1400-4000 m asl elevation. *R. arboreum* Sm. flower is one of the important non-timber forest products in the Western Himalayas and are utilized extensively by the local inhabitants, small businesses and their petals are used in the making of ready-to-serve beverages. The present study envisioned chemo-profiling and chromatic characteristics of *R. arboreum* flowers growing wild in different altitudinal areas. The primary pigments responsible for the scarlet red color of these flowers are anthocyanins. Among them, the most abundant anthocyanins were cyanidin-3-*O*-arabinoside, cyanidin-3-*O*-galactoside, and cyanidin-3-*O*-rhamnoside and constituted 90 % of total anthocyanin in *R. arboreum* floral samples.

Rhododendron arboreum

The change in the concentration, and composition of anthocyanins and other flavonoids can vary in petals appearance influencing the interaction of plants with pollinators. Therefore, to study the impact of different geographical location with varying altitudes, integrated studies with respect to chromaticity & chemical composition, the investigation utilized a non-targeted metabolomics methodology to comprehensively analyse primary and secondary metabolites in a fresh *R. arboreum* floral sample.

For our non-targeted metabolomics analysis, we used LC-MS to comprehensively analyse chemical constituents in a fresh *R. arboreum* floral sample. A total of 150 metabolites were detected and categorized as terpenoids, fatty acid and their derivatives, amino acids, nucleosides, alkaloids, tannins, quinones, and polyphenols.

This study is the first to quantify the flavonoids especially anthocyanin and other phenolics, in the flowers of *R. arboreum* collected from 38 different locations with altitudinal ranges of 1,300-2,700 m. In the samples, cy-3-*O*-ara, Q-rham, Chl A, and cy-3-*O*-gal were observed to be in significant amount. The quantified compounds were also subjected to chemometric analysis, i.e PCA which generated overlapping clusters for locational collected samples and remained nearly uniform despite of their altitudinal location differences. It indicates there may be a similarity in the chemical composition of floral petals obtained from different regions. However, cyanidin glycosides were associated with high altitude 2,000-2,100m and 1,600-1,700 m.

Qualitative and quantitative comparison of compounds in different parts of *Thalictrum foliolosum* DC using UPLC-PDA/UHPLC-QTOF-IMS

Thalictrum foliolosum is least explored species of the *Thalictrum* genus. This plant is known for its immense utility in traditional folk medicine. Different parts of the plant hold various ethnomedicinal values that are yet to be explored from a phytochemical perspective. The current study primarily aimed to investigate and compare the diversity of metabolites in root and aerial parts (stems and leaves) of *T. foliolosum*. For this, a UPLC-PDA-based analytical approach has been employed for the estimation of five isoquinoline alkaloids [magnoflorine, thalidasine, jatrorrhizine, palmatine, and berberine] in different extracts and fractions of the plant. Quantitative results revealed that roots contain the highest content of targeted alkaloids. Extensive metabolite profiling through UHPLC-QTOF-IMS tentatively identified 25 alkaloids while METLIN database identified 268, 104, and 102 metabolites of various classes in

leaves, stems, and roots, respectively. This study is the first to offer thorough metabolite profiling in the plant.

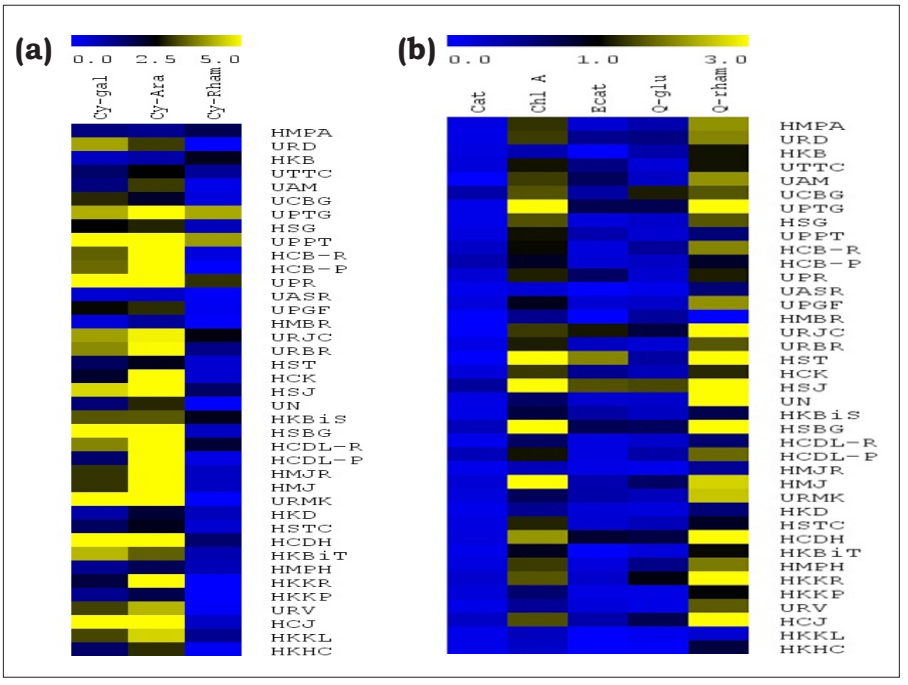
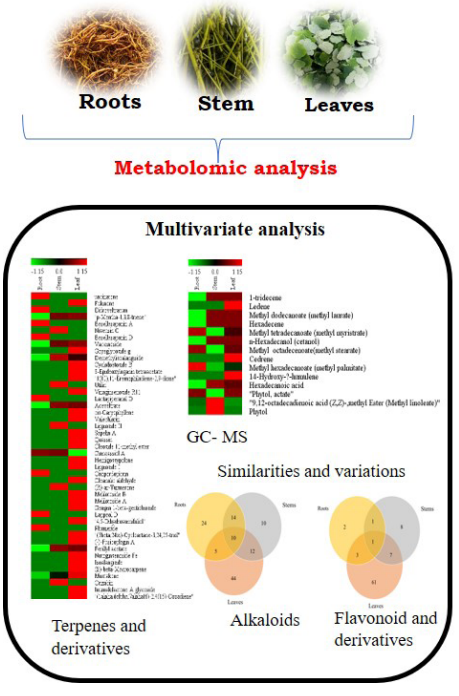


Fig. 1 Heat map of 38 locational *R. arboreum* floral samples (a) Quantification of anthocyanin cyanidin-3-*O*-galactoside (Cy-3-gal), cyanidin-3-*O*-arabinoside (Cy-3-ara), cyanidin-3-*O*-rhamnoside (Cy-3-rham) and (b) Phenolics. Boxes represent average concentrations of triplicate samples in mg/g extract.



GC-MS-based targeted profiling showed the highest content of methyl palmitate (roots and leaves) and hexadecanoic acid (stems and leaves).

Relevant Publications:

- Microchemical Journal. (2025), DOI: 10.1016/j.microc.2025.113244.
- Food Research International. (2024), DOI:10.1016/j.foodres.2024.115427.
- Phytochemical Analysis. (2024), DOI: 10.1002/pca.3354.

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NMR, Metabolomics Natural Product Chemistry and Value addition

Himalayan biodiversity, including medicinal and aromatic plants, has a high potential and demand for drug, cosmeceutical, food, and nutraceutical industries. The increased demand in the market resulted in unethical and illegal practices such as adulteration and substitution. It has been noticed that chemical markers, quality control methods, and scientifically developed products are lacking in the market and also have serious concerns. Thus, our group has isolated chemical markers and developed quality control methods and chemical signatures to cater to the researcher/interventors, startups, MSMEs, and industrial requirements. Products under CSIR missions have been developed and in developing stages. Four products have been licensed this session to their respective stakeholders. Furthermore, the group is also working to discover the mechanistic role of medicinal plants and their derived products. Process, Formulation and value addition is another key focused area, where group is continuously working.

Metabolomics studies

The group has conducted the organ specific metabolome analysis of *Trillium govanianum, Viola canescens, Rhynchostylis retusa, Bunium persicum, Juniperus communis, Artemisia maritima* under different conditions along with this, the samples were also 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 anticholinesterase activity suggest a trade-off between metabolites for therapeutic advantages of *Trillium govanianum* Wall. ex D. Don **(Fig. 1)**

Trillium govanianum is traditionally used to treat innumerable alignments like sexual disorders, cancer, inflammation etc. *T. govanianum rhizomes* have been explored earlier for phytochemical profiling but the comprehensive metabolome of other parts still need to deeply investigated. Thus, current study was aimed for organ-specific (roots, rhizomes, rhizomatous buds, stems, leaves, and fruits) metabolome analysis of *T. govanianum* via advanced analytical techniques with multivariate statistical analysis. targeted steroidal saponins and free sugars and non-targeted metabolites were profiled by UPLC-PDA/ELSD & UHPLC-Q-TOF-IMS. Among steroidal compounds, 20-hydroxyecdysone, pennogenin-3-O-*β*-chacotrioside, dioscin were found predominantly in all parts while diosgenin was identified only in rhizomes. Further, four free sugars viz. 2-deoxyribose (116.24±1.26 mg/g: leaves), fructose (454.76±12.14 mg/g: rhizomes), glucose (243.21±7.53 mg/g: fruits), and galactose (69.06±2.14 mg/g: fruits) were found significant in respective parts. Elemental analysis of targeted samples was determined by atomic absorption spectrophotometer. Heavy metals (Cd, Hg, Pd, As) were absent while micro- (Mn, Na, Zn, Cu) and macro- (Ca, Fe, Mg, K) elements were found in all samples. Furthermore, UHPLC-Q-TOF-IMS had identified 103 metabolites based on their mass fragmentation patterns and 839 were tentatively predicted using METLIN database. The multivariate statistical analysis showed organ-specific clustering and variance of metabolites. Apart from this, extracts were evaluated for in-vitro anticholinesterase activity and found potential inhibitors with IC50 values 2.02±0.15 to 27.65±0.89 mg/mL and 3.58±0.12 to 16.81±2.48 mg/mL of acetylcholinesterase (AChE) and butyrylcholinesterase (BChE) enzyme, respectively. Thus, comprehensive metabolomics and anti-cholinesterase activity of different parts of *T. govanianum* would lay the foundation for improving the medicinal importance and health benefits of *T. govanianum*.

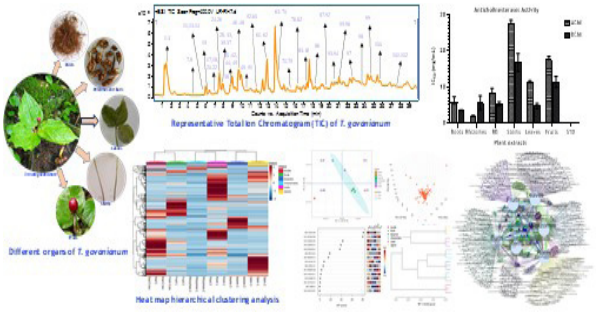

Fig. 1 Comprehensive metabolome anaysis of *T. govanianum*.

Quality Control and health benefits

Ajuga parviflora is traditionally used to treat fever, diabetes, and digestive problems. Currently, quality control method based on Ultraperformance liquid Chromatography-Photodiode array (UPLC-PDA) was developed and validated to determine ajugasterone C, cyasterone, and vanillic acid in *A. parviflora*. Further, antiadipogenic and antidiabetic

potential of A. parviflora was evaluated. The validated UPLC-PDA method was found reproducible to determine ajugasterone C, cyasterone, and vanillic acid. The validated method was used to determine marker compounds in A. parviflora extracts (Ethanol: EtOH, 50% EtOH, and water; leaves and roots). Moreover, the antiadipogenic effect of A. parviflora extracts was examined on 3T3-L1 murine preadipocytes cell line. Cells were subjected to various dosages of leaves and root extracts, and the extent of lipid accumulation was evaluated. Furthermore, cells were treated with different extracts prior to hydrogen peroxide exposure, and then the effects of A. parviflora treatments on oxidative stress, cell survival, and insulin sensitisation were assessed. The targeted compounds were found in all the samples. Biologically, leaves and roots extract of A. parviflora drastically suppressed adipogenesis by lowering intracellular lipid accumulation in dose-dependent manner. They improved insulin sensitivity by promoting glucose uptake and protected cellular health from oxidative damage by reducing reactive oxygen species generation and reversing apoptosis. Findings suggested that ethanol extract of leaves exhibited potent antiadipogenic properties and UPLC-PDA will be a reproducible method to assess the quality of *A. parviflora* and its derived products.

Relevent Publications:

- Scientific Reports. (2024), 14(1): 10675.
- Journal of Herbal Medicine. (2024), 48: 100950.
- Food Bioscience. (2024), 62: 105201.

Research group: Dinesh Kumar, Bindu Rawat, Vandana Kumari, Anil Kumar, Manish Kumar, Rishabh Kaundal, Rajinder Kumar (JRF's, Project Fellows), Sachin Vishisath, Anmol, Krishma, Ayushi, Neha, Iva.

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

Amit Kumari, Scientist
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Separation, SLE study, Process and Product Development

Our lab focus on applied research and transational innovation to harness bioresources for industrial and societal benefit. The work on Menthol, natural sweetener and Floral waste utilization for value added product development has been the primary research areas for technology and then product development. We also emphasize on the fundamental part of the separation science for extracting the economically valuable compounds such as the aroma and floral waxes (aromatic/non-aromatic) from floral waste.

Himalayan Bioresource Mission

Under the Himalayan Bio Resource Mission, a patented method was developed to extract high-purity menthol crystals from *Mentha piperita* in < 2 days, benefiting industries, and boosting rural livelihoods.

The menthol crystals were successfully separated from Peppermint oil having < 50% menthol concentration via application of selective combination of solvent mediated system. As shown in the figures below natural high purity menthol crystals were separated in two stages in less than 2 days.

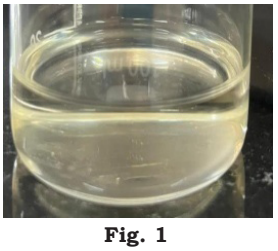

Fig. 1

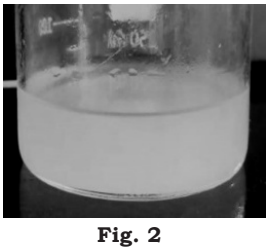

Fig. 2

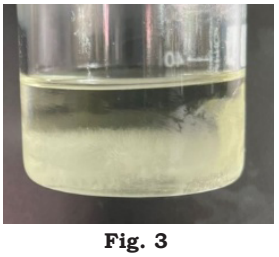

Fig. 3

Fig. 4

Fig. 1 Peppermint Oil 2, Milky Solution 3, Separation of Crystals 4, Dried Menthol Crystals.

Floriculture Mission

Aromatic oils and absolutes are in high demand because of their fragrant and medicinal properties. A large amount of wax is generated after oil extraction which is discarded as waste in the Industries. More than 70% wax was obtained during the extraction process.

So, an eco-friendly procedure for purifying floral waste to create naturally scented floral wax candles was developed. These candles were free from toxic chemicals and had great burning characteristics, such as steady flame height, prolonged burn time, and minimal soot production, which are critical for candle performance and consumer satisfaction. These candles served as a green alternative to conventional paraffin-based candles, which often rely on non-renewable fossil fuels and release harmful by-products during burning. Floral wax was also a great substitute for bee wax as bee wax extraction considerably impacts the natural pollination processes. Under the Floriculture Mission, technologies were created to produce natural perfumes, floral wax, and candles from floral waste, promoting zero-waste practices and women-led microenterprises.

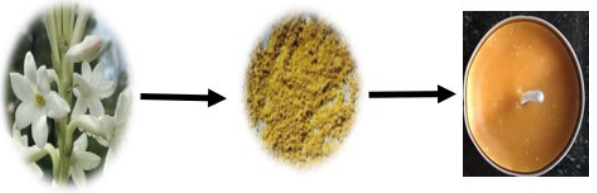

Fig. 5 Process for Floral Wax/Floral Candle using flowers/waste flowers.

Natural Sweetener (Monk Fruit)

The Monk Fruit (*Siraitia grosvenorii*), belongs to Cucurbitaceae family, which has been in use for centuries in Traditional Chinese Medicine for the treatment of cough, sore throat, and minor stomach and intestinal troubles. However, now this plant is known throughout the world for its intense sweet taste. The ripened fruit of this plant has the presence of cucurbitane-type triterpene glycosides known as 'Mogrosides'. The extracted mixture of mogrosides is about 300 times sweeter than sucrose. Among them, Mogroside-V is extremely sweet and has no after-taste effects. For Developing end-to-end technology towards commercial production of a range of products from Monk Fruit, CSIR-IHBT has developed and standardized the **Green Process for Mogroside enriched extract on Semi-Pilot Scale** offering a healthy, plant-based alternative to sugar for food and nutraceutical industries**.** UHPLC method has been developed & validated for determination of total mogrosides in the sweetener samples.

Fig. 6

Fig. 7

Fig. 6, Monk Fruit Juice Concentrate 7, Natural Sweetener

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
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Phytochemistry, Natural Product Chemistry, Value Addition

My laboratory is mainly focused on isolations and characterization of natural compounds, herbal finger printing of marker compounds from Medicinal and Aromatic Plants (MAPs) of Western Himalayan region for value added product development.

Isolation and characterization of phytocompounds from *Urtica* spp. for value addition

The genus *Urtica* belongs to the family Urticaceae a major group of flowering plants Angiosperms. There are about 46 species of plants under this genus. The most common ones are the stinging nettle *Urtica dioica* L. (Dioecious) and *Urtica ardens* L., (Monoecious) that grows in high and low altitudes. There is an increased demand for plant-derived products to be used in traditional medications, nutritional supplements, and in various healthcare products. The leaves of *Urtica* spp. are rich source of terpenoids, carotenoids, and fatty acids along with several essential amino acids, vitamins, and tannins respectively (Kregiel et al., 2018).

Accordingly, the research work was aimed to investigate the marker compounds from *Urtica* spp. and their characterization using various analytical techniques for value addition. Through this study a comprehensive understanding of the metabolites in two species will be known for the development of health beneficial formulations.

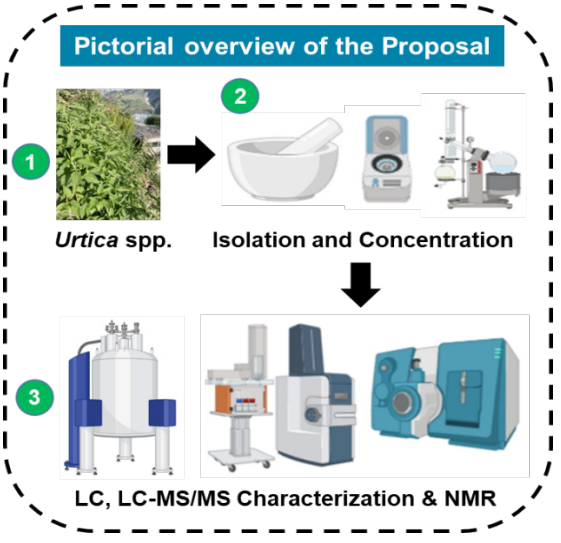

Fig. 1 Graphical representation of the study design.

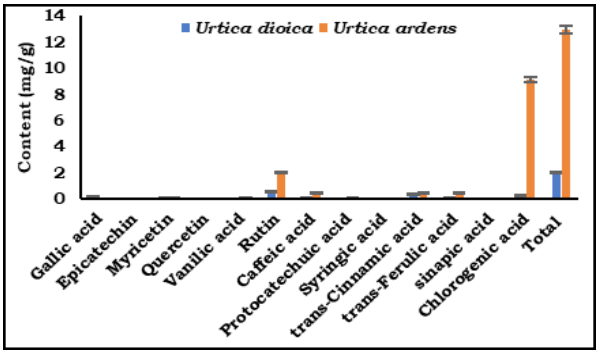

Fig. 2 LC-MS quantification profile of targeted metabolites of *U. dioica* and *U. ardens*.

Research group: Shayam Singh Maina, Akanksha, Rohini Sharma.

DIETETICS AND NUTRITION TECHNOLOGY DIVISION

Shashi Bhushan, Senior Principal Scientist & Head
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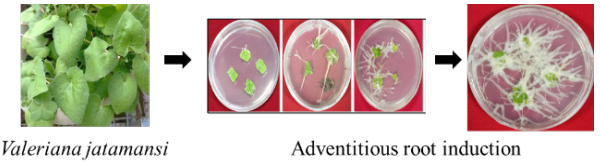
Division of Dietetics and Nutrition Technology

The primary research goal is to use plant cell and organ culture technology to develop long-term sustainable alternatives for the production of industrially important plant metabolites. Only 15% of medicinal plants are cultivated, while the remaining 85% are collected from forests. In this regard, efforts are being made to find eco-firendly methods to generate raw ingredients that help to preserve Himalayan plants in their natural habitats while also providing a sustainable source of high-quality phytoconstituents for the food, cosmetic, and herbal industries.

Valeriana jatamansi adventitious root cultures as a sustainable source of high-value metabolites

Naturally occurring low molecular weight secondary metabolites of plants, polyphenols have a high biological demand for their antibacterial and antioxidant qualities in order to prepare botanical medications and dietary supplements. Gallic acid, p-coumaric acid, rutin, ferulic acid, cinnamic acid, and kaempferol are naturally occurring polyphenol derivatives found in high-altitude medicinal and aromatic plants. The current study assessed *Valeriana jatamansi* leaf-induced adventitious roots for polyphenol production as a sustainable alternative. Adventitious roots were induced **(Fig. 1)** and proliferated from leaf explant on Schenk and Hildebrandt (SH) medium enriched with 2.0 mg/L indole-3-butyric acid (IBA). Induced roots were further multiplied on optimized SH medium having 1.0 mg/L IBA and 3.0% sucrose **(Fig. 2)**. Furthermore, the accumulation of polyphenol constituents was assessed using Ultra Performance Liquid Chromatography from parent plant parts (leaves and rhizomes) and adventitious roots. The resultant data exhibited significantly high accumulation of total polyphenols derivatives (451.58 µg/g DW) in adventitious roots dominating to rhizome (187.79 µg/g DW) and leaves (263.68 µg/g DW) after two months of submerged cultivation.



Valeriana jatamansi Adventitious root induction

Fig. 1 Induction of adventitious roots from leaves of *V. jatamansi*.

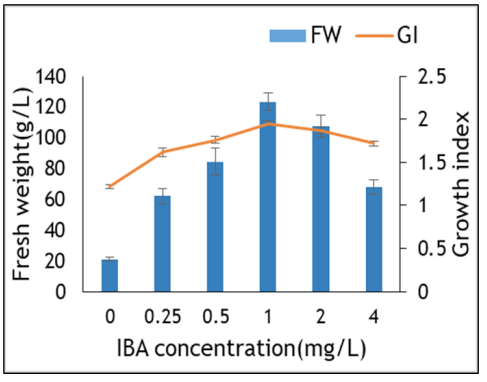


Fig. 2 Effect of auxin (IBA) on induction of adventitious roots from leaves of *V. jatamansi*.

Additionally, the qualitative analysis also showed predominance of rutin (217.86 ± 0.32 µg/g DW) and kaempferol (22.82 ± 8.36 µg/g DW) than plant parts. The in vitro developed bioprocess has a substantially shorter submerged culture cycle (2 months) than naturally cultivated plants (~ 2 years), that could be vital factor in determining feasibility at phytopharmaceuticals industrial scale. Conclusively, the current investigation unequivocally shows potential of in vitro induced *V. jatamansi* adventitious root culture as a substitute for the production of phytoconstituents at large scale.

Production of volatile disulfide compounds using *Ferula assa-foetida* callus culture

In vitro plant cell and tissue culture techniques offer a sustainable and controlled approach for the production of industrially important phytochemicals. It eliminates the dependency on whole plants, seasonal availability and natural habitats. Using this technology, valuable bioactive compounds can be efficiently synthesized. This technology not only ensures a consistent supply of high-quality phytoconstituents but also supports biodiversity conservation by reducing the exploitation of wild plant resources.

This year, efforts were made to establish a process to produce volatile disulfide compounds using *Ferula assa-foetida* callus culture. *F. assa-foetida* L. (Hing or Heeng) is an important perennial medicinal species of Apiaceae family known for its dried latex (oleo-gum resin) exudates having intense characteristic pungent odour due to the presence of numerous sulfur compounds. *F. assa-foetida* plants are native to Middle East (Iran and Afghanistan) and also

found in parts of Central Asia (Kazakhstan, Uzbekistan, Tajikistan, and Turkmenistan). The market for Ferula assa-foetida, commonly known as asafoetida, has been growing steadily, driven by its culinary and medicinal applications. In 2024, the global assafoetida market was valued at USD 36.5 million and is projected to grow at a CAGR of 6.3%, reaching USD 62.3 million by 2033. Considering the market potential and restricted geographical distribution of *F. assa-foetida*, a sustainable method was developed for the induction of callus from the leaves and to assess it's potential to produce volatile disulfide compounds responsible for their characteristics aroma. In this invention, a process is developed to utilize *F. assa-foetida* callus cultures to produce volatile disulfide derivatives.

Relevant Publications:

➢ International Journal of Radiation Biology. (2024), 100(7): 1104–1115.

Research group (From left to right): Ms Deepika Choudhary, Mr Prashant Kumar, Dr Shashi Bhushan, Dr Ashok Gehlot and Ms Manjeet Singh Dhrek.

Mahesh Gupta, Senior Principal Scientist
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Food Science and Technology

The lab works in the area of development of nutraceuticals and nutritionally rich food formulation using Himalayan bioresources.

Characterization of malted ragi (Eleusine coracana L.) based on the physico-chemical, functional, antioxidant properties, and *in vitro* protein digestibility

The study evaluated the effect of lactic acid fermentation on the physico-chemical, functional, antioxidant properties, and antinutritional, along with *in vitro* protein digestibility of raw and malted ragi flour at different intervals for 24 and 48 h. RRF and MRF were inoculated with *Lactiplantibacillus plantarum*, oven-dried and milled into flour samples at each fermentation time. The process of optimizing malted ragi involves germinating soaked grains at 28 °C for 24 h, followed by open-pan roasting at 70 °C **(Fig. 1)**. The results exhibited a significant increase ($p < 0.05$) in (*in vitro)* protein digestibility (63.66 to 79.98% and 85.77 to 90.27%), carbohydrate content and water absorption index. However, the phytic acid was significantly reduced with increasing fermentation time. Thus, fermenting malted ragi flour for 48 h is an effective approach for enhancing protein digestibility and bioactive components, with a significant decrease in antinutrient content.

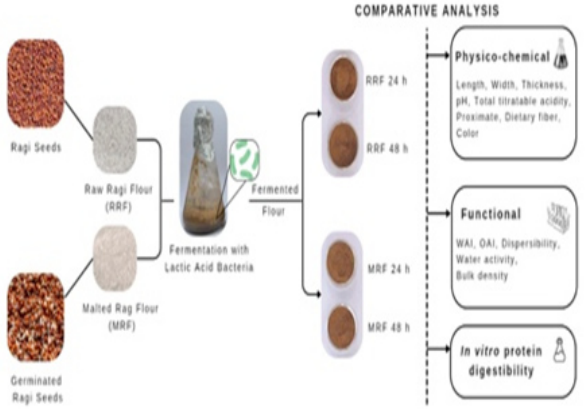

Fig.1 Production process for malted and fermented ragi flour.

Standardization of soluble dietary fiber extraction for techno-functional, structural, and *in vitro* prebiotic potential from mango and pomegranate peel

Peel is a major bio-waste and a potential source of various bioactive molecules, creating immense environmental issues with no commercial significance. Therefore, different methods of extraction, including enzymatic, chemical, microwave, ultrasonication, and homogenization, with varied sample concentrations at 2%, 5%, and 10% (w/v) were utilized for maximum soluble dietary fiber (SDF) extraction from both pomegranate (Bhagwa and Daru) and mango (Totapuri and Safeda) peel. The maximum SDF yield of 29.26 ± 0.25% was observed at 5% w/v for homogenization-assisted enzymatic extraction (HEE) from mango peel (Safeda). The proximate and techno-functional properties of SDF exhibited enhanced thermal stability and structural properties. Scanning electron microscopy revealed a loosened and porous structure, as well as the samples demonstrated significant prebiotic activity with the synthesis of three major short-chain fatty acids (SCFAs) (propionic (3.60 ± 0.08 mg mL−1) > acetic (2.64 ± 0.01 mg mL−1) > butyric acid (1.27 ± 0.01 mg mL−1)). Hence, this study emphasise the role of waste fruit peel as a potent source of SDF, exhibiting profound prebiotic activity with imminent industrial application.

Immunological Activities and Metabolomic Study of *Prunus salicina* and *Prunus domestica* sp.

The present study exhibited a comparative metabolomic investigation of *Prunus salicina* and *Prunus domestica* subsp. *syriaca* along with their immunological studies **(Fig. 2)**. In preliminary studies, fruits were studied for proximate compositions (moisture, ash, fiber, fat, and protein). It was observed that the total phenolic content of *P. domestica* peel was the highest (6.11 mg/g GAE) compared to *P. salicina* peel (4.93 mg/g GAE). Targeted metabolomics revealed chlorogenic acid as one of the major phenolic acids in plum. Using a non-targeted metabolomics approach, metabolite discriminations among the fruit sections are represented by a Venn diagram, heatmap, and PCA. A total of 130 metabolites were identified in fruit sections, using the METLIN database. The cytotoxic test showed no cell damage, even at higher dosages for up to 48 hours. The present study suggests fresh insights into the distribution of phytochemicals in the peel and pulp sections of the fruit, which can be considered for health-beneficial products and nutraceuticals.

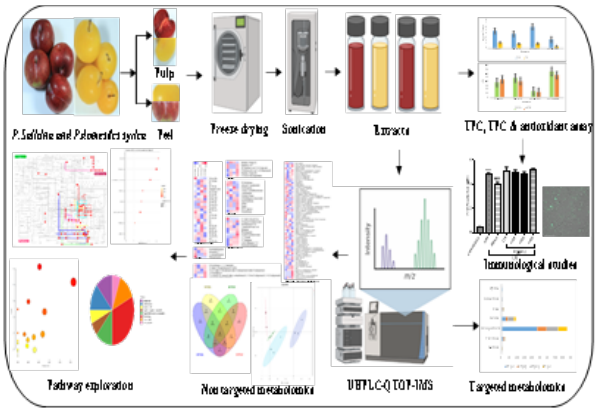

Fig. 2 Workflow of *P. salicina and P. domestica* subsp. *syriaca* metabolomic and immunological study.

Metabolomics Advancements in the Applications for Development of Functional Beverages

This review explores recent advancements and innovations in metabolomics applications within the realm of functional beverages, encompassing both fermented and unfermented drinks **(Fig. 3)**. Recent findings highlight the transformative role of metabolomics in elucidating the complex biochemical interactions that define the health-promoting properties of functional beverages. Metabolomics enables the identification and quantification of diverse metabolites such as phenolic compounds, organic acids, and vitamins, offering insights into their biosynthesis and metabolic fates during beverage processing and consumption. It also facilitates identifying and enhancing the health benefits of fermented and unfermented functional beverages. Therefore, future advancements will focus on using advanced analytical techniques and computational methods to connect metabolomics to the development of next-generation functional beverages.

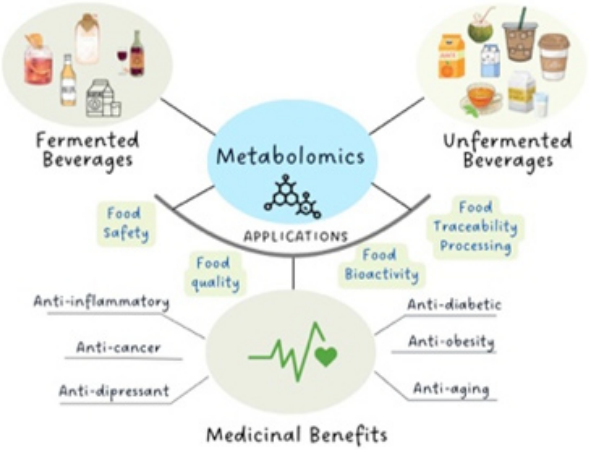

Fig. 3 Metabolomic approaches for functional beverages.

Relevant Publications:

- International Journal of Food Science and Technology. (2024), 59(8): 5285-5302.
- Sustainable Food Technology. (2024), 2(4): 1128-1138.
- Sustainable Food Technology. (2024), 2(5): 1506-1516.
- Food Biotechnology. (2024), 38(4): 343-365.
- Current Food Science and Technology Reports. (2025), 3(1): 1-16.

Research group: Shriya Bhatt, Rashim Kumari, Manoj S Aroor, Rahul Dev, Pallavi Phian, Shambhvi, Payal Chauhan, Sakshi Verma, Shivani.

Yogendra Padwad, Principal Scientist
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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, ageing, diabetes and cancer.

Role of MAPKAPK2/MK2 in HNSCC progression and a therapeutic molecular target

MAPKAPK2/MK2 is well implicated in the progression of Head and Neck Squamous Cell Carcinoma (HNSCC), and potent MK2-inhibitors are required to suppress its activity. Several MK2-inhibitors have been developed in recent years to combat its effects on cancer. However, inadequate solubility, insufficient cellular permeability, systemic toxicity-mediated side effects, and low bioavailability have severely impeded the advancement of MK2-inhibitors to clinical trials. This necessitates efforts towards developing less toxic and optimally bioavailable potent MK2-inhibitors in HNSCC. We evaluated the *in-vitro* efficacy, *in-vivo* single-dose acute toxicity, and *in-vivo* pharmacokinetic profiling of recently developed pyrrolone-fused Benzosuberene (PfBS) molecules as MK2-inhibitor analogues. The PfBS impeded HPV+ and HPV- HNSCC cell proliferation and two-dimensional migration.

Moreover, MK2-inhibitors lowered HNSCC cell clonogenic survival in a dose-dependent manner, significantly enhancing radiation-induced cell death via exerting radio-sensitizing effects. Furthermore, γ-H2AX immunostaining revealed that PfBS analogues impaired DNA damage repair in HNSCC cells exposed to gamma radiation. In mice, PfBS MK2 inhibitors at 300 mg/kg were well-tolerated without any lethal effects **(Fig. 1).**

Pharmacokinetic studies showed that PfBS analogues exhibited rapid absorption (Tmax), adequate plasma concentration above the micromolar levels (C0 or Cmax), limited tissue distribution (Vd), and faster elimination from the body (Cl). Overall, this study summarizes *in-vitro* efficacy, safety, and pharmacokinetics of developed MK2-inhibitors and opens avenues for pharmacodynamics and mode of action studies of the most effective leads in HNSCC.

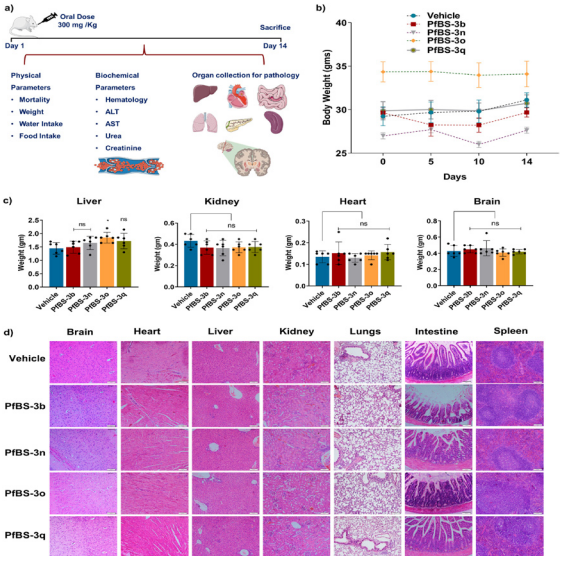
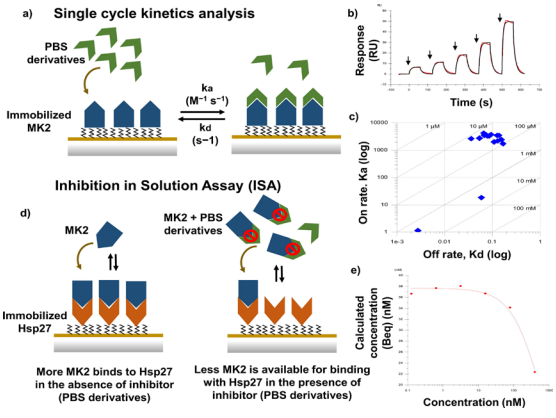


Fig. 1 Evaluation of Pyrrolone-fused Benzosuberene MK2 Inhibitors as Promising Therapeutic Agents for HNSCC: *in vitro* Efficacy, *in-vivo* safety, and pharmacokinetic profiling.



Sarface Plasmin Resonance (SPR) assays. a) Schematic representation of the workflow of single cycle kinetics experiment to determine association rate constant (ka), dissociation rate constant (kd), and affinity constant (KD).

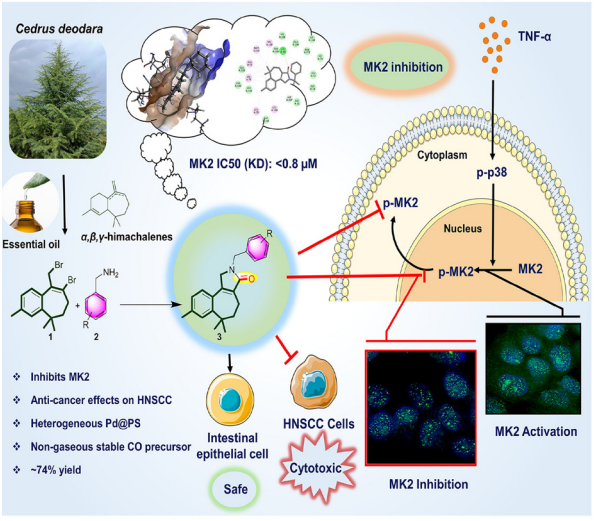
Increased disease burden and lacuna of targeted therapies require novel and safe pharmacological inhibitors to suppress the well-explored molecular targets in Head and Neck Squamous Cell Carcinoma (HNSCC).

Here, we used dibromo-substituted Benzosuberene synthesized from the mixture of α, β, γ-himachalenes and used them as a precursor for the synthesis of Pyrrolone-fused Benzosuberene (PfBS) as MK2 inhibitors through aminocarbonylation approach in a single-pot reaction. The devised protocol provides a broad

substrate scope, facile recovery, recyclability of Polystyrene-supported palladium (Pd@PS) nanoparticle catalyst, and fewer synthesis steps.

In-silico molecular docking, pharmacophore modelling, and ADMET analysis revealed MK2-inhibitory potential and drug-likeliness of PfBS analogues. Surface plasmon resonance (SPR) analysis revealed effective high binding affinity (K_D) and kinetics of PfBS analogues with MK2. Additionally, the SPR-mediated in-solution inhibition assay established the MK2-inhibition properties of PfBS analogues through abrogation of MK2-Hsp27 interaction.

Further, *in-vitro* studies validate the findings in HNSCC cells where PfBS analogues exhibited significant anti-proliferative effects on CAL 27 tongue squamous carcinoma cells and were found safe on IEC-6 intestinal epithelial cells. Immunofluorescence analysis and western-blot assays potentiated that selected analogues inhibited the inflammatory cytokine TNF-α mediated activation of MK2 on cellular and molecular levels in HNSCC cells. In conclusion, this study presents novel MK2-inhibitors and opens avenues for further pre-clinical and clinical efficacy evaluation of developed PfBS analogues in the treatment of HNSCC.



Relevant Publications:

- Drug Development Research. (2025), 86(2), e70062.
- Molecular Pharmaceutics. (2024), 22(1), 255-269.
- Biomolecular Structure and Dynamics. 42(21): 11954-11975.

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

Vikram Patial, Principal Scientist
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Division of Dietetics and Nutrition Technology

The increasing global interest in natural products, nutraceuticals, and novel synthetic compounds has highlighted the need for rigorous scientific evaluation to ensure their safety and therapeutic potential. Our work focuses on the comprehensive assessment of these substances using validated animal models, providing critical insights into their pharmacological and toxicological profiles.

Picroside-enriched fraction from *Picrorhiza kurroa* mitigates steatohepatitis

Picrorhiza kurroa Royle ex Benth is a highly significant plant species with exceptional ethnobotanical value. Classical Ayurvedic text acknowledged *P. kurroa* for its notable therapeutic potential. The plant exhibits a wide range of pharmacological properties—including antimicrobial, hepatoprotective, antioxidant, antibacterial, antimutagenic, and antineoplastic effects—primarily attributed to the presence of iridoid glycosides. The therapeutic potential of a picrosides-rich fraction (PF) derived from *Picrorhiza kurroa* was evaluated in mitigating non-alcoholic steatohepatitis (NASH), a severe liver condition characterized by fat accumulation, inflammation, and fibrosis. The total picroside-I and II content in PF were estimated as 58.97%. Fructose-induced zebrafish and methionine-choline-deficient (MCD) diet-induced mouse models were used to validate the efficacy.

The results demonstrated that PF significantly reduces hepatic lipid accumulation, downregulates genes involved in lipogenesis (such as *Srebp1c*, *Fas*, and *Cd36*), and attenuates oxidative and endoplasmic reticulum stress markers (*gpx*, *ddit3*). In mice, PF treatment improved body weight, lowered serum liver injury biomarkers (ALT, AST, ALP, bilirubin), and restored liver histology by reducing steatosis, necrosis, and inflammation. Furthermore, PF enhanced mitochondrial biogenesis by upregulating *Pgc1a*, *Tfam*, and *Nrf2*, and increased antioxidant levels (SOD, glutathione) while reducing lipid peroxidation (MDA levels). It also suppressed pro-inflammatory cytokines (*NFκB*, *TNFa*, *IL6*) and fibrogenic markers (*TGFβ*, *aSMA*), suggesting its anti-inflammatory and anti-fibrotic effects. Overall, the findings indicate that PF from *Picrorhiza kurroa* could be an effective plant-based therapeutic strategy for managing NASH through the modulation of lipid metabolism, mitochondrial function, and inflammatory responses.

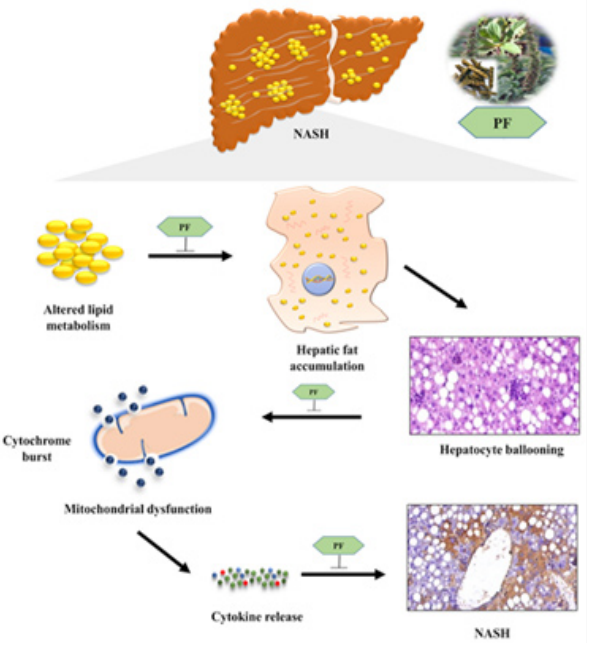

Fig. 1 Graphical representation of the efficacy of Picroside-enriched fraction against NASH.

Role of Sirtuin 1 in acute liver injury

Sirtuin 1 (SIRT1), a NAD^+-dependent deacetylase, mitigates acute liver failure (ALF) by modulating the p53/glutathione peroxidase 4 (GPX4)/gasdermin D (GSDMD) signaling axis. ALF, characterized by rapid hepatocyte death involving ferroptosis and pyroptosis, often leads to high mortality. The study highlights that activation of SIRT1 inhibits p53 activity through deacetylation, which elevates GPX4 levels and suppresses GSDMD, thereby reducing ferroptotic and pyroptotic cell death. This axis regulates oxidative stress, inflammation, and cell death, indicating a crosstalk between ferroptosis and pyroptosis. The findings suggest that targeting SIRT1 may offer a novel therapeutic strategy for treating ALF.

Collaborative work

Pyrrolone-fused benzosuberene MK2 inhibitors have been validated as promising therapeutic candidates for the treatment of head and neck squamous cell carcinoma. Their in vitro efficacy, safety profile, and pharmacokinetics were assessed (Drug Development Research, 2025; 86: e70062). In another study, a self-

nanoemulsifying formulation was shown to enhance the oral bioavailability and insulin-sensitizing effect of a Formononetin–Vitamin E conjugate in type 2 diabetic mice (Molecular Pharmaceutics, 2025; 22(1): 255–269). The anticarcinogenic activity of *Inula racemosa* Hook. f. root extract was evaluated in a rat model of mammary tumors (Environmental Toxicology, 2025; 40(1): 111–127). Likewise, the Ayurvedic formulation *Arjuna Ksheerapaka Churna* was scientifically validated for its potential in managing dyslipidemia through preclinical studies.

Relevant Publications:

- Phytomedicine. (2025), 137: 156368.
- World Journal of Gastroenterology. (2024), 30(34): 3850-3855.

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

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Pharmacology

Our research focuses on exploring and validating the therapeutic potential of medicinal plants in the Himalayan region using experimental animal models. The primary goal is to develop neuroprotective nutraceuticals aimed at modifying disease states in humans. The lab is also involved in the scientific validation of Ayurvedic formulations.

Scientific validation of *Arjuna Ksheerapaka Churna* for dyslipidemia

Arjuna Ksheerapaka, a milk-based Ayurvedic decoction made from the powdered bark of *Terminalia arjuna* (Roxb.) Wight & Arn., is traditionally used to manage various cardiovascular disorders. Our work evaluated the efficacy of *Arjuna Ksheerapaka Churna* (AKC) in treating dyslipidemia through both preclinical and clinical investigations.

In the preclinical phase, Sprague Dawley rats were fed a high-fat diet (HFD) for 7 weeks to induce dyslipidemia, followed by 4 weeks of treatment with AKC. Biochemical and histopathological assessments were conducted using rosuvastatin as a reference drug. The results showed that AKC treatment led to significant reductions in serum total cholesterol, low-density lipoprotein (LDL), triglycerides, and fasting blood glucose levels, along with an increase in high-density lipoprotein (HDL) levels compared to the vehicle control. Additionally, AKC lowered serum aminotransferase levels more effectively than rosuvastatin, indicating better hepatic safety.

A randomized, active-controlled clinical trial was conducted on AKC at the Rajiv Gandhi Government Post-Graduate Ayurvedic College and Hospital, Paprola, Himachal Pradesh. The trial was registered with the Clinical Trial Registry of India via Registration No.: CTRI/2020/06/026173. The clinical study involved 30 dyslipidemic patients randomized into two groups (n = 15 per group) who received either AKC (6 g/day) or rosuvastatin (10 mg/day) orally for 8 weeks. Key metrics, including body mass index, serum lipids, and hematological parameters, were measured at baseline and after the treatment. The results showed that AKC significantly reduced triglycerides, total cholesterol, and LDL levels, with effects comparable to that of rosuvastatin. However, insignificant changes were observed in other biochemical or hematological markers in either group by the end of the trial.

Overall, both preclinical and clinical findings support the lipid-lowering efficacy of AKC, along with the added benefit of better hepatic safety in the animal model. The study concludes that AKC is a promising alternative for managing dyslipidemia, demonstrating therapeutic effects equivalent to those of rosuvastatin **(Fig. 1)**.

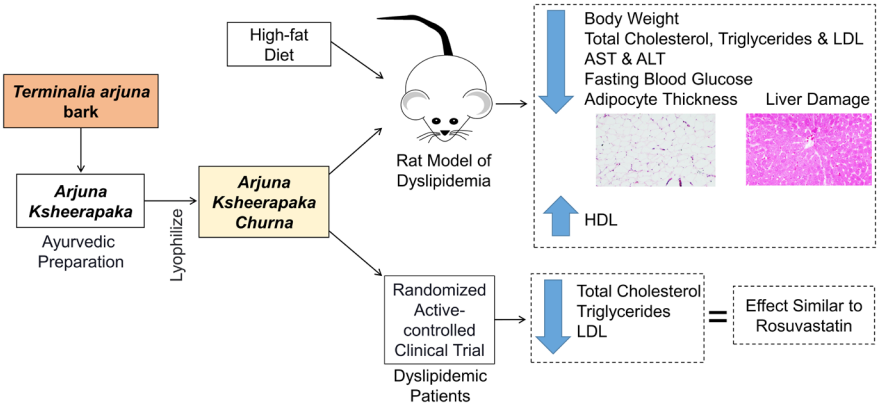

Fig. 1 Schematic representation of study to support the preclinical and clinical efficacy of *Arjuna Ksheerapaka Churna* (AKC) for dyslipidemia.

Neuroprotective efficacy study of *Fagopyrum tataricum*

Fagopyrum tataricum (L.) Gaertn, commonly known as Tartary buckwheat, has been traditionally used for a variety of health benefits. In folk medicine, it is often recommended for enhancing cognitive function and managing inflammatory conditions. Our work aimed to evaluate the neuroprotective potential of a seed extract of *Fagopyrum tataricum* against neurotoxicity induced by acrylamide.

Phytochemical profiling of the extract was conducted using high-performance liquid chromatography. The quantified compounds were further analyzed for their molecular interactions through *in-silico* docking studies. The anti-inflammatory potential of the extract was assessed using an *in-vitro* protein denaturation assay. For the *in-vivo* evaluation, 5-day-old zebrafish larvae were exposed to 1 mM and 2.5 mM concentrations of ACR along with extract, forllowed by behavioral studies and molecular expression analysis. The extract showed the presence of a variety of flavonoids and other phenolic compounds. The protein denaturation assay confirmed its anti-inflammatory activity. Treatment with the extract significantly improved locomotor deficits and reduced mortality in the zebrafish larvae exposed to ACR. The biochemical assays showed a reduction in ACR-induced oxidative stress, evidenced by decreased brain lipid peroxidation and protein carbonylation. Molecular studies revealed that the extract treatment upregulated antioxidant genes such as *nrf2*, *gpx*, and *hmox1a* while downregulating *trxr2*. It also inhibited Gsk-3β activity, which helped preserve levels of Nrf2 and β-catenin. Docking analysis suggested a strong hydrogen and hydrophobic interactions between the identified compounds of the extract and the Gsk-3β. Overall, the seed extract of *Fagopyrum tataricum* demonstrated neuroprotective effects against ACR-induced toxicity by mitigating Gsk-3β-mediated oxidative stress.

Relevant Publications:

- Journal of Biochemical and Molecular Toxicology. (2025), 39(4): 70213.
- Chemical Engineering Journal. (2025), 507: 160272.
- Molecular Neurobiology (2025). doi: 10.1007/s12035-025-04776-x.

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

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Animal Science

The development of cost-effective, natural, and safe herbal therapeutics for chronic respiratory and skeletal disorders in India is critical, given the substantial disease burden. Chronic respiratory diseases (CRDs), notably chronic obstructive pulmonary disease (COPD) and asthma, accounted for 75.6% and 20.0% of CRD-related disability-adjusted life-years (DALYs) in India in 2016, respectively. Concurrently, osteoarthritis prevalence escalated 2.66-fold from 23.46 million cases in 1990 to 62.35 million in 2019. With India comprising 18% of the global population, the rising incidence of CRDs and skeletal disorders underscores an urgent need for accessible treatments. Conventional pharmacotherapies for these conditions are often limited by efficacy, cost, and accessibility, necessitating alternative approaches. Though the number of patients with respiratory and skeletal diseases is very high, traditional medications for the treatment of these diseases are limited. Thus, our work is aimed at developing low-cost, natural safe therapeutic herbal medication for treatment and prevention of these disorders. Our research group investigates the molecular mechanisms underlying pulmonary inflammatory diseases and skeletal immunological pathologies, with a focus on allergen-induced asthma, rheumatoid arthritis (RA), and osteoarthritis (OA). We employ standardized animal models, including ovalbumin-lipopolysaccharide (OVA-LPS)-induced respiratory inflammation, collagen-complete Freund's adjuvant (CFA)-induced RA, and monosodium iodoacetate (MIA)-induced OA, to elucidate the pathogenesis of these conditions. These models facilitate the characterization of inflammatory pathways and the evaluation of bioresources for their anti-inflammatory and therapeutic potential.

Validating the role of active constituents of *Linum usitatissimum in* mitigating inflammation.

Validating tole of herbacetin in mitigating inflammation

Herbacetin, a flavonol prevalent in traditional medicinal plants, was investigated for its therapeutic potential against lipopolysaccharide (LPS)-induced chronic inflammation in RAW 264.7 macrophages, concanavalin A-challenged splenocytes, and *in silico* models. The study revealed that herbacetin significantly attenuated oxidative stress by reducing nitric oxide, reactive oxygen species, and mitochondrial membrane potential hyperpolarization while suppressing pro-inflammatory cytokines (TNF-α, IFN-γ, IL-6, IL-5, IL-17), matrix metalloproteinases (MMP-2,3,9,13), and inducible nitric oxide synthase, alongside modulating M1/M2 macrophage polarization markers (iNOS/Arg-1/MSR-1/MRC-1). Furthermore, herbacetin inhibited apoptosis and autophagosome accumulation, evidenced by decreased caspase-6 and enhanced p62 and Bcl-2 expression, and prevented lysosomal destabilization. It also

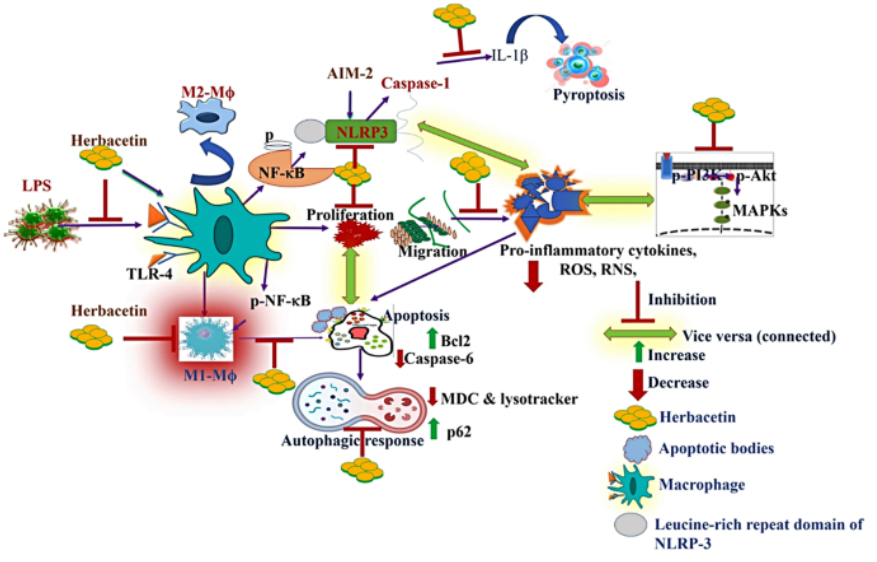

Fig. 1 Molecular mechanism of herbactin to mitigate inflammation.

curtailed NLRP3 inflammasome activation, caspase-1, AIM-2 expression, and IL-1β release while downregulating TLR-4, NF-κB, PI3K, Akt, ERK1/2, and JNK signaling pathways. *In silico* analyses confirmed herbacetin's binding affinity to these targets, and *ex vivo* studies demonstrated enhanced regulatory T-cell populations, collectively underscoring herbacetin's multifaceted anti-inflammatory properties as a promising therapeutic candidate for LPS-associated chronic inflammatory disorders.

Validating the role of ALA and SDG in mitigating inflammation.

Our investigation substantiates the hypothesis that alpha-lipoic acid (ALA) and secoisolariciresinol diglucoside (SDG), both individually and synergistically, ameliorate chronic inflammation associated with arthritis by modulating a complex interplay of inflammasome activation, oxidative-inflammatory cascades, and autophagy dysregulation. Specifically, ALA and SDG attenuate NLRP-3 and AIM-2 inflammasome activity, suppressing caspase-1-mediated IL-1β production while concomitantly mitigating excessive nitric oxide (NO), reactive oxygen species (ROS), and proinflammatory cytokine generation, thereby alleviating oxidative stress and mitochondrial membrane hyperpolarization. Furthermore, these compounds enhance M2 macrophage polarization and restore autophagy, counteracting inflammation-induced impairments. Mechanistically, they modulate redox-inflammatory signaling pathways, including PI3K-Akt, MAPKs, PTEN, and NF-κB, while rectifying perturbed structural protein regulation in lipopolysaccharide-challenged macrophages and SW982 fibroblasts. Although these findings underscore the multifaceted anti-inflammatory and immunomodulatory properties of ALA and SDG *in vitro*, further *in vivo* validation using relevant animal models is imperative to confirm their therapeutic efficacy in rheumatoid arthritis and related immunopathologies and will be conducted in the future.

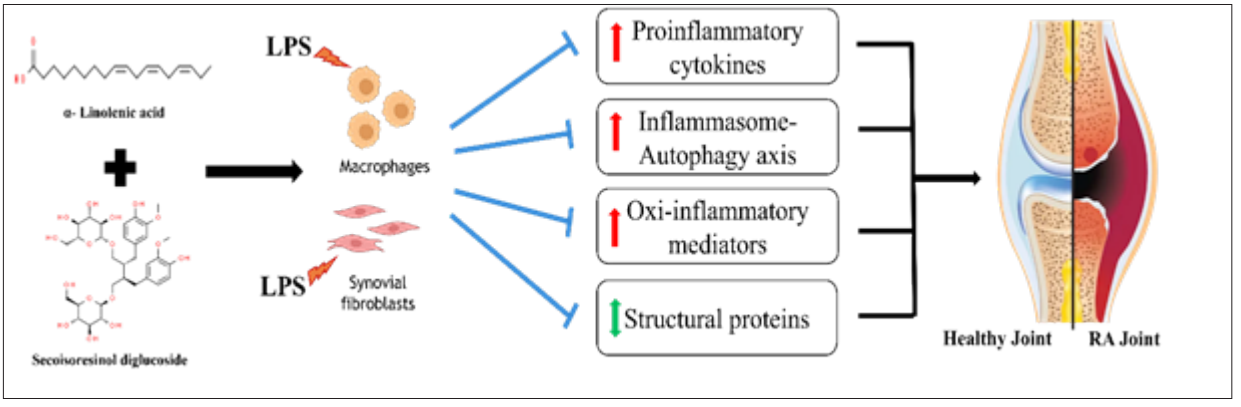

Fig. 2 Schematic representation of effect of ALA and SDG on LPS induced RAW264.7 macrophages and SW982 fibroblasts.

Relevant Publications:

- Molecular Biology Reports. (2024), 51(1): 1-16.
- Food Research International. (2025), 115427.

Research group: Monika Kumari

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Dietetics & Nutrition Technology Division

Our laboratory works on two aspects, *viz.* (i) the development of value added products from aromatic and herbal plants and (ii) augmenting the bioavailability and therapeutic efficacy of nutraceuticals through advanced drug delivery systems.

(i) Development of value-added products from aromatic and herbal plants

India is endowed with a rich biodiversity, including over 8,000 medicinal and approximately 1,200–2,500 aromatic plant species. These plants have long been integral to the preparation of drugs in traditional and modern systems of medicine, as well as in the development of herbal cosmetics and functional foods. Essential oils derived from aromatic plants are widely utilized in the flavor, fragrance, and cosmetics industries and are gaining increasing importance in aromatherapy.

Our laboratory is primarily focused on the development of value-added products from medicinal and aromatic plants by applying advanced pharmaceutical technologies and formulation techniques. The goal is to produce commercially viable and market-ready products that harness the therapeutic potential of these natural resources.

(ii) Augmenting the Bioavailability and Therapeutic Efficacy of Nutraceuticals Through Advanced Drug Delivery Systems

Dietary phytochemicals are increasingly recognized for their protective roles against a range of chronic diseases, including diabetes, cardiovascular disorders, cancer, and neurodegenerative conditions. Despite their promising therapeutic potential, the clinical translation of many phytochemicals is hindered by challenges such as poor aqueous solubility, limited permeability, short biological half-life, and overall low bioavailability in humans.

To address these limitations, our laboratory is actively exploring advanced pharmaceutical technologies aimed at improving the delivery and efficacy of nutraceuticals. Our current research focuses on the development and optimization of innovative delivery systems, including Self-emulsifying drug delivery systems (SEDDS), Solid dispersions, Cyclodextrin inclusion complexes, Nano-emulsions, Lipid nanocapsules and Polymeric particle-based systems. These technologies are being employed to enhance both the bioavailability and therapeutic efficacy of select bioactive compounds. Ongoing work includes formulation and evaluation of phytochemicals such as phloretin, epicatechin, genistein, formononetin, and alpha-lipoic acid.

Enhanced Oral Delivery and Antidiabetic Efficacy of VESylated-Formononetin via Self-Nanoemulsifying Drug Delivery System

The increasing incidence of diabetes and insulin resistance necessitates the need for effective therapeutic strategies. In this study, we developed a self-nanoemulsifying drug delivery system (SNEDS) of formononetin–vitamin E conjugate (VESylated-FMN) to enhance oral bioavailability and glycemic control. The optimized SNEDS exhibited rapid emulsification (~79.17 nm droplets), excellent stability, and improved *in vitro* release. *In vivo* studies in rats and diabetic mice demonstrated enhanced bioavailability (~1.3-fold AUC_{0-t}), safety, and superior insulin-sensitizing effects. VESylated-FMN-SNEDS upregulated insulin-sensitizing genes, improving glycemic control in high-fat diet-fed mice. This formulation presents a promising approach to boost the therapeutic efficacy of formononetin for metabolic disorders.

Development of Pterostilbene Nanoemulsion-Loaded Chitosan/Alginate Film for Sustainable Food Packaging

Petroleum-based food packaging poses environmental risks due to its non-biodegradability. To address this, we have developed a biodegradable chitosan/sodium alginate (CS/SA) film incorporated with pterostilbene nanoemulsion (PTBNE), leveraging PTB's antioxidant and antibacterial properties. PTBNE was prepared via high-pressure homogenization and characterized by DLS, TEM, and AFM. The PTBNE-CS/SA

film, fabricated via solvent casting, exhibited enhanced mechanical strength, water resistance, and barrier properties. Structural and morphological analyses confirmed uniform dispersion. The film showed superior bioactivity and biocompatibility and effectively preserved shiitake mushrooms for 10 days, matching polythene performance. This eco-friendly film offers a promising alternative to conventional plastic food packaging.

Relevant Publications:

- International Journal of Biological Macromolecules. (2025), 139241.
- Molecular Pharmaceutics. (2025), 22: 255-269.
- ChemMedChem. (2025), 20: e202400532.

Research group (From left to right): Navneet Kumar, Rakesh Kumar Dhritlahre, Ankit Saneja, Nabab Khan, Neha Rana, Ruchika.

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Food Technology

Food protein has long been linked to the body's growth, development, and maintenance, making it an essential macronutrient. In India, the National Family Health Survey conducted in 2019-20 indicated malnutrition in children under five years, with stunting at 35.5%, wasting at 19.3%, and underweight at 32.1%. Among women aged 15 to 49 years, 18.7% were reported as malnourished. 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 (ICMR-NIN, 2020).

In this context, pulses have enough potential to be used as raw materials with adequate dietary protein to develop protein-enriched food products. Pulse from the Himalayan region, such as kidney beans, rice beans, horse gram, adzuki beans, cowpeas, field peas, etc., are important sources of dietary proteins. Additionally, research on reducing antinutrients (phytates, tannins, trypsin inhibitors, saponins, etc.) that can bind to minerals and reduce protein digestibility is essential for desired nutritional quality. Several processing methods can significantly reduce these antinutritional factors, enhancing the nutritional quality of pulses.

The India pulses market size reached 36.0 million tons in 2024 and is expected to reach 60.0 million Tons by 2033, exhibiting a growth rate (CAGR) of 5.38% during 2025-2033 (https://www.imarcgroup.com/india-pulses-market). Major pulses-based food products in the market comprise chickpeas, lentils, moong beans, pigeon peas, soybeans, etc. The Himalayan pulses are underutilized in the processed food category. Hence, these pulses can be a potential raw material for high-protein food products.

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Food Technology

Ayush aahar or Ayurvedic aahar is a nutrition and food regime has been approved as new category by FSSAI in 2022. It is based on the importance of proper food and food habits as described in classical Ayurvedic texts like – Charaka Samhita, Bhavaprakash, and Sharangdhara. The oldest nutritional practice in the world classically describes the concept of – "Food as medicine". Under Trayopastambha (three pillars of health), i.e., Ahar (Food), Nidra (Sound Sleep) and Brahmcharya (Control of senses) are the pre-requisite to a healthy life as per Ayurved, Ahar has been mentioned foremost as it lies in foundation the of physical and mental health.

Keeping this in view, ayurveda principles and herbs mentioned in classical literature are being explored to further the emerging concept of Ayush Ahar to make it a robust scientific evidence-based practice along with knowledge derived from the classical literature of Ayurveda. The products thus being developed will be analysed for their nutritive profile so as to project as neutraceuticals, i.e., foods having pharmacological and medicinal value.

As per Invest India (a GOI enterprise), the Ayush sector is a rapidly growing, investor-friendly market with significant export potential, backed by government support and a strong focus on innovation and sustainability. Its manufacturing segment alone has burgeoned from under $3 Bn in 2014 to an impressive $23.3 Bn by 2022, marking an exponential growth trajectory, and it is projected to grow further exponentially.

ENVIRONMENTAL TECHNOLOGY DIVISION

Sanjay Kr. Uniyal, Chief Scientist
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Biodiversity Conservation, Ecology, and Traditional Knowledge

Our team is dedicated to exploring species, sampling vegetation, preserving traditional knowledge, and curating repositories**.**

Field explorations

Eight field surveys were conducted in the cold deserts of Himachal Pradesh and Ladakh, and a total of 200 specimens were collected (**Fig. 1**).

Fig. 1. Specimen collection, *Urtica hyperborea* (in inset) represents an important resource.

Characterizing the Nubra valley Landscape

The Valley lies between the Karakoram and Ladakh mountain ranges, representing a unique eco-region. During the period, four ecosystems, namely agriculture, riverine, alpine, and forest, were sampled and characterized. The soil pH ranged from 6.08 (agroforestry) to 7.25 (riverine).

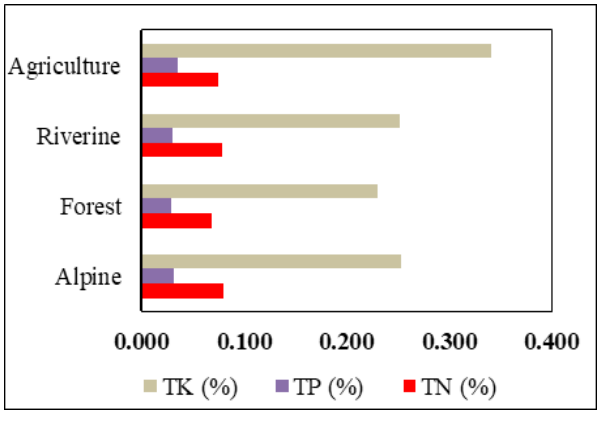

Fig. 2 Soil characteristics in the Nubra valley.

Similarly, total N, P, and K also varied between the studied ecosystems (**Fig. 2).** Organic carbon (OC%) was highest in forest soil (1.850%), reflecting high litter deposition and microbial activity. Micronutrient levels (Fe, Mn, Zn, Cu) were higher in alpine soils, especially Iron (Fe: 83.950 mg/kg) and Manganese (Mn: 15.837 mg/kg as compared to other ecosystems.

Tools for household use

Structured recordings on the making and use of plant-derived tools showed a prevalence of 29 tools in the cold deserts of Ladakh. Among other, they were primarily used in agricultural activities, for food processing, commodity storage structures etc. Sixteen taxa were used for making these tools, of which Salix was prime **(Fig. 3)**.

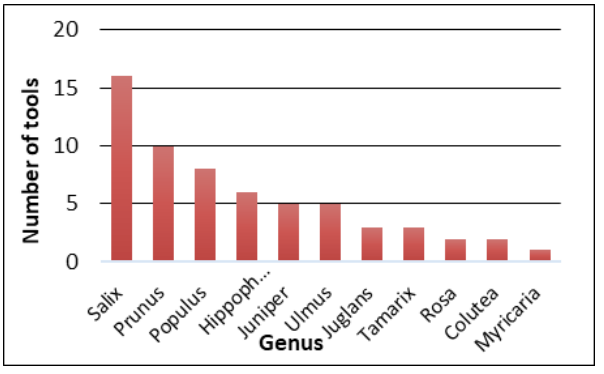

Fig. 3 Taxa used for preparing tools.

Food resources and ethnic cuisines Surveys were conducted to Chicham, Kibber, Komic, Hikkim, Tabo, Lari villages located in the trans Himalayan region of Himachal Pradesh **(Fig. 4).**

Fig. 4 Field recordings in the trans-Himalaya.

Using structured questionnaires, data on the food plants and ethnic cuisines were recorded. Diverse recipes primarily made from *Tsampa* and *Churpe* were noted to be of high importance for the inhabitants (**Fig. 5**)

Fig. 5 Traditional Food a. Femer, b. Gyuma, c. Murpa, d. Marnyuk, e. Sattu,f. Tsunalik, g. Tsalma gungshi, h. Tsung paksal, i. Thupka, j. Zara, k. Churpe.

Communities for Science

Two schools were enrolled for recording phenological stages of *Betula* as a part of the citizen science programme (**Fig. 6**). The students in the school were made aware and practically demonstrated the protocols for recording phenophases.

Fig. 6 Students involved in the programme.

CSIR-TKDL Point of Presence

The activity pertaining to the digitization of the Sowa Rigpa system of medicine continued. This medicinal system is largely practiced by the Buddhists and the associated literature is mostly available in Bhoti language. During the reporting period, close to 2000 new records along with 1000 prior art information were added to the database.

Relevant Publications

- Human Ecology. (2025), 53: 15–27.
- Trees and Livelihoods. (2025), 1–13.

Research group (From left to right): Anchal Sharma, Aradhna Bharti, Tsering Dolma, Shweta Sharma, Pranav Mishra, Chhering Phunchok, Sanjay K Uniyal, Shambhavi, Sonam Chhomo, Phantok, Nilza, Dawa Choedon, Tanzin Angmo, Yogesh.

Amit Kumar, Chief Scientist
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Remote Sensing and GIS

Our lab specializes in high-resolution remote sensing for mapping Himalayan bioresources using AI techniques for multispectral and hyperspectral drone and satellite data.

Development of a spectral repository of medicinal plants using machine learning techniques for their identification

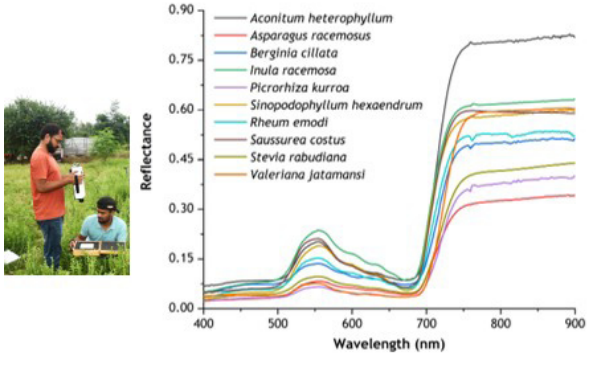

Fig 1. Spectral signatures of medicinal plants.

The identification of medicinal plant species is a crucial task for assessing the status of our bioresources. Conventional methods primarily rely on taxonomy and laboratory-based instruments, which are time-consuming and require the requisite expertise. This study utilised non-imaging HRS handheld sensors to build a spectral repository for 10 important medicinal plant species **(Fig. 1)** from diverse locations across Indian Himalayan states, representing varying altitudinal and ecological conditions. The spectral repository encompasses 1237 distinct spectral signatures obtained from the leaves and canopies of the targeted plant species. The developed RF model was applied to 'PRISMA' satellite data to identify *Saussurea costus* crops in farmers' croplands, achieving a classification accuracy of 81.31% and a kappa coefficient of 0.76.

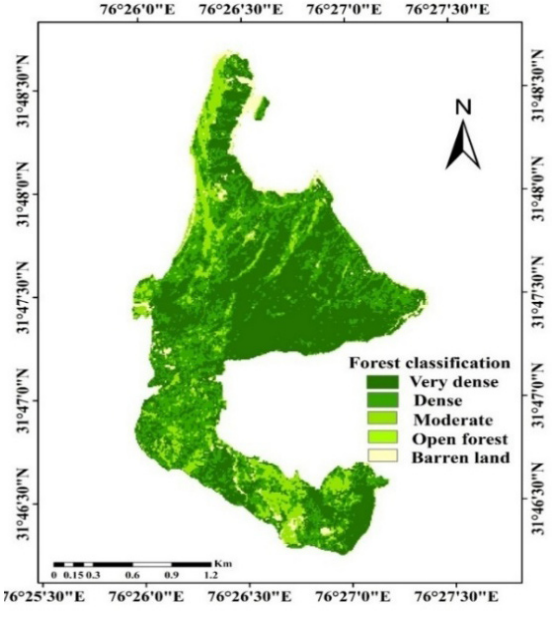

Fig 2 Land use land cover map of the study area.

Biomass and carbon stock estimation of subtropical Himalayan forest under threat

Optimal satellite-derived Sentinel 2A indices were identified for above-ground biomass prediction with the best-fitting biomass model and changes in carbon stock over time due to biomass loss. The result indicated that the green band, red edge band vegetation index, and carotenoid reflectance index were suitable for above ground biomass estimation. The study predicted a total loss of 22,917.15 tonnes of CO_2 in mixed subtropical forests in the Hamirpur region of Himachal Pradesh, representing a 12.04% reduction in carbon stock within the study area **(Fig. 2)**. These findings offer critical baseline data for environmental management and carbon balance in the forest ecosystem.

Species interactions with respect to biomass accumulation in the subtropical Himalayan forests

Fig 3 Field survey for biomass estimation.

Work carried out to understand the interaction within mixed plant communities and their impact on individual tree above ground biomass accumulation in the Himalayan sub- tropical forest, India **(Fig. 3)**. The study revealed that 98% of species showed positive associations, significantly enhancing AGB accumulation, while 2% showed negative associations. These finding suggested that mixed– species plantation upholding species diversity are more effective for

biomass generation than monoculture plantation and these novel identified species pairs are recommended for plantation in sub-tropical forest regions for high biomass generation with medicinal importance.

Relevant Publications:

- Biosystem Engineering. (2025), 249: 58-70.
- Environment and Natural Resources Journal. (2024), 22(4): 378–393.
- Applied Ecology and Environmental Research. (2025), 23(1): 1433-1452.

Research group: Vivek Dhiman, Akash, Manisha, Kishor Chand Kandpal, Amit Kumar, Meenakshi, Swarn Shree, Smurtisikha.

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Plant Ecology

(I) Studying Impacts of Climate Change on Alpine-Treeline ecosystem

(a) Monitoring of alpine vegetation

The effect of changes in snow-melt timing result in alterations in growing season length of alpine plants (21 species occurring at Rohtang, western Himalaya) on their phenology. It was found that experimental early snow-melting caused advancement in early-season phenological events and delay in late-season events **(Fig. 1)**.

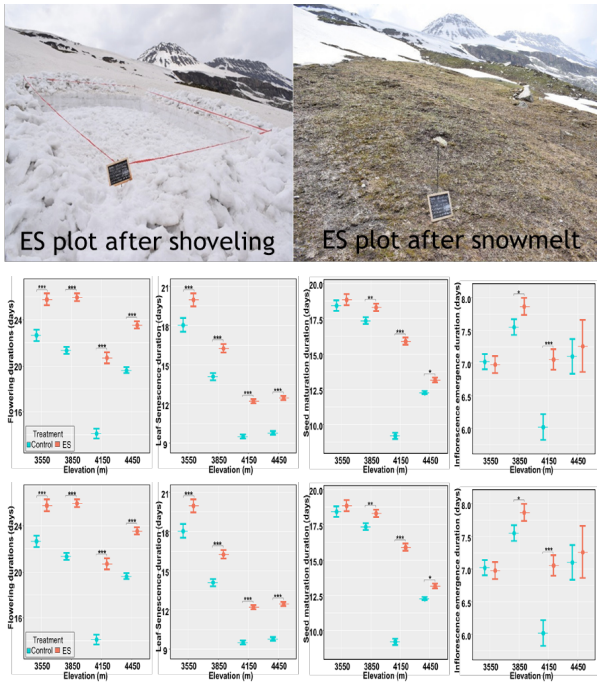

Fig. 1 (a) Control and treatment (Early Snowmelt (ES)) plots (b) Effect of early snow-melting on the duration of different phenophases.

(b) Shrubification of Alpine Meadows

Utilising a very high resolution (spatial resolution 10m) Sentinel-2A satellite imagery, shrub cover was estimated at 09 sites (watersheds) in the alpine region of western Himalaya representing 03 dominant species **(Fig. 2)**. The average patch size & shrub cover for *R. anthopogon* were 14.28m^2 & 37.69%, 15.88 m^2 & 33.86%, and 15.78 m^2 & 35.23% at lower, middle and upper elevations respectively. Similarly, these were estimated for *Juniperus polycarpos,* and *Caragana versicolor*. There's a large percentage of shrub cover in the alpine landscapes.

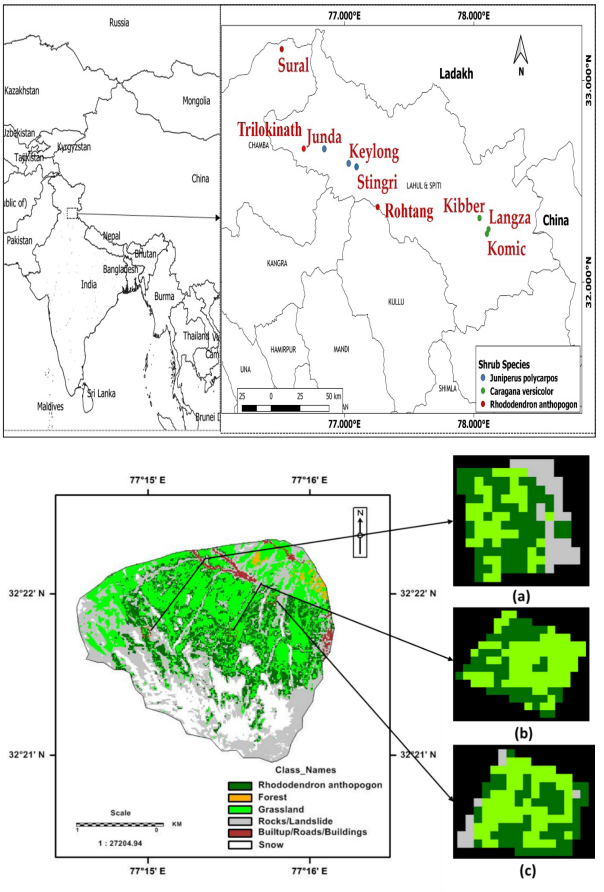

Fig. 2 Study sites and a representative site indicating extent of *Rhododendron anthopogon* coverage at Rohtang.

(II) Adaptation Strategies of High Elevation Plants

(a) Adaptation to high UV radiation

Fig. 3 (a) Study species and UV attenuation chamber placed over a tree.

An experiment was setup to study the adaptation of *Juniperus polycarpos*, a coniferous tree of

Lahaul Himalaya, to high UV radiation & low temperature. The selected tree saplings were covered with specifically made chambers made of acrylic sheets of varying thickness for UV-A&B attenuation **(Fig. 3)**.

(b) Thermo-tolerance of alpine plants

The leaf thermal tolerance was studied for 52 species from the Himalayan alpine region of trans-Himalaya, belonging to different growth forms. Thermal tolerance (T_{50}) was determined and thermal safety margins of all the studied species were found to be much higher than the daily maximum leaf temperature recorded through thermal imaging during the study period.

(III) Ecological studies on high altitude vegetation

Floristic studies were conducted in Pangi, a remote region in western Himalaya and established elevational transects for assessing species distribution. The present study recorded a total of 771 plant species across the region. Species richness was found to be decreased with increasing elevation, showing a humped shaped pattern, with maximum richness observed in the mid-elevations (2,400m to 3,300m above sea level). This study documents a first ever comprehensive checklist on the flora of Pangi along with information on elevational distribution of plant species.

(IV) Conservation of threatened medicinal plants

Habitat Suitability Modelling of *Elwendia persica* (syn. *Bunium persicum*) vern. Kala Zira

Ecological Niche Modelling was undertaken for mapping the suitability of occurrence of *E. persica* using MaxEnt Model **(Fig. 4)**. This habitat suitability map proved to be a yardstick for collection of geographically sparse accessions which had distinct characteristics in terms of essential oil content and chemical profile.

(V) Assessment of Environmental Impacts in Protected Areas

The Ecological Carrying Capacity (ECC) of Eco-Sensitive Zone (ESZ) of Renukaji Wildlife Sanctuary in District Sirmour (H.P.) **(Fig. 5)** in a project sanctioned by DEST&CC, Shimla.

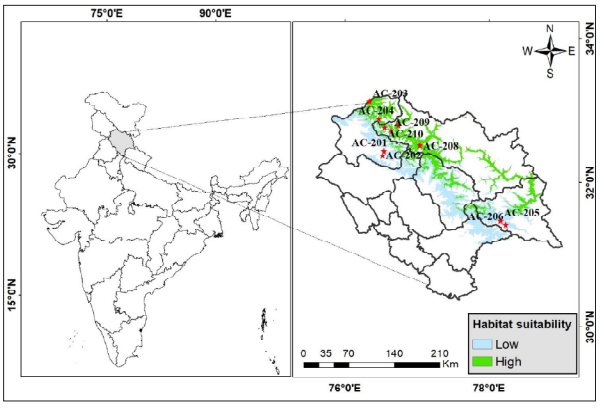

Fig. 4 Probability of occurrence of populations and sites of collection.

The spatio-temporal distribution of ECC was obtained from 2016 to 2023 and represented in the form of maps with zonation on a five-point scale from very low to very high. The currently observed 'overall high' ECC in the landscape could indicate a healthy vegetation, whereas a low ECC observed could be attributed to the high rate of soil erosion along the river and khud areas.

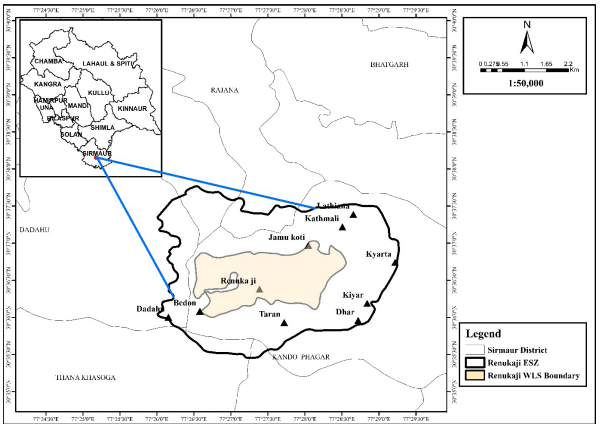

Fig. 5 Study area depicting the ESZ around Renukji WLS.

Relevant Publications:

- Journal of Vegetation Science. (2024), 35: e13269.
- Journal of Mountain Science. (2024), 21(11): 3739–3753.

Research group (From left to right): Mr. Om Prakash (STO-III), Mr. Girjanand (Lab Attendant-2), Nandita Mehta, Manish Sharma, Anupam Bhatt, Elennie Hopak, Bittu Ram, Harish (PAII), Anil (PA), Kajal (Ph.D. Students).

Ashok Singh, Principal Scientist
ashoksingh@ihbt.res.in
Plant Ecology, Biodiversity Conservation

Our group mainly works on the generation of information related to ecology, population assessment of important medicinal plant species, niche area modeling, and their characterization in the Trans Western Himalayan regions of the Indian Himalayas. Furthermore, studies were also being conducted on *ex-situ* conservation and propagation of quality plants of important species at the *Centre for High Altitude Biology* (CeHAB of CSIR-IHBT) Ribling, Lahaul and Spiti (HP). In addition, we also perform studies related to environmental issues like water, decomposition of night soil fertilizers and their applications, *etc.*

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 along with different habitats in the high-altitude areas of Himachal Pradesh (Kinnaur, Lahaul & Spiti, Chamba, and Kullu districts) to observe ecological and phenological parameters under different projects.

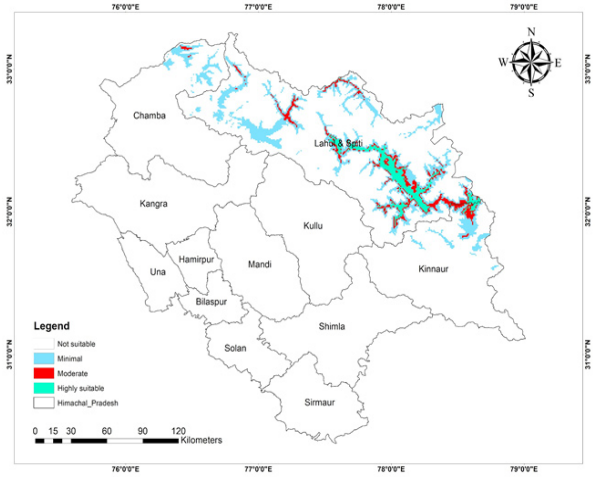

Fig. 1 Distribution of *Arnebia euchroma* in the Himachal Pradesh.

A total of 67 sites were surveyed along with an altitudinal range of 1300 to 4544 masl. Population assessment of species *Eremurus himalaicus, Polygonatum cirrhifolium, Arnebia euchroma, Allium carolinianum, A. jacquemontii,* etc. were performed and their associated diversity along an altitudinal distribution pattern was recorded. To develop a field gene bank, the sample planting materials of variable accessions were collected from the surveyed sites **(Fig. 1 to 3)**.

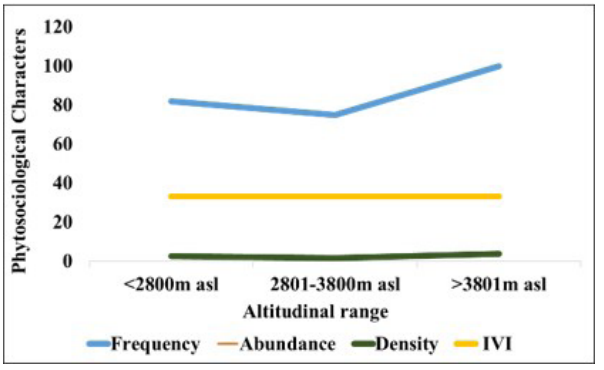

Fig. 2 Altitude-wise distribution of *Eremurus himalaicus* in the Himachal Pradesh.

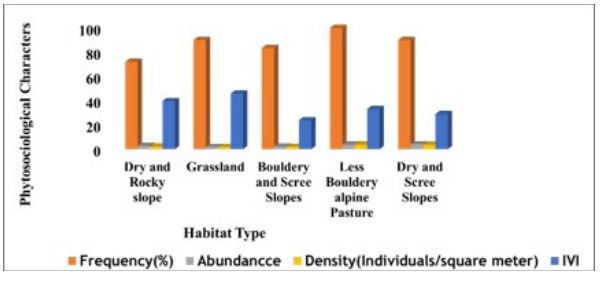

Fig. 3 Habitat-wise distribution of *Eremurus himalaicus* in the Himachal Pradesh.

Status of Field Gene-bank Conservatory: Aimed studies for the conservation of threatened medicinal species were done at CeHAB Ribling, Lahaul & Spiti, HP (3450 masl), and CSIR-IHBT Palampur (1328 masl). Of which 15 species were conserved in seed bank conservatory of MAP species at CeHAB **(Fig. 4)**.

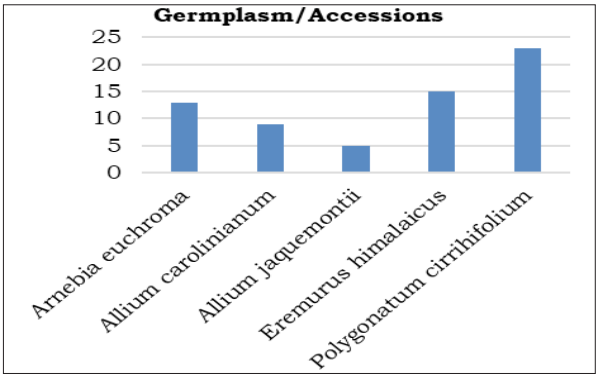

Fig. 4 A germplasm status of field genebank conservatory at CeHAB Ribling (Lahaul and Spiti) HP.

Characterization for the selection: Elite accessions of *Arnebia euchroma, Polygonatum cirrhifolium, etc.* were selected based on their superior physical appearances.

Research on the Dry Toilets: The studies on **"***Utilization of compost booster for newly designed and developed sanitary dry toilets with the recovery of fertilizer from human urine in the Himalayan region (ComSan-DT)*" funded by CSIR under the FTC program were done. The fabrication and installation of 4 units of low-cost dry toilets (FRP/PVC material) in the public domain in the Lahaul Valley through a societal MOU agreement done on June, 2024. Conceptualized the aesthetically improved odor-free dry toilets with Scientists of CSIR NEERI Nagpur, and is quite hygienic, user-friendly sustainable sanitation solution for the high-altitude Himalayan regions.

Fig. 5 Installation of low-cost dry toilets in Lahaul Valley.

Relevant Publication:

- The Indian Forester. 2025.

Research group: Phoola Devi (PA-I), Sachin Negi (PhD Scholar), Dr. Ashok Singh, Rajat Bhardwaj (PhD Scholar), Aniket.

Vikas Kumar, Senior Scientist
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Plant Taxonomy

Our team focuses on floristic and revisionary studies of key sites and taxa in the Himalayas. Through regular surveys, we collect and identify a wide range of Himalayan plant species. We contribute to the enrichment of the herbarium of CSIR-IHBT by gathering specimens from Himalayan regions. Additionally, we promote science popularization through the creation and maintenance of a herbal garden.

Floristic survey: For the floristic survey in Kangra, field tours were carried out across various regions, including the Dhauladhar Wildlife Sanctuary (DWLS), Panchrukhi, and other areas of the Kangra district. Approximately 150 plant samples were collected, of which 120 were identified and processed for the herbarium. For conservation purpose a few propagules of medicinal plants were also collected for Herbal garden.

Taxonomic studies of the genus *Cremanthodium*: For taxonomic revision of the genus *Cremanthodium* Benth. in Indian Himalaya, we conducted field and collection tours to East Sikkim, Lahaul Spiti and Tawang district of Arunachal Pradesh and six species were collected. For molecular analysis, leaves samples of four species have been collected, amplified and sequenced based on ITS and *trnc-PetN* intergenic spacer. To study chemical constituents, GC-MS and HPLC were also performed.

Taxonomic novelties: *New species:* While exoloring the Eastern Himalayas, we discovered a new plant species, *Cremanthodium dibangii* Vik. Kumar & Rahul Kumar, in the alpine meadows of Dibang Valley, Arunachal Pradesh. Similarly, another previously unknown species, *Hemipilia himalayensis* Vik.Kumar & Agrawala, a member of family Orchidaceae, was also discovered from the same region, **(Fig. 1).**

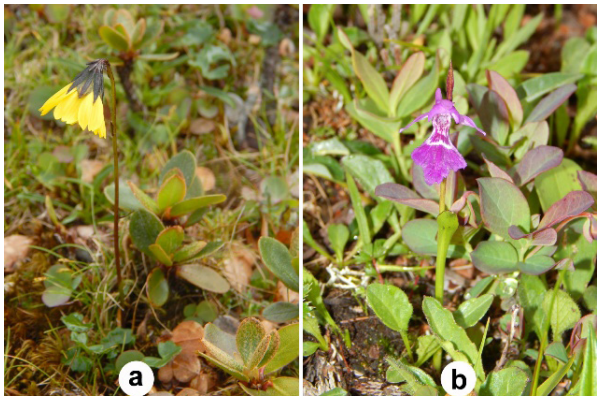


Fig. 1 New species discovered from Indian Himalayan Region- a. *Cremanthodium dibangii*; b. *Hemipilia himalayensis*.

New records for India: During our filed exploration of Tawang district in Arunachal Pradesh, we encountered a few populations of *Cremanthodium oblanciligulatum* Long Wang, C. Ren & Q.E. Yang, a species only reported from China. Now making the first report of this species in India. Besides, we also recorded the bird's-nest orchid, *Neottia bicallosa* X.H. Jin (family Orchidaceae), from Arunachal Pradesh, as a new distributional record for the flora of India. Both species are endemic to the Himalaya and were previously reported only from China **(Fig. 2)**.

Fig. 2 New species record for India- a. *Cremanthodium oblanciligulatum*; b. *Neottia bicallosa*.

New reports for the state: During the floristic study of Dhauladhar Wildlife Sanctuary, we collected and identified *Calanthe trulliformis* King & Pantl. (family Orchidaceae), a threatened species. This species was previously reported in the Eastern Himalayas, specifically from Arunachal Pradesh, Sikkim, and West Bengal. Its occurrence in Himachal Pradesh represents extended distribution of this speices in Western Himalayas. Additionally, *Neottia longicaulis* (King & Pantl.) Szlach, another species from the Orchidaceae family, was also collected within the sanctuary. This species has been reported in Sikkim and Uttarakhand, and its presence in Kangra now represents a new distributional record for the flora of Himachal Pradesh **(Fig. 3)**.

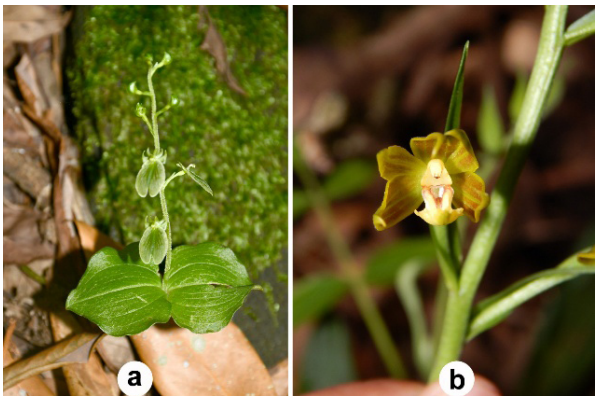


Fig. 3 New species record for Himachal Pradesh- a. *Neottia longicaulis* ; b. *Calanthe trulliformis.*

Conservation of medicinal plants in Herbal Garden: As part of *ex-situ* conservation efforts, over 110 species, including threatened ones, have been conserved and maintained at the Herbal Garden of CSIR-IHBT. The garden has also become a hub for science popularization and awareness, with numerous students and farmers visiting to learn more about plant conservation and their medicinal uses **(Fig. 4)**.

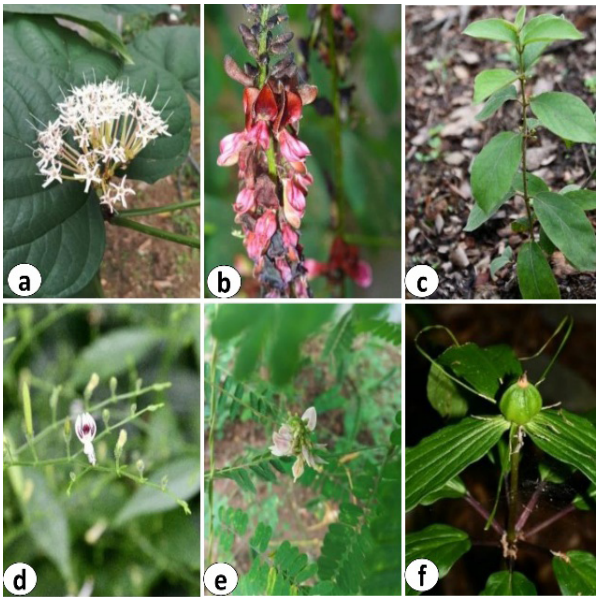


Fig. 4 Species conserved in Herbal Garden- a. *Clerodendrum colebrookeanum* Walp.; b. *Indigofera tinctoria* L.; c. *Gymnema sylvestre* (Retz.) R.Br. ex Sm.; d. *Andrographis paniculata* (Burm.f.) Wall. ex Nees; e. *Abrus precatorius* L.; f. *Paris polyphylla* Sm.

Relevant Publications:

- Annales Botanici Fennici. (2025), 62: (39-47).
- Annales Botanici Fennici. (2025), 62: (89-93).
- Plant Science Today. (2025), 12(1): 1-5.
- Vegetos. (2024), 1-6.

Research group (From left to right): Kamini Thakur, Vikas Kumar, Rahul Kumar and Rahul Thakur.

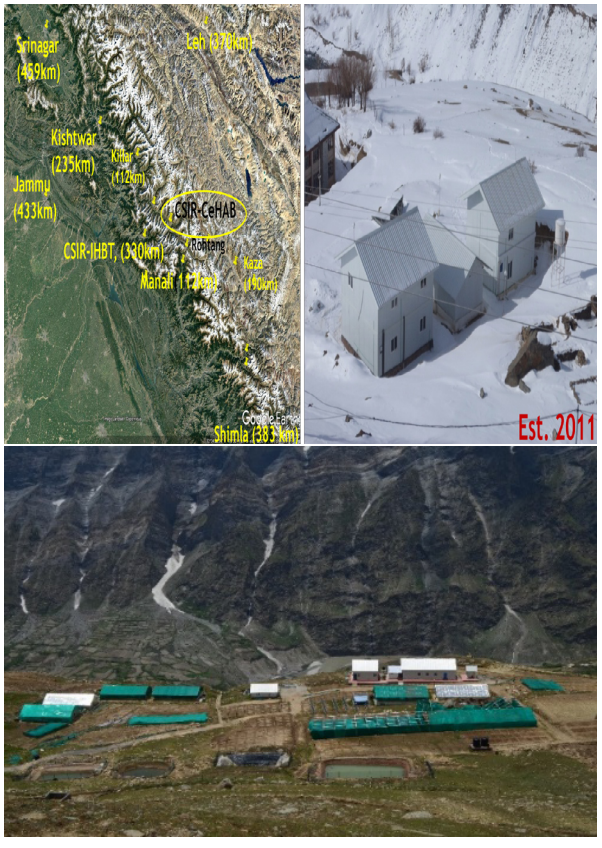
CENTRE FOR HIGH ALTITUDE BIOLOGY (CeHAB)

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 extent of shrubification of alpine meadows was estimated for 09 watersheds in the high altitude region using very high resolution Sentinel-2A satellite images which ranged from 23.81% to 43.08% for 03 dominant species. It could be inferred that this percentage is large especially at the middle elevations of these watersheds and given the more competitiveness of alpine shrubs over herbaceous species, this extent could increase in future and have important ramifications on these ecosystems.

(ii) The Floristic surveys were completed in Pangi sub-division of Chamba District which finally yielded 771 species occurring in the region. and a total of 124 species of higher plants were recorded. The species distribution pattern was analysed along elevation which revealed a hump shaped curve with more species richness in the middle elevations and more proportion of unique species at the higher elevations. This is the first ever comprehensive checklist of flora of Pangi.

Habitat suitability modelling of *Elwendia persica* (Boiss.) Pimenov & Kljuykov (syn. *Bunium persicum* and vern. Kala Zira) was conducted in the state of Himachal Pradesh. The highly suitable areas of the occurrence of its populations were predicted in the high elevation region of the state and guided to locate its populations.

(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. We studied the phenological responses of 21 alpine species distributed over 04 monitoring elevations. It was found that experimental ES caused advancement in early-season phenological events (leaf unfolding, bud burst, first flowering) and delay in late-season events (end of flowering, seed maturation, leaf senescence).

(ii) An experiment was 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. At Yangthang, a site adjacent to our Research Centre, selected tree saplings were covered with specifically made chambers made of acrylic sheets of varying thickness for UV-A&B attenuation. The samples are being analysed for morpho-anatomical, physiological, biochemical, or molecular level changes.

(iii) In another unique study on alpine plants, the leaf thermal tolerance was studied for 52 species, belonging to different growth forms. Thermal tolerance (T_{50}) was determined and thermal safety margins of all the studied species were found to be much higher than the daily maximum leaf temperature recorded through thermal imaging.

(III) *Ex situ* conservation of native, endemic & threatened plants including establishment of conservatories

(i) Conservation of *Picrorhiza kurrooa* and *Nardostachys jatamansi* through Tissue Culture.

(ii) *Picrorhiza kurrooa* is a high-value medicinal herb used in traditional medicine for the treatment of various ailment using rhizomes, rich in kutkin (picrosides I & II), as a primary commercial part. The high-yielding lines identified from wild populations collected from Rohtang Pass, H.P. were established under TC conditions. Using the cost-effective micro propagation protocol established in lab from leaf and nodal explants *in vitro* plants were mass multiplied. Plantlets were also pre-hardened in sand.

Another medicinal plant *Nardostachys jatamansi,* which is a Himalayan endemic medicinal herb listed as critically endangered A2cd ver 3.1 in IUCN Red Data Book. The tissue culture (TC) methods have been harvested to conserve this plant. An efficient protocol standardized earlier in lab was used for mass propagation of the plants.

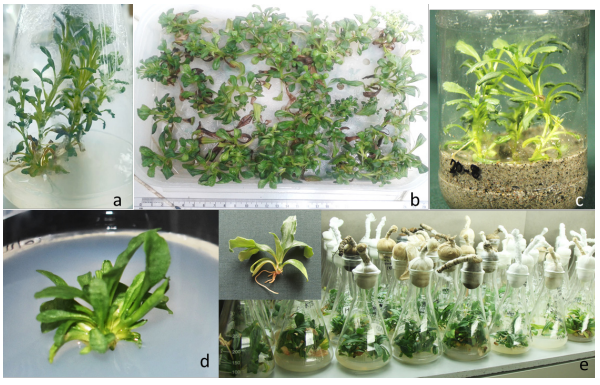


Fig. 1 *En masse in vitro* propagation of *P. kurroa and N. jatamansi a-c)* micropropagation of *P. kurroa d, e)* micropropagation of *N. jatamansi*.

(iii) Establishment & Enrichment of Field Gene Bank (FGB) at Ribling

The FGB established at CeHAB includes 40 threatened plant species with multiple accessions. The FGB was enriched with more accessions for various species such as Angelica glauca, Eremurus himalaicus, Polygonatum cirrhifolium, Arnebia euchroma, Colchicum luteum etc.

Fig. 2 Conservation of *Eremurus himalaicus, Angelica glauca* and *Carum carvi* in the Shadehouses.

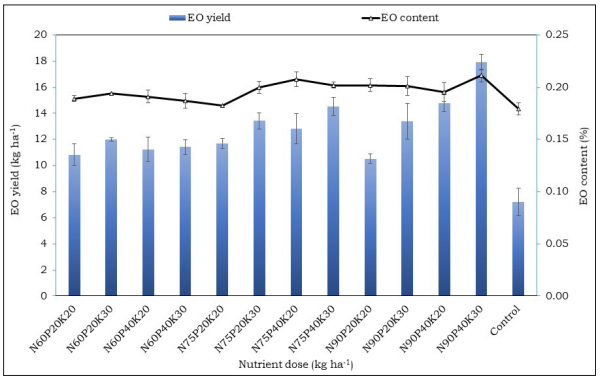
Further, multiple accessions of woody plant species (*Rosa webbianum*, *Myricaria sequarosa*, *Salix denticulata*, *Crataegus oxyacantha*, *Ribes orientale*, *Rosa eglanteria*, *Fraxinus xanthoxyloides*, *Prunus cornuta*, *Lonicera* sp., *Berberis* sp., *Collutea nepalensis*) were also added to the FGB. Their cuttings were planted in the poly-sleeves for their propagation and establishment of nurseries.

Seed Bank Repository: A total of 7 varied accessions of *Carum carvi, Angelica glauca, Sinopodophyllum hexandrum, Aconitum heterophyllum, Saussurea costus, Inula racemosa, Eremurus himalaicus* were conserved in the seed bank repository. This facility was prepared at room temperature in cold climatic conditions, which helps control loss of viability for upto 5 years.

(IV) To develop strategies for conserving and promoting high altitude bio-resource.

(A) Studies on developing Agro-technology of *Dracocephallum heterophyllum* {Modulating the essential oil yield and composition of *Dracocephalum heterophyllum* with varying nutrient levels}

Dracocephalum heterophyllum Benth. commonly known as white dragonhead, is a plant of utmost industrial importance used in cosmetics, food and medicines. Studying proper nutrient management practices is crucial to fulfill its ever-growing demand since fertilizer supplementation is an effective method to attain a higher yield. Therefore, an experiment was conducted at CeHAB to evaluate the impact of varying levels of nutrients on essential oil (EO) content, yield and composition of EO. The results revealed that $N_{90}P_{40}K_{30}$ recorded higher EO content and yield over other treatment combinations. In case of EO composition, heat map analysis showed that the treatment combination $N_{90}P_{40}K_{30}$ recorded significantly higher geraniol, citronellyl acetate and Z-citral content. Moreover, all fertilizer treatments outperformed the control, where no fertilizer additions were made.



(V) Societal upliftment through extension of technologies and skill development programmes

Training/Awareness Programmes

The following Training-cum-Awareness programmes were conducted: -

Title	Date	Venue	Sponsored project	No. of participants
Phytopharmaceutical Mission III	27 Oct	Jobrang	MMP075201	10
-do-	10 Nov	Chicham	-do-	12

Jobrang **Chicham**

Facility creation for public sanitation with the FRP/PVC dry toilets and free-flowing compost booster:

Online tri-party agreement between CSIR-IHBT Palampur, CSIR NEERI Nagpur and 4 different farmer's societies of Lahaul Valley (Jyoti Mahila Mandal Mooling, Gram Vikas Sehkari Sabha Thorang, The Krishak Vikas Sabha, VPO-Marbal, Lohol Society Keylong) has been done in the CeHAB Tandi office on August 6.

This facility is helpful for utilization of compost booster for fabricated sanitary dry toilets with recovery of night soil based fertilizers in the cold desert areas.

PLANNING PROJECT MONITORING & EVALUATION (PPME)

&

BUSINESS DEVELOPMENT AND MARKETING UNIT (BDMU)

Institutional Research Planning

Facilitated formulation of various documents sent to CSIR headquarters (Quantitative data on technologies transferred, TTC-2030, Evaluation of Innovation Excellence Indicators – CII, inputs from DSIR Annual report 2024-25 etc.), prepared Procurement Plan 2024-25 & 2025-26, KPI information on projects, demand for additional grant, RE-BE-2024-25 & 2025-26, compiled slides of Institutional achievements. Provided information for AcSIR NIRF 2025, Pilot Plants, eSamikSha, Viksit Bharat, monthly report covering significant achievements, quarterly report, replies of parliament queries (37). Other important inputs were regularly furnished to the competent authority as and when required.

For constant updating institutional data on various domain, 29 proforma and report on daily basis were uploaded on to C-DIS portal during 2024-25. PPME recorded initiation of 11 new projects funded by various agencies (DBT, DST, SERB, NMPB, NMHS, ICMR, MSME, Directorate of Industries and Commerce, UT Ladakh etc.). As a part of routine activity, carried out updation and maintenance of databases pertaining to project, staff, paper, patent, ECF, resource management etc. For facilitating decision making, the Division carried out monitoring of institutional performance with respect to publication, ECF, patent, technology transfer and societal impact. The Division also compiled Institutional information for CSIR Annual Report.

PPME organized the events of national importance as detailed below:

- National Technology Day (13th May, 2024)
- CSIR-IHBT Foundation Day (2nd July, 2024)
- Azadi Ka Amrit Mahotsav - Rashtriya Boudhik Sampada Mahotsav/National Intellectual Property Festival (10th May, 2024)
- CSIR Foundation Day (17th October, 2024)
- National Science Day (28th February, 2025)

The Division conducted 67th and 68th Meeting of Research Council of CSIR-IHBT on 05th July, 2024 and 09th December, 2024 respectively.

During 2024-25, PPME facilitated visit of following foreign national as part of ISTAG activities

- Obtained permission for holding International Workshop entitled "EMBO Workshop on High Elevation Plant Adaptation in a Changing Climate (HEPACC)" at CSIR-IHBT, Palampur on 25-28 February, 2025
- Security & Sensitivity Clearance for project entitled "Effects of alpha2-antiplasmin in neovascularization and chronic venous thrombus remodeling" sponsored by the American Society of Hematology, USA to CSIR-IHBT

Resource planning and monitoring: Facilitated in the fund allocation and expenditure as per the need and mandate of the Institute. During the Monthly Expenditure Monitoring Meeting (MEMM) with CPD, the spending pace was managed. Coordinated meetings to plan new infrastructures and equipment. To cater to manpower need of the institute, appropriate steps were taken to seek approvals and to induct new manpower.

The unit is actively involved in monitoring progress under the R&D Seed Fund (RDSF) and Prioritized Equipment Fund (PEF) schemes of CSPS-2024.

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. Prepared Project Data and Role Mapping Data for mapping into Access Portal. Coordinated development and deployment of Recruitment Portal for inviting online application for JSA advertised vide Advt. No. 1/2025

Information Disclosure: Seven appeals were processed under the RTI Act, and two grievance was resolved on the CPGRAMS portal. The mandatory disclosures were consistently updated on the website.

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), Incubation Facilities under "Chief Minister's Start up Scheme", 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 2024-25, BDMU facilitated for signing 219 agreements/MoUs including, Twenty Seven Technology Transfers, One Hundred Thirty Four Material Transfer Agreements (MTAs), One Need based Agreement, Forty One miscellaneous MoUs signed with different farmer societies, academic and R&D collaborations with government institutes/ universities, and sixteen MoUs/Agreements under "Chief Minister's Start up Scheme" for incubation and facility use of CSIR-IHBT, and one international MoU. 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 about CSIR-IHBT technology based business opportunities. Provided inputs/ data to CSIR Hqr related to Quantitative Data on technologies transferred, BDMU inputs for DSIR Annual report 2024-25, monthly reports etc.

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 2024-25 CSIR-IHBT has signed twenty five agreements for transfer of technology i.e.(i) Agreement for Transfer of Technology for manufacturing/ processing of iron enriched bars with M/s Good Food Boutique Pvt. Ltd., Ludhiana (ii) Agreement for Technology on formulation promoting cartilage health M/s Auretics Ltd., New Delhi (iii) Agreement to Transfer the Technology for manufacturing/ processing of multigrain protein powder with (a) M/s Good Food Boutique Pvt. Ludhiana (b) Mahalaxmi Malt Products Pvt Ltd Palwal Haryana (iv) Technology for cultivation and production of Brahmi under the vertical aeroponic system with Kangra (Komal) Innovation and wellness initiative (KIWI), Nagrota Baghwan, Distt Kangra (H.P) (v) Technology for Hydroponic stevia cultivation and Technology for Brahmi and Jatamansi production under aeroponic system with M/s Satvik Agritech Labs Private Limited, Kanpur (U.P) through NRDC, New Delhi (vi) Agreement to Transfer Technology for aeroponic technology for Valeriana Jatamansi production and extraction of the produce (a) Jnaani Nutritionals Private Limited, Dindigul, Tamil Nadu (vii) Technology for Hydroponic Plant (Lettuce, Spinach, Kale, Microgreens, Capsicum, Tomatoes) with Himalayan Bliss Gopalpur Tehsil Palampur, Distt Kangra (viii) Agreement for Transfer of Technology for artifact making using dry flowers with (a) Pragati Social Development Initiative, Kolkata (b) Shiv Shakti Self Help Group, VPO Bhuana Palampur, Distt Kangra- (c) Gurudwara Self Help Group, VPO Kailashpur, Tehsil Panchrukhi, Distt Kangra (d) Grihini Sawyam Swarojgar Sangh, VPO Malahari Tehsil Indora, Distt Kangra H.P (ix) Technology for the Lilium and Tulip processing including grading, sorting, packaging and cold storage of bulbs (a) Shansha Cut Flower Cluster (SCFC), Village Dalang, P.O. Gondhla, Tehsil Keylong, Distt Lahaul and Spiti (b) M/s Dhariti Agro Farms Pvt. Ltd., Vill Kheda, Goula Par, Haldwani, Nainital, Uttrakhand (x) Agreement to transfer Technology for manufacturing/ processing of millet panjeeri having three variants (i) Plain millet panjeeri, (ii) Multi millet panjeeri (iii) Millet based beverage mixes i.e. multipurpose flour for ladoo and other preparation with Tashvika India Food Pvt. Ltd, Dwarka, New Delhi (xi) Technology for Herbal Tea (Rhododendron tisane and tea blends, and one more variant) with M/s SudKrishna Himproduct Private Limited, Panchkula, Haryana (xii) Technology for Lavender Tea and Instant Sea buckthorn Tea with Prorima Health Care, Jaipur, Rajasthan (xiii) Technology for

making herbal incense cones and sticks from temple waste flower with a) Himaliya Ucch Shikhariya Utpaad Mahila Samuh Village Nalda, Post Office Jahalman, Tehsil Udaipur, District Lahaul & Spiti b) Shailza Self Help Group, Village and Post Office Gugga Saloh, Block Bhawarna, Tehsil Palampur, Distt Kangra (xiv) Technology for full spectrum operations for preparation of biofertilizer using the desired microbe with M/s Biomimicry Technologies Pvt. Ltd., MV Extension, Delhi (xv) Technology for manufacturing Energy/Granola bars (Millet and cereals, protein based) to M/s Good Food Boutique Pvt. Ltd Ludhiana (xvi)Transfer of Technology 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) Ragi green gram porridge mix powder, and v) Multi grain porridge mix powder with Mahalaxmi Malt Products Pvt Ltd. Distt Palwal, Haryana (xvii) Technology for making travel/pocket perfumes (4-5 variants) to Phadicraft, Gagret, Una Himachal Pradesh (xviii) Technology Agreement for Crude Ethyl Acetate Leaf Extract, A Composition, Process of Preparation and Application Thereof (Development of Botanical Formulation from Plant Extracts and Seed Oil of TriadicaSabifera (L) Small for the control of Aphid, Aphis craccivora Koch (Aphid Control), xix) Technology Agreement for Standardized fraction of Picrorhizakurroa for the treatment of Non Alcoholic Fatty Liver Disease (NAFLD)

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: 27 Technology Transfer Agreements; 134 Material Transfer Agreements; 14 agreements with Startups, 01 Need based Agreement, 41 Misc. MoUs (with farmer's Societies, NGOs, cooperatives, academia and R&D collaborations, and one International MoU with Empowering Farmers Foundation (EFF), Tanzania to collaborate for developing the Industry in Africa through introduction of modern methods of Tissue Culture, Hydroponic, and Aeroponic methods of growing plants and high value floriculture and aromatic crops. 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 agreement 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:

- Participated in "CSIR One Week One Theme (OWOT)" from 24th to 25th June, 2024 and showcased Institute's technologies.
- Participated in 83rd CSIR Foundation Day celebrations at Bharat at NASC Complex, Delhi Pragati from 24th to 29th September, 2024. Shri Jagdeep Dhankhar, Vice President, India visited CSIR-IHBT stall and appreciated the efforts of the Institute for farmers upliftment.
- Participated in the International conference on Communication and Dissemination of Traditional Knowledge (CDTK-2024) held from 13th and 15th of November, 2024 at Gurugram University, and showcased Institute's technologies.
- Participated in 'IISF 2024" (28th November 5th December 2024) at IIT Guwahati. In this mega exhibition, showcased the CSIR-IHBT technologies (Agro technology, Biotechnology, Chemical Technology, and Food and Nutraceuticals Technology etc.) and delivered lecture on Technologies available at CSIR-IHBT Palampur.
- Participation in the "Workshop on Innovation and Sustainable Business Strategies for S&T" at CSIR-IICT Hyderabad on 27th January, 2025.

Relevant Publications:

➢ Singh S, Sharma D, Rana A and Bhargav B (2024) Extension networks and floricultural advancement dissemination. IN: Ornamental Horticulture: Latest Cultivation Practices and Breeding Technologies. Springer Publication, DOI: https://doi.org/10.1007/978-981-97-4028-4_16.

Research group (From left to right): Ms. Deepika Sharma, Sh. Didar Singh, Dr. Sukhjinder Singh and Akhil Rana.

RAMANUJAN FELLOW, CSIR-POOL SCIENTIST, WOMEN SCIENTIST, YOUNG SCIENTIST

Mamta, Women Scientist-A Fellow
mamtakau90@gmail.com
Fermentation and Phytofarming Technology

The Project Funding- "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: In relation to the efficient sequestration of CO_2 and nitrogen, the PI has been working on the physiological, biochemical, and molecular aspects of plant adaptation. They found that high-altitude plants showed increased activities of phosphoenol-pyruvate carboxylase (PEPC), ribulose-1,5-bisphosphate carboxylase /oxygenase (Rubisco), aspartate aminotransferase (AspAT), and glutamine synthetase (GS), indicating enhanced carbon and nitrogen conservation. PEPC likely captures atmospheric and photorespired CO_2, while elevated GS promotes NH_3 assimilation via the GS-GOGAT pathway. OAA formed is used for Asp synthesis with Glu as an amino donor. These changes suggest that coordinated upregulation of PEPC, AspAT, and GS supports improved C and N use efficiency in high-altitude conditions. No major differences were observed in malate dehydrogenase, NAD-malic enzyme, or citrate synthase activities between locations. A conceptual model was developed based on these findings **(Fig. 1)**.

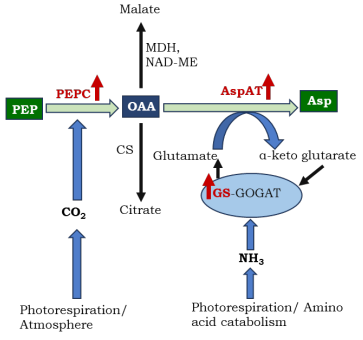


Fig. 1 A schematic diagram showing changes in photosynthetic metabolism in plants growing at high altitude (HA).

Based on the above data, the hypothesis was proposed that a transgenic plant over-expressing PEPC, GS, and AspAT would ensure higher PEPC activity for capturing CO_2 and making the carbon backbone available for routing nitrogen into organic form through the joint activity of AspAT and GS. Here, we tested the possibility of efficient utilization of C and N by coexpression of *ZmPEPC*, *GmAspAT*, and *NtGS* in *Brassica juncea* to improve plant growth and yield under different CO_2 environments {~400 ppm (ambient) and ~200 ppm (low)} and nitrogen concentrations (6Mm, 3Mm and 0.3Mm) following our earlier attempt where we demonstrated that the heterologous expression of *ZmPEPC*, *GmAspAT*, and *NtGS* in Arabidopsis led to improved reassimilation of photorespired CO_2 and NH_3, resulting in increased plant growth (Kaachra *et al.,* 2018).

Development of *Brassica junces* transgenic plants and PCR conformation

Transgenic *Brassica juncea* plants co-expressing PEPC, AspAT, and GS were developed via *Agrobacterium*-mediated transformation using hypocotyls as explants. PCR assay confirmed the presence and expression of targeted genes, and QD-PCR identified *BjPAG5*, *BjPAG8*, and *BjPAG11* as single-copy homozygous lines selected for further analysis. Enzymatic assays validated gene overexpression, showing significantly higher expression levels in transgenic lines compared to the vector control (*BjVC*) **(Fig. 2)**.

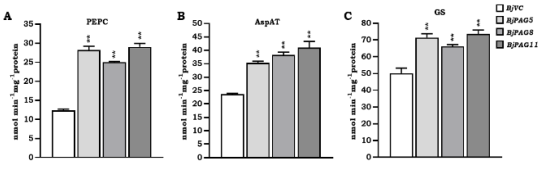


Fig. 2 Enzyme assays showed higher activities of the target enzymes in the selected lines.

Evaluating plant performance under ambient (~400 ppm) and low CO_2 (~200 ppm) environment

To assess the impact of *PAG* co-expression under different CO_2 levels (~400 ppm and ~200 ppm), *BjPAG* and *BjVC* plants were grown in controlled conditions **(Fig. 3A, B)**. *BjPAG* transgenics showed significantly higher leaf area, shoot fresh weight, and shoot dry weight under both CO_2 conditions **(Fig. 3C–E)**.

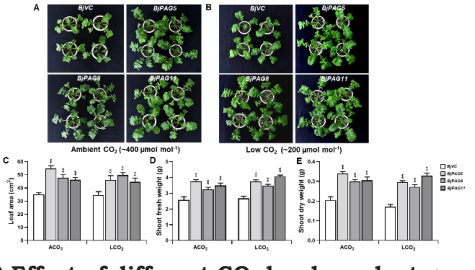


Fig. 3 Effect of different CO_2 level on plant growth of 45-days old control and transgenic plants.

Biochemical estimations and stomatal study under ambient and low [CO_2]

BjPAG plants exhibited enhanced photosynthetic pigments, carbohydrate accumulation, and reduced ammonium and ROS levels under both CO_2 environments **(Fig. 4A–G)**. Stomatal density was also higher on both adaxial and abaxial surfaces than *BjVC* plants **(Fig. 4H, I)**. These findings suggest that enhanced PEPC, AspAT, and GS activity supports better carbon and nitrogen assimilation, leading to improved photosynthesis, sugar and starch levels, and overall biomass in *Brassica juncea*.

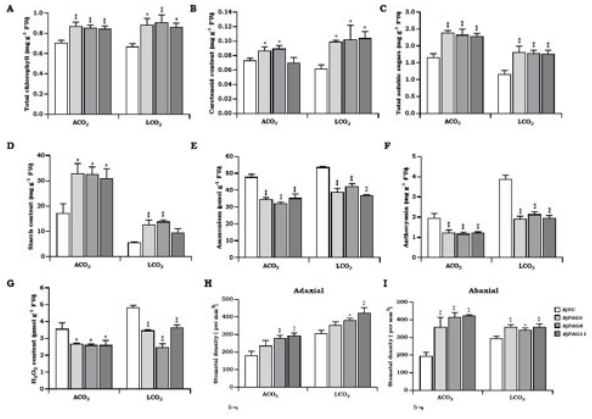


Fig. 4 Different biochemical parameters were investigated in 45-days-old *Brassica* transgenic plants grown at different CO_2 environments.

Evaluating plant performance under different nitrogen concentrations 6mM 3mM and 0.3mM)

To assess the impact of *PAG* co-expression, *BjVC* and *BjPAG* transgenic plants were grown under varying N levels **(Fig. 5A)**. *BjPAG* lines showed significantly higher shoot fresh and dry weight than controls **(Fig. 5B, C)**.

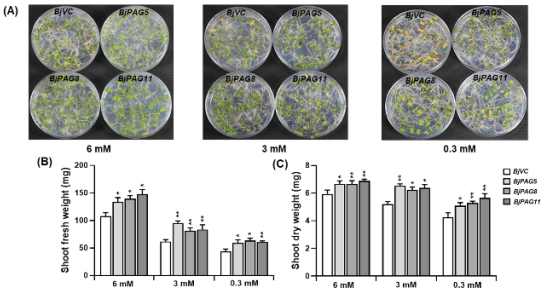


Fig. 5 Effect of different N level on plant growth of 21-days old control and *BjPAG*-coexpressing plants.

Biochemical estimations and stomatal study under different nitrogen concentrations

BjPAG plants exhibited increased photosynthetic pigments, carbohydrate content, and reduced ROS levels under different N concentrations **(Fig. 6A–F)**. Stomatal density on both leaf surfaces was also higher in *BjPAG* lines **(Fig. 6G, H)**. These results suggest enhanced PEPC, AspAT, and GS activities aid in C and N conservation, leading to greater intracellular CO_2 concentration for increased photosynthesis, chlorophyll, sugars, starch, and biomass.

Improved growth, seed yield and oil content in *BjPAG* plants under different N supply

Under all N levels, *BjPAG* plants showed enhanced growth and yield traits: more leaves, greater leaf area, taller plants, more siliques/seeds, and higher seed and 100-seed weights **(Fig. 7)**. Oil content also increased significantly: 14% (*BjPAG5*), 26% (*BjPAG8*), and 21% (*BjPAG11*) over *BjVC* **(Fig. 8A, B)**.

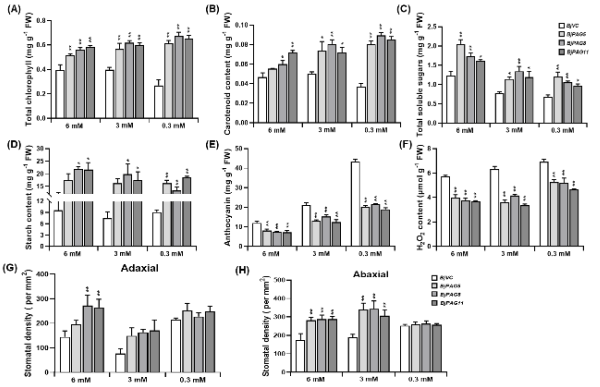


Fig. 6 Different biochemical parameters were investigated in 45-days-old *Brassica* transgenic plants grown at different N concentrations.

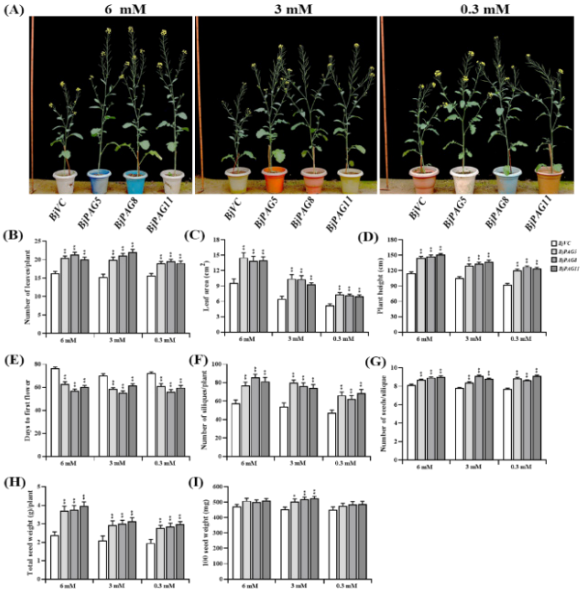


Fig. 7 Effect of varying N concentrations on the growth and seed yield of *BjPAG*-coexpressing plants.

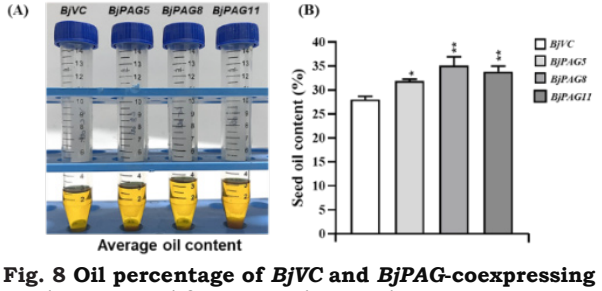


Fig. 8 Oil percentage of *BjVC* and *BjPAG*-coexpressing seeds extracted from petroleum ether.

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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 is the leading cause of morbidity globally and the second most common reason for mortality. Ischemic stroke (IS) is the most common (87%) stroke, often distinguished pathologically as obstruction of cerebral blood flow owing to embolus formation. This condition results in a lack of blood and oxygen supply, subsequently obstructing overall cellular metabolism. Currently, the only clinically approved approach by the Food and Drug Administration (FDA) for IS therapy focuses on dissolving the clots with tissue plasminogen activator. This gold standard treatment is administered within 3-4 h of the onset of stroke. The major limitation associated with this approach is its narrow treatment window. Moreover, the restoration of blood flow in ischemic tissue can paradoxically amplify and exacerbate the ischemic damage, leading to ischemia-reperfusion (I/R) injury. This I/R injury can trigger a series of chain reactions, including oxidative stress, cerebral edema, inflammation, mitochondrial perturbation, calcium ion influx, and apoptosis. Oxidative stress refers to the imbalance between the production of reactive oxygen species (ROS) and the activity of antioxidant enzymes. It plays a pivotal role in the pathogenesis of ischemic stroke, and following reperfusion, it triggers cerebral IR injury. Ischemia disrupts the balance, leading to excessive production of reactive oxygen species (ROS). Oxidative stress and mitochondrial impairment occur in the early stages of ischemia and are pivotal in cerebral IR injury, contributing to the progression of neurodegenerative processes. Hence, it is critically necessary to develop novel antioxidant treatment strategies to reduce IR harm. Superoxide dismutase (SOD) is of special interest as a potential therapeutic agent because of its high dismutation potential of superoxide anions, one of the predominant forms of ROS. However, most of the available SODs associated with some undesirable features such low production level, short half-life (6 min), poor pharmacokinetics and permeability across the blood-brain-barrier (BBB). Moreover, injected SOD accumulates preferentially in the kidney limiting its targeted delivery and renal clearance. These shortcomings of stability and poor pharmacokinetics across the BBB can be overcome with nanoformulation. The present study was designed to produce a purified tag-free nanoformulated mSOD delivery system for enhanced therapeutic efficacy. Therapeutic potential of formulated mSOD will be studied in the Zebra fish and mice models for IR injury.

Project summary

The present study aimed to develop an mSOD nanoformulation for therapeutic delivery in IR injury. The mSOD gene (His-tag-free) from *Camellia sinensis* has been identified and expressed in the pET-28a (+) vector. The recombinant clone has been transferred to *E. coli* BL21 cells, and the soluble protein was optimally expressed at 28°C **(Fig. 1)**. For clinical application, purified protein will be employed for nanoformulation, and in vivo studies will be carried out in zebrafish and mice model.

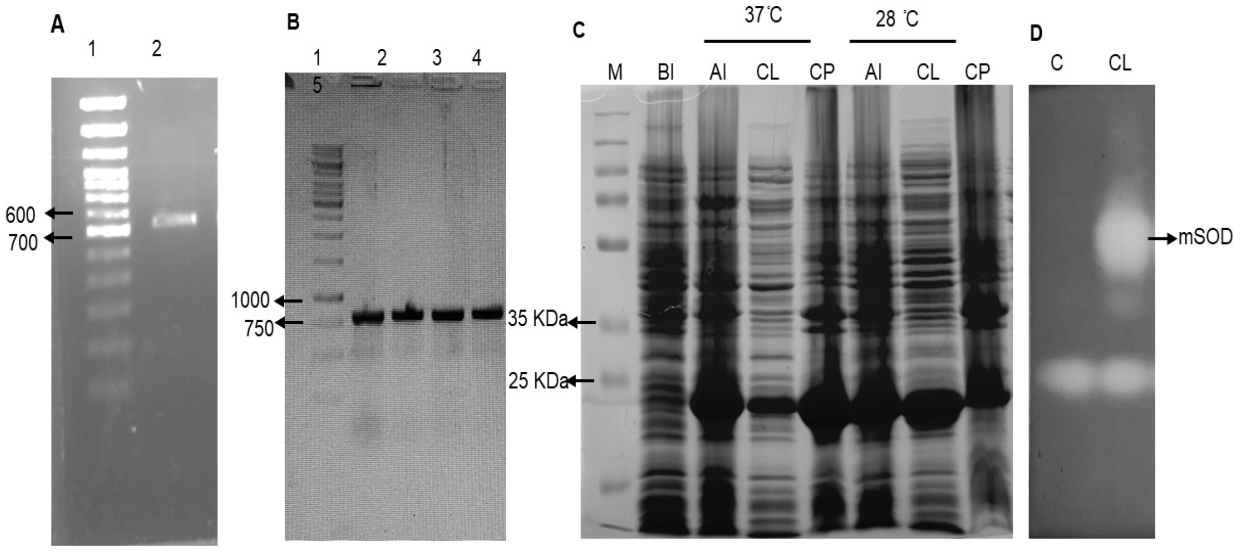


Fig. 1 Cloning of a mitochondrial superoxide dismutase and expression in pET28a (+). Panel A represents the gene amplification around 700 bp. Here, lane 1 represents the DNA ladder and lane 2 represents gene amplification at 52°C. Panel B represents the colony PCR of transformants using vector-specific T7 primers. Panel C represents the SDS PAGE analysis. M represents Marker, BI: Before induction, AI: after induction, CL: cell lysate, CP: cell pellet. Panel D represents the zymography of the cell lysate. Here, C: control sample, CL: cell lysate.

SCIENCE & TECHNOLOGY SUPPORT SERVICES

1) Ornamental Bulb Processing Facility

The Facility was inauguration by Dr. Jitender Singh, Honourable Minister of state for S&T and Earth science,Vice President CSIR,on 26th Feb 2025. The facility is of 150 sqm area and completition cost is Rs 52.00 Lacs.

2) 12 no Type IV Staff Quarters

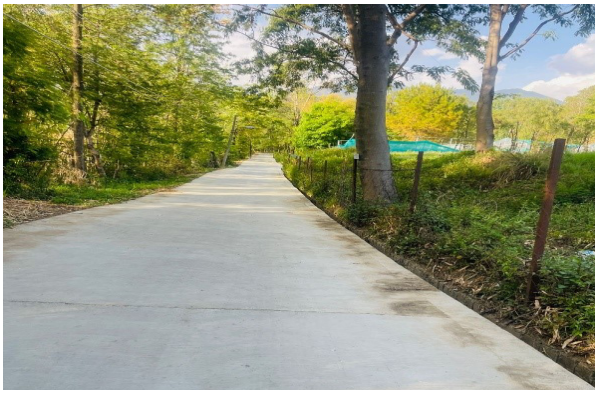
The work of C/o 12 no. Type-IV staff quarters has been approved by the CSIR on September 2021 and successfully completed & inaugrated on 02.07.2024. The completetion cost of the project is Rs 818.00 Lacs. The covered area of the building is 2125 sqm.

3) Phytofactory Facility

Foundation stone of Phytofactory Facility was laid by Dr. Jitender Singh, Honourable 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 cost is Rs 85.38 Lacs.

4) Concrete Paved Chandpur Research Farm Road

The inauguration of road was done by Dr. Jitender Singh, Honourable Minister of state for S&T and Earth science,Vice President CSIR,on 26th Feb 2025. The road is of 1650 meter length and approved cost is Rs 190.00 Lacs



5) Autonomous Green House Facility

The Facility was inauguration by Dr. Jitender Singh, Honourable Minister of state for S&T and Earth science,Vice President CSIR,on 26th Feb 2025. The facility is of 300 sqm area and completition cost is Rs 50.00 Lacs

6) 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.

7) Gymnasium Facility

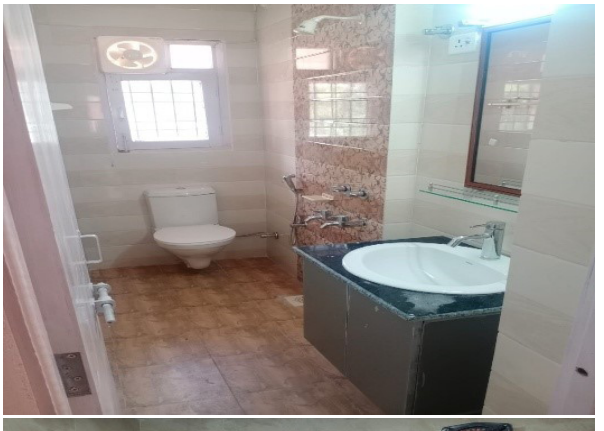
The Facility was inauguration by H.E. ANISHA K. MBEGA, High Commissioner, United Republic of Tanzania, India, New Delhi on 2nd July 2024.

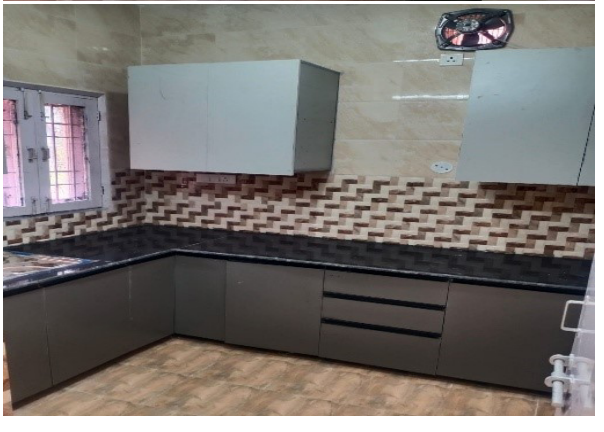
8) Raceway Production Facility

The Facility was inauguration by Dr. N.KALAISELVI Director General, CSIR & Seceretary,DSIR,GOI on 17 March 2025.

9) Upgradation of Staff Quarters Type IV-12 Nos (D5-D16) & Type III (C1-C4)- 4nos.

Under the CSIR-Special Scheme (CSPS) the work of Upgradation of Staff Quarters Type IV-12 Nos (D5-D16) & Type III (C1-C4)- 4nos has been approved by DG CSIR. The work has been started and in progress.





ADMINISTRATION

The Administration carries roles & responsibilities to handle all the administrative matters of the Institute and to assist the Director/HoDs of the Institute to manage all the affairs including R & D activities to fulfil the mandate of CSIR-IHBT, Palampur in accordance with CSIR Bye-Laws/rules/guidelines.

The Administration plays critical role at every phase of career advancement for all the employees, right from their recruitment, orientation training, performance appraisal and various service matters to their superannuation. It also facilitates all the employees including research scholars in their sphere of duty so that they can perform their task evenly.

Other major activities performed by the administration are enumerated as follows:

- Assist the Director/the Head of Departments/ Principal Investigators on various issues and to take decisions of administrative nature viz. recruitment, assessment & promotion, DPC, establishment, vigilance, legal, RTI, finance related, store related, purchase related grievances of staff and others as the case may be. Maintaining liaison with CSIR Headquarters, New Delhi on administrative matters.
- Implement policies in pursuance of guidelines as issued by the CSIR Headquarters, New Delhi.
- Provide administrative support to various functional bodies (Committees/Functional Groups) within the organization.
- Provide conducive working conditions and environment in the laboratory through interpretation as well as implementation of governing rules and regulations.

The Administration is headed by the Controller of Administration/ Administrative Officer. He is supported by the Section Officers, a group of Assistant Section Officers, Senior Secretariat Assistants, Junior Secretariat Assistants and supporting staff including Security Services and Rajbhasha Cell.

Security Section

The Security Section is responsible for the complete safety and security of the valuable resources inside the premises of this Institute. The section strives to secure the premise of this Institute by patrolling, inspecting buildings on day to day basis and monitoring the various access points attentively through electronic surveillance system.

The section has successfully restrained the trespassers through continuous attentive vigil. It maintains the record of movement of visitors as well as materials coming inside and exiting the premises of this Institute. In addition, it provides other essential assistance as and when required at the main entrance of this Institute.

Administration group: Sh. S. D. Rishi, Sh. Prajwal Rai, Sh. Ranjeet Kumar Gupta, Sh. Sanjay Kumar, Sh. Didar Singh Patial, Smt. Santosh Kumari, Sh. Baldev, Sh. Kiran Kumar, Smt. Pooja Awasthi, Sh. Boni Kumar, Sh. Ankit Rohilla, Smt. Jyoti and 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 2024-25, the Institute received Government Grant of Rs.8879.164 lakh (including Rs.1019 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, 3 items of Works & Services and 1 major equipment in the financial year 2024-25. Accordingly, an expenditure of Rs.654.989 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.96.08 lakh as Lab Reserve Fund and Rs.554.988 lakh as ECF during the financial year 2024-25.

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 eMarket place). 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 2024-25:

- Dual Microfocus Based Advanced Single Crystal XRD System
- LC-MS MS System
- Thermogravimetric Analyzer (TGA)
- Multiskan SkyHigh Microplate Spectrophotometer
- Multi-purpose Essential Oil Distillation Units
- Computer Workstations
- Microplate Spectrophotometer
- High End Servers
- Hematology Analyzer
- Plant Growth Chamber
- Micro Balance

Stores and Purchase group: Sh. Sanjay Rawat, Sh. Ravinder Singh, Sh.Sohan Singh, Sh. Rajeev Sood, Ms Deepika 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 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 includes 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.

Relevant information on impact factor of journals, publishers' guidelines to authors, publishing policy of journals for selecting quality journals for publication of their research articles as well as online submission of research articles were provided. In this year, 30 books of research value, 45 Hindi books covering scientific and societal issues and 30 thesis were added to the library collection. The books, journals and other documents was updated in KOHA an open source software of library management. The Koha software is available for access on internet/ intranet through website http://library.ihbt.res.in.

OPAC- Online Public Access Catalogue: The library catalouge was updated and made available for access on intranet and internet. The OPAC is accessible and searchable online through http://14.139.59.218/. Users can view, online checkout status, reservation of books, and recommendation of new books, journals, etc. The records searched in this database by keywords, author, title, publisher, accession number, subject, ISBN, etc.

Similarity and Grammar Check: The library checked various documents through the iThenticate database for detection of similarity/ plagiarism. Similarity reports provided to concern scientists and scholars. The Grammarly software made available and uploaded on all scientist and scholars PCs for grammar checks. Drafts of the documents were also checked by library staff with the Grammarly database for grammar correction and reports were provided for further improvement by scientist, scholars and staff.

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: IHBT Library coordinated the Press and media activities of the institute for preparation of press notes on various technologies developed and scientific programmes organized in the institute for the communication of new knowledge to society through the print and electronic media.

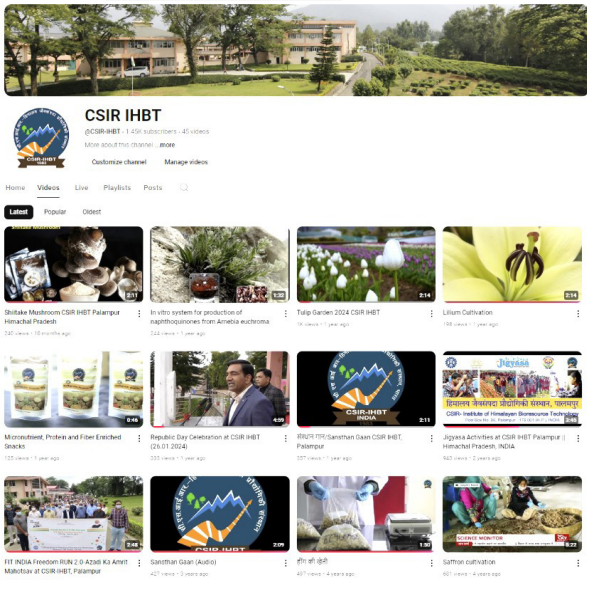
The library subscribed employment newspaper & twelve Hindi and English languages newspapers. The dailies media coverage of this institute scanned and communicated to directorate and related scientists for their information. The scanned news items were uploaded on blog at- http://ihbtinnews.blogspot.in/.

Library group: Mrs. Jasveer Kaur, Mrs. Rujala Devi, Sh. Saurabh Sharma and Sh. Sarwan Kumar

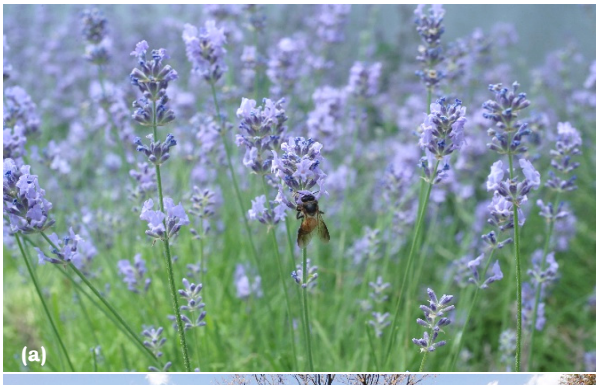
PHOTOGRAPHY UNIT

The institute has a professional photography unit that offers a wide range of services. Our primary goal is to provide high-quality photographic and videographic documentation of scientific research and institutional events.

In 2024-2025, the unit created knowledge-based short films for social media to showcase the institute's R&D activities. One notable project was a short film on "Vitamin D2-Enriched Shiitake Mushroom," which successfully engaged a broader audience.



The unit also documents the institute's R&D activities through still photography and videography. We capture various crops, including wild marigold, valerian, damask rose, Picrorhiza, Crataegus, ginkgo, stevia, rosemary, geranium, lemongrass, lavender, saffron, heeng cultivation, bamboo, monk fruit cultivation, and floriculture efforts, featuring tulips, lilies, gerberas, carnations, chrysanthemums, roses, alstroemerias, and gladiolus, as well as tissue culture processes. Additionally, we are involved in all institutional projects, such as the floriculture mission and aroma mission.



Photographs of: *Lavender* (a), Tea field (b), *Vartical farming* (c), Heeng field (d), *Stevia* field (e), and Exhibition under CSIR-Jigyasa programme (f).

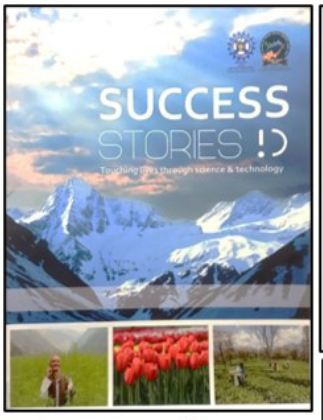
It has been a productive year for the unit, as we visually represent the institute's activities and achievements through various photographic and design contributions.

The annual report cover and the "SUCCESS STORIES" publication play a vital role in communicating the institute's impact and goals to a wider audience. Our photographic inputs add a powerful visual dimension to these important documents.

We also designed a brochure for the "Tulip Festival cum National Symposium on Ornamental Bulbous Flowers," which was an excellent way to attract participants and showcase the beauty of our floriculture mission.

Furthermore, we contributed to the SSBMT Outdoor Final 2025 by designing the abstract cover page, banner logo, t-shirt logo, and participant certificate, helping to create a cohesive and engaging identity for the event.

Finally, the 2025 calendars, both wall and table, serve as a practical yet visually appealing way to keep the institute's work in the minds of stakeholders throughout the year.



राजभाषा

राजभाषा विभाग, भारत सरकार तथा सीएसआईआर मुख्यालय के निर्देशानुसार राजभाषा नीति के अनुपालन हेतु संस्थान में प्रभावी राजाभाषा कार्यान्वयन से सम्बद्ध समस्त कार्यों का निष्पादन राजभाषा अनुभाग द्वारा किया जाता है। भारत सरकार की राजभाषा नीति के कार्यान्वयन एवं हिंदी भाषा के माध्यम से विज्ञान के प्रचार–प्रसार में हमारा संस्थान सतत् प्रयासरत है। राजभाषा हिंदी को बढ़ावा देने हेतु संस्थान हिंदी से संबन्धित कई प्रकार के गतिविधियों एवं कार्यक्रमों का भी आयोजन करता है। वर्ष 2024–25 के दौरान संस्थान की राजभाषा गतिविधियों का संक्षिप्त विवरण निम्नलिखित प्रकार है:

संस्थान में 30 अगस्त से 19 सितम्बर, 2024 तक हिंदी पखवाड़ा का आयोजनः सी.एस.आई.आर – हिमालय जैव संपदा प्रौद्योगिकी संस्थान में तक हिंदी पखवाड़ा का आयोजन किया गया। इसके अंतर्गत दिनांक 30 अगस्त 2024 को एक कार्यशाला का आयोजन किया गया। डा. राकेश शर्मा, वरि. हिंदी अधिकारी, सीएसआईआर–एनआईओ, गोआ ने 'राजभाषा कार्यान्वयन में एआई आई टी टूल्ज की भूमिका' पर प्रस्तुतिकरण किया।

संस्थान के निदेशक डा. सुदेश कुमार यादव ने हिंदी पखवाड़ा के अंतर्गत आयोजित की जाने वाली प्रतियोगिताओं के लिए अपनी शुभकामनाएं दीं तथा सभी कर्मियों से आह्वान किया कि इन आयोजनों में अपनी सक्रिय प्रतिभागिता सुनिश्चित करें। उन्होंने वैज्ञानिकों से आह्वान किया कि वे अपने शोध को हिंदी माध्यम से जन–जन तक पंहुचाए। उल्लेखनीय है कि हिंदी पखवाड़ा के दौरान संस्थान के वैज्ञानिकों, तकनीकी तथा प्रशासनिक कार्मिकों के लिए हिंदी टिप्पण लेखन, लोकप्रिय विज्ञान लेखन एवं रिसर्च स्कॉलर के लिए हिंदी भाषण आदि प्रतियोगिताओं का आयोजन किया गया।

क्र.सं.	तिथि	प्रतियोगिता
1	03.09.2024	लोकप्रिय विज्ञान लेखन
2	04.09.2024	भाषान्तर / टिप्पण लेखन
3	09.09.2024	हिंदी भाषण प्रतियोगिता (रिसर्च स्कॉलर के लिए)

हिंदी दिवस का आयोजनः संस्थान में 19 सितम्बर 2024 को हिंदी दिवस का आयोजन किया गया तथा 30 अगस्त 2024 से प्रारंभ हुए हिंदी पखवाड़े का समापन हुआ। इस अवसर पर सीएसआईआर– राष्ट्रीय विज्ञान संचार एवं नीति अनुसंधान संस्थान (निस्पर), नई दिल्ली से विज्ञान प्रगति के संपादक डा. मनीष मोहन गोरे ने हिंदी में विज्ञान लेखन की बातें, कुछ जानी कुछ अनजानी' विषय पर अपनी प्रस्तुति दी। अपनी प्रस्तुति में उन्होंने विज्ञान लेखन से जुड़ी बारिकियों, विज्ञान संचार के उद्देश्यों और सामाजिक लाभों के बारे में चर्चा की। उन्होंने वैज्ञानिको अपील किया कि वे अनुसंधान के साथ–साथ अपने प्रयोग और शोध के बारे में जन सामान्य से भी संवाद स्थापित करें। ऐसे प्रयासों से आम जन में विज्ञान को लेकर एक समझ विकसित होगी तथा उनका नजरिया तार्किक होगा।

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 का एक

वार्षिक प्रकाशन के रूप में तैयार करें। साथ ही शोध एवं विकास संबन्धी उपलब्धियों को जन–जन तक पंहुचाने की दिशा में संस्थान द्वारा अंग्रेजी में प्रकाशित संस्थान की शोध उपलब्धियों की सफलता की कहानियों को हिंदी अनुवाद उपलब्ध कराएं ताकि अंतिम संपादन करके इसे प्रकाशित किया जाए। 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 विभिन्न प्रतियोगिताओं के विजेताओं को पुरस्कृत भी किया गया। मंच का संचालन संस्थान के हिंदी अधिकारी श्री संजय कुमार ने किया तथा प्रशासनिक अधिकारी श्री वीरेन्द्र लाम्बा ने धन्यवाद ज्ञापन प्रस्तुत किया।

विज्ञान के क्षेत्र में हिन्दी माध्यम से श्रेष्ठ कार्य के लिए पुरस्कार 2023–24

डा. उपेन्द्र शर्मा

हिन्दी लोकप्रियविज्ञान लेखन प्रतियोगिता

पुरस्कारः	प्रथम पुरस्कार	सुश्री मीनाक्षी रावत
	द्वितीय पुरस्कार	सुश्री दीपिका शर्मा
	तृतीय पुरस्कार	सुश्री जसबीर कौर

हिंदी टिप्पण लेखन प्रतियोगिता

पुरस्कारः	प्रथम पुरस्कार	श्रीमती पूजा अवस्थी
	द्वितीय पुरस्कार	श्री किरण कुमार
	तृतीय पुरस्कार	श्री बलदेव

हिंदी भाषण प्रतियोगिता

पुरस्कारः	प्रथम पुरस्कार	श्री प्रणव मिश्रा
	द्वितीय पुरस्कार	सुश्री दीक्षा जसरोटिया
	तृतीय पुरस्कार	श्री विवेक धीमान

हिन्दी टिप्पण प्रोत्साहन योजना के अन्तर्गत वर्ष 2023–24

1	श्री बोनी कुमार	प्रथम पुरस्कार
2	श्री मुकुल शर्मा	द्वितीय पुरस्कार
3	श्री पवित्र गाइन	तृतीय पुरस्कार

सीएसआईआर–आईएचबीटी में साहित्यिक परिचर्चा एवं महिला कवि सम्मेलन का आयोजनः सीएसआईआर दृहिमालय जैवसंपदा प्रौद्योगिकी संस्थान, पालमपुर में भाषा और संस्कृति विभाग हिमाचल प्रदेश और रचना साहित्य एवं कला मंच के सौजन्य से 10 दिसम्बर 2024 को साहित्यिक परिचर्चा एवं महिला कवि सम्मेलन का आयोजन किया गया। कार्यक्रम में मुख्यातिथि संस्थान के निदेशक डॉ. सुदेश कुमार यादव ने कहा कि साहित्य समाज का दर्पण है और भाषा और संस्कृति विभाग हिमाचल प्रदेश द्वारा आयोजित यह कार्यक्रम बहुत ही सार्थक पहल है। संस्थान भविष्य में भी विभाग और अकादमी के सहयोग से इस प्रकार के कार्यकमों को व्यापक स्तर आयोजित करना चाहेगा ताकि वैज्ञानिक, कर्मी एवं शोधछात्र भी इससे कुछ सीखें। संस्थान इन आयोजनों में हर संभव सहयोग करेगा।

कार्यक्रम के अध्यक्ष डॉ. सुशील कुमार फुल्ल ने विभाग ओर संस्थान का धन्यवाद किया और इच्छा प्रकट की कि रचना कला साहित्य मंच भविष्य में भी इस प्रकार के कार्यक्रमों को आयोजित करेगा। 'हिमाचल प्रदेश में हिंदी साहित्य में चित्रित समाज' विषय पर शोधपत्र डॉ. आशु फुल्ल ने प्रस्तुत किया, भाषा और संस्कृति विभाग हिमाचल प्रदेश और रचना साहित्य एवं कला मंच के सौजन्य से शोधपत्र पर चर्चा की गई जिसपर त्रिलोक मेहरा, पंकज दर्शी, भूपेन्द्र जम्वाल 'भूपी', राजीव त्रिगर्ती, गंगाराम राजी, प्रभात शर्मा, चिरानन्द आनन्द, कुशल कटोच, विक्रम गथानिया, कृष्ण चन्द्र महादेविया आदि विद्व ानों ने अपने अपने विचार प्रकट किए। सहायक निदेशक भाषा एवं संस्कृति विभाग हिमाचल प्रदेश सुरेश राणा ने मंच का संचालन किया और ज़िला भाषा अधिकारी कांगड़ा अमित गुलेरी भी इस अवसर पर मौजूद रहे। द्वि तीय सत्र में कवि सम्मेलन का आयोजन किया गया जिसमें रूपेश्वरी शर्मा ने पांचाली का अंतर्द्वंद्व कविता का वाचन किया। कमलेश सूद, सुमन शेखर, सुदर्शना भटेड़िया, सोनिया शर्मा, सुमन बाला, हरिप्रिया, डॉ. शिल्पी आदि ने भी अपनी अपनी रचनाओं से श्रोताओं को मंत्रमुग्ध किया। डॉ. अलका वत्स ने भजन प्रस्तुत किया जिसे सभागार में उपस्थित विद्यार्थियों ने खूब सराहा।

सम्मेलन में प्रतिभागिता एवं प्रस्तुतिकरण

- चतुर्थ अखिल भारतीय राजभाषा सम्मेलन, 14–15 सितम्बर 2024, भारत मंडपम, राजभाषा विभाग, भारत सरकार

- अमृतकाल में राष्ट्रीय वैज्ञानिक चेतना का उन्नयन , राष्ट्रीय हिंदी विज्ञान सम्मेलन, 30–31 जुलाई 2024, सीएसआईआर–एएमपीआरआई, भोपाल,

राष्ट्रीय हिंदी विज्ञान सम्मेलन में प्रस्तुतिकरण एवं प्रतिभागिता

आम लोगों, किसानों, उद्यमियों तक संस्थान के अनुसंधान कार्यों/उपलब्धियों/प्रौद्योगिकी को विभिन्न मीडिया जैसे समाचारपत्रों, पत्रिकाओं, रेडियो, दूरदर्शन, सोशल मीडिया के साथ–साथ विभिन्न प्रशिक्षण, कार्यशालाओं, कार्यक्रमों, संगोष्ठियों व प्रदर्शनी, वैज्ञानिक/तकनीकी विज्ञापन/पोस्टर सामग्री आदि के माध्यम से प्रचार–प्रसार भी संस्थान का लक्ष्य है।संस्थान द्वारा किये जा रहे शोध कार्यो को आम जनता तक पहुंचाने के उद्देश्य से विविध सामग्री/दस्तावेजों का अनुवाद, संपादन एवं प्रकाशन में सहयोग 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 तिमाही एवं वार्षिक 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।

राजभाषा विभाग, भारत सरकार एवं परिषद् मुख्यालय द्वारा समय–समय पर जारी निर्देशों के अनुरूप हिन्दी में कार्य करने के लिए उचित वातावरण बनाने और राजभाषा हिन्दी में मूल रूप से कार्य करने को प्रोत्साहित करने के लिए हिन्दी 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 17 हजार रुपये की 34 पुस्तकें खरीदी गई।

संस्थान के कार्मिकों का राजभाषा हिंदी ज्ञान संबंधी रोस्टर तैयार एवं अपडेट करना। नए कार्यभार ग्रहण करने वाले कर्मियों को निदेशक की ओर से राजभाषा हिंदी में कार्य करने के लिए व्यक्तिशः आदेश जारी किए गए। 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 राष्ट्रीय विज्ञान दिवस, स्वच्छता पखवाड़ा, सतर्कता जागरुकता सप्ताह, कौमी एकता सप्ताह, सद्भावना दिवस, जनजातीय दिवस, सीएसआईआर स्थापना दिवस, आईएचबीटी स्थापना दिवस, किसानों एवं उद्यमियों के लिए आयोजित प्रशिक्षण कार्यक्रमों, विभिन्न कार्यशालाओं / समारोहों के आयोजनों में सहयोग किया।

CSIR SKILL DEVELOPMENT PROGRAMS - JIGYASA - INCUBATION CENTRE - AcSIR - IMPORTANT EVENTS

CSIR-Institute of Himalayan Bioresource Technology organized various activities under the "Jigyasa-programme (Jigyasa 2.0 virtual laboratory) to motivate students towards science during 2024-25. A total of 9804 students and teachers from different schools (JNVs, KVs, State Govt. and Public schools) participated in different activities conducted throughout the year **(Table 1)**. They were exposed to various R&D activities (state-of-art facilities in the area of biotechnology, bioinformatics, agrotechnologies of commercially important crops, floriculture, natural product chemistry, synthetic chemistry, internationally recognised herbarium, remote sensing and mapping facilities, regulatory research facility, pilot plant for nutraceuticals, essential oil and herbals, etc. and other facilities) of the Institute through demonstrations, exhibitions, lectures, hands-on trainings, visits and outreach activities. Activities conducted under Jigyasa programme finds a place amongst the 42 success stories of the Institute as "JIGYASA"-Student-Scientist Connect.

Different activities under Jigyasa Programme

Table 1. Details of students and teachers participated in Jigyasa Programme

Sr. no.	Model of Engagement	Duration in days	Student Grade	No. of Teachers	No. of Students			
					KVS	NVS	State Govt. Schools	Other Schools
1	One Day Visits	01 (156 different schools)	1st to 12th	735	612	292	3302	645
2	Lab Specific Activities/ Onsite Experiments	03	10th to 12th	09	42	131	0	0
3	Visits of Scientists to schools/ Outreach Programme	14	6th to 12th	159	100	601	1330	1170
4	Popular Lecture Series	04	6th to 12th	36	216	0	67	244
5	Mentoring Programme for Adopted ATL schools	01	6th to 12th	04	50	0	0	0
6	Teachers' Workshop	01	-	05	0	0	0	0
7	Micro Research Projects for Students	01	12th	0	0	01	0	0
8	Exhibitions	01	1st to 12th	02	0	50	0	0
9	Innovation Programme	05	12th	0	0	0	0	01
Total				950	1020	1075	4699	2060

Apart from school students, this year, 1663 students and faculty members of various universities, institutes and colleges from 11 different states and UTs visited the Institute (Table 2).

Sr. No.	Name of College / University/ Institute	Date	No. of Students	No. of Faculties
1	BBAU, Lucknow (UP)	03.04.2024	47	03
2	RVS College of Horticulture (TN)	03.04.2024	74	03
3	University of Lucknow (UP)	05.04.2024	13	04
4	Shaheed Kartar Singh Sarabha Ayurvedic Medical College Sarabha, Ludhiana (PB)	25.04.2024	43	02
5	Indo-Swiss Training Centre, CSIR-CSIO, Chandigarh	30.04.2024	58	04
6	Eternal University, Baru Sahib, Sirmour (HP)	21.05.2024	45	06
7	MCM DAV College, Kangra (HP)	21.05.2024	40	02
8	CSKHPKV, Palampur, Distt. Kangra (HP)	24.06.2024	31	01
9	Eternal University, Baru Sahib, Distt. Sirmour (HP)	08.07.2024	14	03
10	Govt. Degree College, Takipur, Distt. Kangra (HP)	30.08.2024	12	02
11	PCTE Group of Institutes, Ludhiana, (PB)	03.09.2024	24	02
12	Graphic Era Deemed to be University, Dehradun (UK)	10.09.2024	43	02
13	KDC Govt. College, Jaisinghpur, Distt. Kangra (HP)	12.09.2024	44	06
14	Govt. Arya College, Nurpur, Distt. Kangra (HP)	20.09.2024	90	05

Sr. No.	Name of College / University/ Institute	Date	No. of Students	No. of Faculties
15	ABV Govt. Degree College Sunni, Shimla (HP)	09.10.2024	31	04
16	Guru Jambheshwar University of Science & Technology, Hisar (HR)	17.10.2024	46	04
17	Panjab University, Chandigarh	21.10.2024	44	02
18	University of Rajasthan, Jaipur (RJ)	22.10.2024	21	06
19	Sardar Patel University, Mandi (HP)	25.10.2024	34	01
20	Central University of Jammu (J&K)	07.11.2024	53	02
21	Saraswati Ayurvedic College, Mohali (PB)	18.11.2024	31	03
22	Govt. Degree College, Lanj, Distt. Kangra (HP)	22.11.2024	08	02
23	NIFTEM (HR)	26.11.2024	19	01
24	Panjab University, Chandigarh	29.11.2024	18	01
25	SCVB Govt. Degree College, Palampur, Distt. Kangra (HP)	10.12.2024	30	01
26	Govt. Collge Naura, Distt. Kangra (HP)	10.12.2024	03	00
27	Govt. PG College Dharamshala, Distt. Kangra (HP)	13.12.2024	23	02
28	NIT Hamirpur & MANUU Hyderabad (TG)	24.12.2024	65	10
29	MCM DAV College, Distt. Kangra (HP)	27.01.2025	38	03
30	MCM DAV College, Distt. Kangra (HP)	28.01.2025	42	02
31	PCTE Group of Institutes, Ludhiana (PB)	31.01.2025	48	02
32	Prof. N. R. Madhva Menon, Interdisciplinary Centre for Research and Ethics and Protocol, Cochin University of Science, Kochi, Kerela (KL)	11.02.2025	10	01
33	RGM Govt. Degree College, Jogindernagar, Distt. Mandi (HP)	20.02.2025	14	03
34	JUIT University, Solan (HP)	24.02.2025	41	03
35	GGDSD College, Rajpur, Distt. Kangra (HP)	24.02.2025	33	04
36	DBS Global University, Dehradun (UK)	04.03.2025	34	03
37	CGC Landran, Mohali (PB)	07.03.2025	49	03
38	KMS College of IT & Management, Dasuya (PB)	17.03.2025	35	04
39	Central University of Himachal Pradesh (HP)	12.03.2025	61	03
40	Hans Raj Mahila Mahavidyalaya, Jalandhar (PB)	17.03.2025	35	02
41	PCTE Group of Institutes, Ludhiana (PB)	18.03.2025	53	02
42	Doaba College, Jalandhar (PB)	28.03.2025	40	07
	Total		**1537**	**126**

Under CSIR-Integrated Skill Initiative Phase-II programme, trained 320 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	Male	Female	Urban	Rural	Reserved	General
1	29.05.2024-31.05.2024	Hands-on training in gene cloning and sequencing	10	1	9	10	0	3	7
2	07.05.2024-06.06.2024	Gardener Training	8	8	0	8	0	4	4
3	03.06.2024-28.07.2024	Plant Tissue Culture Technician (Batch-I)	9	5	4	3	6	6	3
4	03.06.2024-02.07.2024	Gujarat State Biotechnology Mission (GSBTM) under summer research internship program	9	6	3	8	1	3	6
5	01.07.2024 05.07.2024 & 08.07.2024-12.07.2024	Hands-on training cum exposure visit to agro and process technologies of floriculture, aromatic, medicinal, spices and plantation crops	52	24	28	52	0	36	16
6	02.09.2024-01.11.2024	Plant Tissue Culture Technician (Batch-II)	2	1	1	1	1	0	2
7	27.11.2024-29.11.2024	Hands-on training on molecular biology techniques	16	4	12	11	5	7	9
8	06.01.2025-10.01.2025	Hands-on training cum exposure visit to agro and process technologies of floriculture, aromatic, medicinal, spices and plantation crops	24	13	11	24	0	12	12
9	10.03.2025-09.05.2025	Plant Tissue Culture Technician (Batch-III)	1	1	0	0	1	1	0
10	April, 2024-March, 2025	Research Internship/ Project work	189	47	142	102	87	57	132
Total			**320**	**110**	**210**	**219**	**101**	**129**	**191**




Details of interns/ tranees at CSIR-IHBT, Palampur

Institute is providing trainings to Graduate/ Post Graduate/ Ph.D. students from different Institutes, Universities and affiliated colleges. This year, 189 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 2)**.

Table 2 Details of research internship/ training imparted at CSIR-IHBT (April, 2024 to March, 2025)

S. No	Student Name	Affiliation	Course	Duration (months)	Supervisor	Title of certificate
1	Ms. Reetika Sharma	MCM DAV College Kangra (Passout)	M.Sc. Chemistry	3	Dr. Upendra Sharma	Plant based natural product chemistry: Exploring photochemistry of medicinal and aromatic plants
2	Ms. Nisha Bhati	Lachoo Memorial College of Science & Technology, Jodhpur	M.Sc. Biotechnology	3	Dr. Rohit Joshi	Physiological, biochemical and molecular analysis of different elicitors on *in-vitro* grown *Picrorhiza kurrooa* plants
3	Mr. Dhruv Agrawal	Vellore Institute of Technology, Tamil Nadu	B.Tech. Biotechnology	3	Dr. Ashish Warghat	Practical exposure of tissue culture techniques and soilless cultivation of medicinal plants
4	Ms. S. Vaishnavi	Vellore Institute of Technology, Tamil Nadu	M.Sc. Int. Biotechnology	9	Dr. Vivek Dogra	Decoding the mechanism of chloroplast triggered programmed cell death
5	Mr. Mohammad Sahil Khan	University of Allahabad, UP	M.Sc. Bioinformatics	4	Dr. Ravi Shankar	Unraveling the molecular responses to abiotic stress in Arabidopsis thaliana through transcriptomics data analysis using WGCNA and Bayesian Network modelling approach
6	Ms. Sunanda Jassal	Pajnab University (Passout)	M.Sc. Biochemistry	3	Dr. Ram Kumar Sharma	Genomic techniques for plant diversity characterization

S. No	Student Name	Affiliation	Course	Duration (months)	Supervisor	Title of certificate
7	Ms. Vanshika Thakur	HPU, Shimla (H.P.)	M.Sc. Microbiology	3	Dr. Shiv Shankar Pandey	Basic techniques in plant biotechnology and microbiology
8	Ms. Shreya Sharma	CSKHPKV, Palampur, HP	B.Tech. Food Science	4	Dr. Mahesh Gupta	Development of pomegranate bar incorporated with dietary fibre from edible flower residue
9	Ms. Priyanka Kaundal	CCP, Landran, Mohali (Pb)	M. Pharmacy	5	Dr. Ankit Saneja	Investigation of cytotoxicity of formononetin formulations
10	Mr. Prashant Kumar Dhangar	Chandigarh University, Mohali, Punjab	M.Sc. Bioinformatics	5	Dr. Ravi Shankar	Employing Deep-Learning for Reliable miRNA Target Identification in Plants
11	Ms. Anchal Sharma	Rayat Institute of Pharmacy, Rail Majra (Punjab Technical University)	M.Pharm (Pharamaceutical Chemistry)	3	Dr. Pamita Bhandari	Isolation and characterization of Berberine in *Thalictrum foliolosum*
12	Ms. Ankita	Rayat Institute of Pharmacy, Rail Majra (Punjab Technical University)	M.Pharm (Pharamaceutical Chemistry)	3	Dr. Pamita Bhandari	Enrichment of polyphenolic fractions from the waste of Marigold flower
13	Mr. Harish B M	CSKHPKV Palampur (H.P.)	Ph.D.	1	Dr. Rohit Joshi	Hands-on training on advanced tools and techniques of plant tissue culture and plant transformation
14	Ms. Dhanlakshmi	Amrita Vishw Vidyapeetham, Kerala	M.Sc. Bioinformatics	5	Dr. Ravi Shankar	Comparative assessment of software tools for gene regulation studies in plants
15	Ms. Kritika Kumawat	Jaipur National University, Jaipur, (RJ)	B.Tech (Biotechnology	5	Dr. Kunal Singh	Understanding the developmental dynamics utilization the comparative transcriptomics and metabolomics studies in small and large corms of *Crocus sativus*
16	Mr. Adarshjit Das	Symbiosis School of Biological Science, Symbiosis International University, Pune, Maharashtra	M.Sc. Biotechnology	4	Dr. Arun Kumar	Heterologous expression, purification, and bio-chemical characterization of superoxide dismutase
17	Ms. Rupali Gupta	CSKHPKV, Palampur, Himachal Pradesh	B.Sc. (Hons.) Community Science	3	Dr. Mahesh Gupta	Characterization of pearl millet and finger millet to access the nutritional, functional and physico-chemical properties for the development of millets spread
18	Mr. Amit Raj	CSKHPKV, Palampur, Himachal Pradesh	B.Sc. (Hons.) Community Science	3	Dr. Mahesh Gupta	Characterization and value addition of cauliflower greens
19	Mr. Madhukar Prabhash	Translam Institute of Pharmaceuical Ed. & Research, Meerut (U.P.)	M. Pharmacy	6	Dr. Upendra Sharma	Synthesis of N-heterocyclic scaffolds and their *in-silico* evaluations
20	Ms. Prerna Gupta	Banasthali Vidyapith, Rajasthan	M.Sc. Bioinformatics	5	Dr. Ravi Shankar	Employing deep-learning for accurate identification of RBPs and their RNA interactions in human

S. No	Student Name	Affiliation	Course	Duration (months)	Supervisor	Title of certificate
21	Ms. Shiwangi Bharti	JECRC, University, Jaipur	B.Sc. Microbiology	4	Dr. Aparna Maitra Pati	Exploring Bioremediation Potential of Plant Growth Promoting Rhizobacteria
22	Ms. Pardeep Kaur	Chandigarh University, Mohali, Punjab	M.Sc. Int. Biotechnology	5	Dr. Vidyashankar Srivatsa	Nutritional, Functional & Sensory Characterization of Chlorella Fortified Instant Pasta Formulations
23	Ms. Rashika Parmar	Chandigarh Universtiy, Mohali, Punjab	M.Sc. Microbiology	5	Dr. Aparna Maitra Pati	Exploration of bacteria from agro-waste for hydrolytic and PGPR activities
24	Ms. Siddhi Pandey	Chandigarh University, Mohali, Punjab	M.Sc. Bioinformatics	6	Dr. Ravi Shankar	Employing Dense Net Deep-Learning for identification of plant lncRNAs
25	Mr. Pradeep Singh	Shoolini University, Solan, Himachal Pradesh	M.Tech. Biotechnology	4	Dr. Amitabha Acharya	Synthesus, characterization and evaluation of antimicrobial efficacy of copper nanoparticals
26	Ms. Rashmi Sharma	Chandigarh University, Mohali, Punjab	M.Sc. Chemistry	5	Dr. Pamita Bhandari	Isolation and characterization of specialized metabolites from Swertia purpurascens
27	Ms. Angel Thakur	Chandigarh University, Mohali, Punjab	M.Sc. Biotechnology	6	Dr. Ram Kumar Sharma	Genomic approaches for plant diversity characterization and management
28	Ms. Surya Suresh	Kerela Institute of Digital Science and Technology, kerala	M.Sc. Data Analysis and Bio AI	5	Dr. Ravi Shankar	Integrative approaches for plant repeat discovery: leveraging deep learning, homology, and *De novo* based methods
29	Ms. Simran Ganjoo	Chandigarh University, Mohali, Punjab	M. Sc. Bioinformatics	6	Dr. Rituraj Purohit	Exploring Phycocyanin: Structural insights and interaction analysis of Phycocyanobilin with Bovine Beta Lactoglobulin
30	Ms. Kanika Chauhan	Chandigarh University, Mohali, Punjab	M.Sc. Bioinformatics	6	Dr. Vishal Acharya	Leveraging deep learning approaches for virulence factors prediction in Human-Fungal interactions
31	Ms. Mahesh Dahiya	Chaudhary Devilal University, Sirsa (HR)	M.Sc. Biotechnology	1	Dr. Poonam Kumari	Effect of herbal extracts on vase life of Gladiolus (*Gladiolus hybridus*)
32	Ms.Anshika Sood	Chandigarh University, Mohali, Punjab	B.Tech. Biotechnology	1	Dr. Vivek Dogra	Fundamental techniques in molecular biology
33	Ms. Gargi	Manipal Universtiy, Jaipur, Rajasthan	M. Sc. Biotechnology	1	Dr. Vivek Dogra	Basic techniques in molecular biology
34	Ms. Kusum Parmar	Career Point University, Hamirpur, Himachal Pradesh	M. Pharmacy	12	Dr. Upendra Sharma	Phytochemical investigation and Biological activity evaluation of *Ageratum conyzoides* Linn.
35	Ms. Neha Thakur	Career Point University, Hamirpur, Himachal Pradesh	M. Pharmacy	12	Dr. Dinesh Kumar	Phytochemical & Therapeutic potentials of *Urtica dioica*
36	Ms. Tania	BBK Dav College For Women, Amritsar	B.Sc. biotechnology	1	Dr. Sanatsujat Singh	Micropropagation of Chrysanthemum

S. No	Student Name	Affiliation	Course	Duration (months)	Supervisor	Title of certificate
37	Ms. Tanya Mahajan	BBK Dav College For Women, Amritsar	B.Sc. Biotechnology	1	Dr. Sanatsujat Singh	Micropropagation of Stevia
38	Ms. Tanu	Hans Raj Mahila Maha Vidyalaya (HMV) College, Jalandhar	B.Sc. Biotechnology	1	Dr. Rohit Joshi	*in-vitro* micropropagation, morphological, physiochemical and molecular analysis of *Lavandula officinalis*: An important aromatic medicinal shrub
39	Ms. Ankita Singh	Geetanjali Institute of Pharmacy, Udaipur, Geetanjali Universtiy	M. Pharmacy	6	Dr. Vikram Patial	Acute and sub-acute oral toxicity studies of a natural sweetener (IHBT-VP15) in rats
40	Ms. Preety	Chandigarh Group of College (CGC) Landran, Mohali	M.Sc. Biotechnology	6	Dr. Vipin Hallan	Screening of different species and cultivars of Cucumis spp. for tomato leaf curl Palampur virus infection and disease development
41	Ms. Palak Das	Chandigarh University, Mohali, Punjab	M. Sc. Biotechnology	6	Dr. Ashish Warghat	Exploring plant tissue culture and soilless farming techniques for sustainable biomass production of *Picrorhiza kurroa*
42	Ms. Sakshi Kashyap	Chandigarh University, Mohali, Punjab	M. Sc. Biotechnology	6	Dr. Vivek Dogra	Physiological and molecular responses of plants towards heat stress
43	Ms. Rishi Sharma	Sant Baba Bhag Singh University, Jalandhar	M.Sc. Medical Microbiology	6	Dr. Aparna Maitra Pati	Plant growth promoting Rhizobacteria mediated heavy metal bioremediation
44	Ms. Deeksha	CT Institute of Pharmaceutical Science, Jalandhar	M.Sc. Biotechnology	6	Dr. Rohit Joshi	Effect of different elicitors on *in vitro* mass propagation of *Nardostachys jatamansi* and *in silico* characterisation of RBOH & bHLH family genes
45	Ms. Ritika Gupta	Chandigarh University, Mohali, Punjab	M. Sc. Biotechnology	6	Dr. Shashi Bhushan	Development of *in-vitro* propagation systems and establishment of hairy root culture cultures for secondary metabolites production
46	Mr. Mohak Mali	Bhupal Nobles' College of Pharmacy, Udaipur, Rajasthan	M. Pharmacy	6	Dr. Ankit Saneja	Synthesis, characterization and anti-cancer efficacy of Formononetin conjugate
47	Ms. Shanvi Katoch	Chandigarh University, Mohali, Punjab	M.Sc. Biotechnology	5	Dr. Jeremy Dkhar	Effect of varying nutrient conditions on seed germination of Kala Jeera (*Bunium persicum*)
48	Ms. Shailja Sharma	Amity University, Noida	B.Tech.+ M.Tech. Biotchnology (Integrated)	2	Dr. Ram Kumar Sharma	Basic Plant DNA Fingerprinting techniques
49	Ms. Kratika Agarwal	Amity University, Noida	M.Sc. Biotechnology	1.5	Dr. Shashi Bhushan	*In vitro* induction and multiplication of important Himalayan medicinal plants

S. No	Student Name	Affiliation	Course	Duration (months)	Supervisor	Title of certificate
50	Mr. Priyanshu	NIT Hamirpur (HP)	B.Tech. Chemical Engineering	1.5	Dr. Dinesh Kumar	Experiential learning on Analytical techniques (UPLC-PDA, LC-MS/MS), Column chromatography, Phyto-nanosponge, and herbal soap
51	Ms. Ashvit Dogra	IISER Mohali	BS-MS	2	Dr. Parlay Das	Chemical conversion, isolation and characterization of carbohydrates to furanic compounds
52	Ms. Eva Kapoor	Chandigarh University, Mohali, Punjab	M.Sc. Botany	1.5	Dr. Satbeer Singh	Biotechnological and classical techniques in crop breeding
53	Ms.Shaina	Chandigarh University, Mohali, Punjab	M.Sc. Botany	1.5	Dr. Satbeer Singh	Techniques to generate and assess genetic variation for crop improvement
54	Ms. Surya Nidhi	Chandigarh University, Mohali, Punjab	M.Sc. Botany	1.5	Dr. Bhavya Bhargava	Basic techniques in soilless cultivation and plant tissue culture
55	Ms. Shreya Thakur	DAV College Chandigarh	B.Sc. (Hons.) Biotechnology	1	Dr. Vipin Hallan	The role of host factors (CCCH and HB-18) during CMV infection
56	Ms. Sumil	Chandigarh University, Mohali, Punjab	M.Sc. Botany	1.5	Dr. Sanatsujat Singh	Molecular techniques and micropropagation for crop improvement
57	Mr. Prashant Kumar	SRM Rampuram, Chennai, Tamil Nadu	B.Tech. CSE	1	Dr. Ravi Shankar	Understanding the fundamentals of Linux OS
58	Ms. Khushi Dhiman	Panjab University, Chandigarh	M.Sc. Human Genomics	1	Dr. Yogendra Padwad	Advanced techniques in nucleic acid isolation and sequencing
59	Ms. Anshika	Khalsa College of Pharmacy, Amritsar	B. Pharmacy	1	Dr. Dinesh Kumar	Hands-on training for chromatography (column chromatography and Ultra-performance liquid chromatography
60	Ms. Avni Sood	Jamia Hamdard, New Delhi	B. Pharmacy	1	Dr. Dinesh Kumar	Hands-on training for chromatography (column chromatography and Ultra-performance liquid chromatography)
61	Ms. Tanisha Khandelwal	Chandigarh University, Mohali, Punjab	M.Sc. Biotechnology	1	Dr. Damanpreet Singh	Hands-on training in animal handling and molecular biology techniques used in experimental pharmacology
62	Ms. Simran Duggal	Manipal Universtiy, Jaipur	M.Sc. Biotechnology	1	Dr. Shiv Shankar Pandey	Basic techniques in recombinant DNA technology
63	Mr. Avek Singh Halla	Jaypee University of Information Technology, Solan	M.Sc. Biotechnology	1	Dr. Rohit Joshi	Micropropagation, phytochemical analysis and molecular studies in *Picrorhiza kurrooa* Royle ex Benth
64	Ms. Gunika Sharma	IISER Berhampur, Odisha	BS-MS Integrated	1	Dr. Arun Kumar	Heterologous expression and purification of an antimicrobial protein
65	Mr. Manan Punj	Dr. B. Lal Institute of Biotechnology, Rajasthan	B.Sc. Biotechnology	1	Dr. Rohit Joshi	Studies on organogenesis and profiling of phytochemical and molecular architecture of *in vitro* developed *Nardostachys Jatamansi* (D.Don) DC

S. No	Student Name	Affiliation	Course	Duration (months)	Supervisor	Title of certificate
66	Ms. Kirti Pathania	Thapar Institute of Enjineering & Technology, Patiala	M.Sc. Biotechnology	1	Dr. Rohit Joshi	*In-vitro* studies on morphological, phytochemical and molecular profiling of winged prickly ash (*Zanthoxylum armatum* DC.) an important medicinal plant of Himalayan region
67	Ms. Reetika Sharma	Thapar Institute of Enjineering & Technology, Patiala	M.Sc. Biotechnology	1	Dr. Ashish Warghat	Hands-on training of plant tissue culture on Mulberry
68	Ms. Aishwarya	Gautam Buddha University, Greater Noida	M.Sc. Biotechnology	1	Dr. Aparna Maitra Pati	Isolation and Characterization of PGPR
69	Mr. Pushpak P	Tontodarya College of Engineering (Passout)	B.E. Mechnical Engineering	1	Dr. Rohit Joshi	Basic training in plant tissue culture & *in-vitro* propagation techniques in saffron (*Crocus sativus* L.) and other commercially important plants
70	Ms. Akriti Sood	Shoolini University, Solan, Himachal Pradesh	M.Sc. Microbiology	1	Dr. Arun Kumar	Heterologous expression and purification of an antimicrobial protein
71	Ms. Kiran	Chandigarh Group of College (CGC) Landran, Mohali	M.Sc. Biotechnology	6	Dr. Shiv Shankar Pandey	Molecular characterization of transgenic tea plants transformed with CRISPR Cas9 vector and protoplast isolation from tea *[Camellia sinensis* (L.) O. Kuntze]
72	Ms. Harshita Koli	GHG Khalsa College of Pharmacy, Ludhiana	M. Pharmacy	6	Dr. Damanpreet Singh	*In-vivo* efficacy evaluation of IHBT-PG-003 in a zebrafish model of high-fat-diet induced cognitive impairments
73	Ms. Sukhmanpreet Kaur	Khalsa College of Pharmacy, Amritsar	B. Pharmacy	1	Dr. Damanpreet Singh	Hands-on Basic Techniques used in Experimental Pharmacology
74	Ms. Kanishka Verma	Bennett University, Noida	B.Tech. Biotechnology	2	Dr. Amitabha Acharya	Evaluation of antibacterial activity of the prepared nanoemulsion
75	Mr. Ravish Kumar	Lovely Professional University (LPU), Jalandhar	M.Sc. Biotechnology	1.5	Dr. Arun Kumar	Hands-on training in gene cloning and genetic transformation
76	Mr. Vishal	Punjab Agricultural University, Ludhiana (Passout)	M.Sc. Biotechnology	6	Dr. Gaurav Zinta	Molecular cloning and generation of overexpression lines to enhance thermotolerance in potato *(Solanum tuberosum* L.)
77	Ms. Rhitorbi Sengupta	Indian Institute of Technology (IIT), Kharagpur	M.Tech. Agricultural Sytems & Management	3	Dr. Gaurav Zinta	Implementing physiological, biochemical, transcriptional and molecular tools to dissect heat stress response in C3 plants
78	Ms. Abhilasha Thakur	Lovely Professional University (LPU), Jalandhar	M.Sc. Biotechnology	1.5	Dr. Jeremy Dkhar	Hands-on training in plant tissue culture and molecular biology techniques

S. No	Student Name	Affiliation	Course	Duration (months)	Supervisor	Title of certificate
79	Ms. Shagun Katoch	PSR Govt. College, Baijnath (Himachal Pradesh)	B.Sc. (Hons.) Biotechnology	1	Dr. Rohit Joshi	*In-vitro* multiplication, phytochemical and molecular analysis of monk fruit (*Siraitia grosvenorii* (Swingle) C. Jeffrey: A non-caloric natural sweetener
80	Ms. Shreya	PSR Govt. College, Baijnath (Himachal Pradesh)	B.Sc. (Hons.) Biotechnology	1	Dr. Rohit Joshi	Micropropagation, biochemical and molecular analysis of giant bamboo *Dendrocalamus asper* (Schult f.) Backer ex Heyne: An exotic edible crop
81	Mr. Akshay Kumar	Shoolini University, Solan, Himachal Pradesh	B.Tech. Biotechnology	1.5	Dr. Yogendra Padwad/ Dr. Mohit Swarnkar	Modern techniques involved in nucleic acid sequencing and isolation
82	Ms.Akshita Parmar	Shoolini University, Solan, Himachal Pradesh	B.Tech. Biotechnology	1.5	Dr. Yogendra Padwad/ Dr. Mohit Swarnkar	Understanding isolation and next generation sequencing for nucleic acids
83	Ms. Gauri Sood	IISER, Mohali	BS-MS (Integrated)	2	Dr. Vivek Dogra	Fundamental techniques in molecular biology
84	Ms. Shikha Kumari	Central Research Institute, Kasauli, Solan (Passout)	M.Sc. Microbiology	6	Dr. Dharam Singh	Molecular and biochemical investigation of cellulolytic extremozymes from Himalayan bacteria
85	Ms. Riya Joshi	Graphic Era University, Dehradun	M.Sc. Biotechnology	6	Dr. Rajiv Kumar	Molecular cloning of C-Repeat Blinding Factors (CBFs) genes from *Picrorhiza kurroa*
86	Ms. Radhika	JC DAV College Dasuya, Punjab (Passout)	B.Sc. Hons. Biotechnology	2	Dr. Vandana Jaiswal	Hands-on experience inbasic molecular biology techniques
87	Mr. Keshav Bhardwaj	IIT Mandi (Pasout)	PH.D. Nanobiotechnology	3	Dr. Narendra Vijay Tirpude	Protective synergistic effect of ALA and SDG against rheumatoid arthritis by inhibiting NLRP3 inflammasome activation and NF-κ B/ p38 signaling pathway in LPS stimulated RAW 264.7 and SW982 cells
88	Ms. Bareera Khan	Shoolini University, Solan, Himachal Pradesh	PH.D. (Biotechnology)	1	Dr. Yogendra S. Padwad	*In-vitro* cell viability and cellular uptake studies using PC-12 and CaCo-2 cell lines
89	Ms. Bharti Gautam	Amity University, Punjab	B.Sc. Human Genetics & molecular Medicine	1	Dr. Vikram Patial	Hands-on training in preclinical models, histopathology and molecular techniques
90	Mr. Eklavya Chauhan	Niser, Bhubaneswar, Odisha	M.Sc. Integrated	1	Dr. Arun Kumar	Hands-on trainig in gene cloning and genetic transformation
91	Ms. Parul Deshwal	Panjab University, Chandigarh	M.Sc. (Hons.) Microbiology	1	Dr. Gaurav Zinta	Molecular biology tools and techniques
92	Ms. Nitika Sharma	Panjab University, Chandigarh	M.Sc. (Hons.) Microbiology	1.5	Dr. Rajiv Kumar	Hands on training on biotechnological tools
93	Ms. Shaivi Dogra	Guru Nanak Dev University, Amritsar	M.Sc. Biotechnology	2	Dr. Shashi Bhushan	Histological studies to ascertain somatic embryogenesis in *in vitro* cultures of *Arnebia*
94	Ms. Ritika	IISER, Tirupati, AP	BS-MS (Integrated)	2.5	Dr. Rajiv Kumar	Hands-on training in Molecular Biology techniques

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95	Ms. Bhawana Kumari	Graphic Era (Deemed to be University) Dehradun	M.Sc. Biotechnology	6	Dr. Rajesh Kumar Singh	Deciphering the role of APETALA genes in flower development in saffron
96	Ms. Shivani	Graphic Era (Deemed to be University) Dehradun	M.Sc. Biotechnology	6	Dr. Aparna Maitra Pati	Exploring the plant growth potential of endophyte and AMF in wheat
97	Ms. Jyothi	Graphic Era (Deemed to be University) Dehradun	M.Sc. Biotechnology	6	Dr. Vidyashankar Srivatsan	Maximizing growth and productivity of microalga Chlorella pyrenoidosa for high value compounds
98	Mr. Naval Kumar	Shoolini University, Solan, Himachal Pradesh	B.Sc. Microbiology Research	2	Dr. Vidyashankar Srivatsan	Nutritional quality evaluation of wild edible plants of Western Himalayas
99	Mr. Umang Dhingra	Shoolini University, Solan, Himachal Pradesh	B.Sc. (Hons.) Biotechnology	2	Dr. Vidyashankar Srivatsan	Nutritional quality evaluation of wild edible plants of Western Himalayas
100	Mr. Divanshu	Panjab University, Chandigarh	B.E. (IT)	1	Dr. Vishal Acharya	In-house scripting for improved image feature extraction in MRI patient samples
101	Ms. Chirag Kaushal	Kanya Maha Vidyalaya (KMV) Jalandhar	B.Sc. Biotechnology	1	Dr. Bhavya Bhargava	Methods and techniques of plant tissue culture
102	Mr. Gaurav Sharma	Guru Nanak Dev University, Amritsar	M.Sc. Biotechnology	2	Dr. Yogendra Padwad	Cellular and molecular biology techniques in anti-obesity lead optimization.
103	Ms. Ashruti	Hemvati Nandan Bahuguna Garhwal University, (UK)	M.Sc. Biotechnology	6	Dr. Yogendra Padwad	Animal cell culture and molecular biology techniques involved to study fibrosis in human pulmonary artery adventitious fibroblasts
104	Ms. Sonam	Kurukshetra University, Kurukshetra	M.Sc. Microbiology	3	Dr. Vipin Hallan	Application of Red Seaweed formulation in control of Tomato Leaf Curl Palampur Virus
105	Ms. Neha Ganeriwal	Birla Institute of Technology, Jaipur	M.Sc. Bioinformatics & Computational Biology	2.5	Dr. Ravi Shankar	Rice transcriptome alteration caused by Black Streaked Dwarf Virus
106	Ms.Vishishtaa Pandit	Birla Institute of Technology, Jaipur	M.Sc. Bioinformatics & Computational Biology	2.5	Dr. Ravi Shankar	Detecting the differential binding patterns of plant transcription factor's splice variants using PTFSpot and PTF-Vāc systems
107	Ms. Jhanvi Sandal	Punjab Agricultural University, Ludhiana	B.Tech. Biotechnology	1.5	Dr. Rohit Joshi	Phytochemical analysis and genetic engineering studies on micropropagated Himalayan medicinal plants
108	Mr. Kavish Bedi	Thapar Institute of Enjineering & Technology, Patiala	B.Tech. Biotechnology	2.5	Dr. Vipin Hallan	Modulation of secondary metabolite biosynthesis genes in contents in *Catharanthus roseus* mediated by Tomato Leaf Curl Palampur virus (ToLCPalV)
109	Ms. Bindu Pal	Dr. Hari Singh Gour Central University Sagar (MP)	M.Sc. Botany	4	Dr. Amit Chawla	Eco-physiological techniques for studying plant adaptation strategies of plants

S. No	Student Name	Affiliation	Course	Duration (months)	Supervisor	Title of certificate
110	Mr. Shubham Sen	St. Thomas College, Bhilai, MP	M.Sc. Biotechnology	6	Dr. Gaurav Zinta	Study on physio-biochemical analysis of plant responses to temperature rise and molecular cloningof thermoresponsive gene *AtMYB44*
111	Ms. Garima Sharma	Guru Nanak Dev University, Amritsar	M.Sc. Chemsitry (FYIC USHS)	1	Dr. Upendra Sharma	Basic of practical organic synthesis
112	Mr. Nikhil Thakur	Dr. YS Parmar University of Horticulture & Forestery, Nauni, Solan (Passout)	Ph.D. Vegitable Sciences	3	Dr. Vandana Jaiswal	Learning the basic techniques in the area of plant molecular biology
113	Ms. Riya Amit Chhabra	Panjab University, Chandigarh	B.Sc. Hons. Chemistry	2	Dr. Vivek Dogra	Basic techniques in molecular biology
114	Mr. Shubham Thakur	Shoolini University, Solan, Himachal Pradesh	M.Sc. Biotechnology	1	Dr. Ashish Warghat	Practical exposure of basic plant tissue culture techniques
115	Ms. Shiny Rajpoot	Shoolini University, Solan, Himachal Pradesh	M.Sc. Biotechnology	2	Dr. Aparna Maitra Pati	Exploring th PGP Traits of rhizobacteria and assessing bioremediation potential
116	Mr. Mridul Dhiman	Dr. YS Parmar University of Horticulture & Forestry, Nauni, Solan	MBA Agirbuisiness and Management	1.5	Dr. Sukhjinder Singh	Techno-economic viability and agreements practice of Marigold (Ornamental), Wild Marigold (Aromatic), and Lemon-grass (Aromatic)
117	Mr. Davinder Kumar	CT Institute of Pharmaceutical Science, Jalandhar	B.Sc. Biotechnology	2	Dr. Bhavya Bhargava	Basic methods and techniques in soilless farming, plant tissue culture and molecular biology
118	Ms. Shivani	Career Point University, Hamirpur	M.Sc. Microbiology	2	Dr. Sarita Devi	Hands-on training for various microbiological techniques
119	Ms. Rakhi	Sri Sai University, Palampur	BBA (HR & Finance)	1.5	Dr. Sukhjinder Singh	Entrepreneurship development thorugh nurturing ideas of Startups
120	Ms. Tanisha Korla	CT Institute of Pharmaceutical Science, Jalandhar	B.Sc. Biotechnology	3	Dr. Gireesh Nadda	Molecular identificatioon and multiplication of industrially important fungus
121	Ms. Rajani Devi	CT Institute of Pharmaceutical Science, Jalandhar	B.Sc. Biotechnology	2	Dr. Rohit Joshi	*In vitro* propagation of medicinal plants and their biochemical and molecular profiling with respect to different physiochemical processes
122	Mr. Bhavesh Maan	UIET, Kurukshetra University, Haryana	B.Tech. Biotechnology	2	Dr. Rajesh Kumar Singh	Molecular cloning and characterization of Trehalose-6-transformation in *Arabidopsis thaliana*
123	Mr. Ayush Pandita	UIET, Kurukshetra University, Haryana	B.Tech. Biotechnology	2	Dr. Vivek Dogra	Molecular techniques in plant biology
124	Ms. Kavita Rana	Career Point University, Hamirpur	M.Sc. Microbiology	2	Dr. Sarita Devi	Hands-on training for various microbiological techniques
125	Mr. Pratham Chandel	Shoolini University, Solan, Himachal Pradesh	B.Tech Biotechnology	3	Dr. Rohit Joshi	Morphological, physiochemical and molecular characterization during different stages of micropropagation

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126	Mr. Deepanshu Banyal	Maharaja Agrasen University, Solan, Himachal Pradesh	M.Sc. Biotechnology	2	Dr. Gaurav Zinta	Morphological and biochemical responses of grain amaranthus species to heat stress
127	Ms. Samridhi	Maharaja Agrasen University, Solan, Himachal Pradesh	M.Sc. Biotechnology	2	Dr. Gaurav Zinta	Screening and genotyping of T-DNA insertion hsfa2 mutants of *Arabidopsis thaliana*
128	Mr. Rajdeep Singh Bhullar	Guru Nanak Dev University, Amritsar	M.Sc. Biotechnology	2	Dr. Rajesh Kumar Singh	Molecular cloning of small Auxin Up-regulated RNA (SAUR) gene of *Crocus Sativus* L. using advanced molecular techniques and its transformation in Arabidopsis
129	Ms. Navpreet Kaur	Guru Nanak Dev University, Amritsar	M.Sc. Biotechnology	2	Dr. Arun Kumar	Cloning, heterologous expression and purification of recombinant protein
130	Ms. Vijeta	Dr. YS Parmar University of Horticulture & Forestry, Nauni, Solan (Passout)	Ph.D. Plant Pathology	1	Dr. Vipin Hallan	Techniques in molecular plant biology
131	Mr. Aman Bansode	Govt. VYT PG Autonomous College, Durg, Chattisgarh	M.Sc. Microbiology	3	Dr. Mahesh Gupta	Study the nutritional and fermentation aspects of traditional product *Aktori*
132	Mr. Bharat	Shoolini University, Solan, Himachal Pradesh (Passout)	B.Sc. Agriculture	3	Dr. Sukhjinder Singh	Economic analysis of stevia cultivation and Kangra Tea Farming
133	Ms. Aastha	Thakur PG College of Education,Dhaliara (HP) (Passout)	MSc. Botany	2	Dr. Ashish Warghat	Micropropagation of *Phyllanthus amarus*
134	Mr. Anchit Kumar	Jain University (Corresponding)	MCA	3	Dr. Ravi Shankar	ResNet based deep learning for genomic pattern discovery
135	Dr. Zhillika	Shri Dhanwantry Ayurvedic College And Hospital, Chandigarh	MD Ayurveda	5	Dr. Ankit Saneja	Development of nanoformulation from flowers of Mundi (*Sphaerantthus indicus* L.) and its *in-vitro* study on *Laryngeal carcinoma*
136	Ms. Nitika Mahajan	SRM Institute of Science and Technology, Chennai, Tamil Nadu (Passout)	B.Tech. Biotechnology	3	Dr. Yogendra s. Pawad	Training on animal cell culture, advanced cell molecular biology techniques: Applications in cancer research
137	Ms. Chitvan	College of Horticulture and Forestry, Hamirpur (Himachal Pradesh) (Passout)	M.Sc. Plant Pathology	3	Dr. Shiv Shankar Pandey	Basic techniques in Recombinant DNA technology
138	Mr. Apoorrab Mehra	PSR Govt. College Baijnath, Himachal Pradesh	B.Sc. (Hons.) Biotechnology	2	Dr. Vipin Hallan	Plant virus detection and diagnosis
139	Ms. Unnati Walia	Himachal Pradesh University, HP	MSc. Microbiology	3	Dr.Gireesh Nadda	Identification and insecticidal activity evaluation of an entomopathogenic fungus
140	Ms. Lavanya Ganesan	Amity University, Mumbai, Maharashtra	B. Tech. Biotechnology	8	Dr. Damanpreet Singh	Neuropotective Potential of *IHBT-TBF-01* in Amyloid-β Induced Rat Model of Alzheimer's Disease

S. No	Student Name	Affiliation	Course	Duration (months)	Supervisor	Title of certificate
141	Ms. Ayushi Walia	Chandigarh University, Chandigarh (Passout)	M.Sc. Chemistry	5	Dr. Dinesh Kumar	Hands-on training on column chromatography and analytical methods used in natural product research
142	Ms. Reva Jaryal	Dr. YS Parmar University of Horticulture & Forestry, Nauni, Solan (Passout)	Phd Seed Sience & Technology	3	Dr. Vivek Dogra	Basics of plant molecular biology
143	Ms. Aabha Singh	Shoolini University, Solan, Himachal Pradesh (passout)	M.Sc. Microbiology	6	Dr. Vidyashankar Srivatsan	Maintenance of axenic cultures of cyanobacteria and green microalgae & their nutritional and phytochemical evaluation towards food application
144	Ms. Ridhima Gaur	Graphic Era University, Dehradun (Passout)	M.Sc. Microbiology	4	Dr. Arun Kumar	Gene cloning, heterologous expression and protein purification
145	Ms. Stuti Sharma	Dr. YS Parmar University of Horticulture & Forestry, Nauni, Solan (Passout)	MSc. Microbiology	3	Dr. Arun Kumar	Cloning, heterologous expression and purification of recombinant protein
146	Ms. Aditi Anand	Dr. YS Parmar University of Horticulture & Forestry, Nauni, Solan (Passout)	Msc Agriculture (Plant pathalogy)	3	Dr. Vipin Hallan	Investigating the role of host factors CCCH and HB-18 in CMV infection through transient silencing and over expression
147	Ms. Aditi	Shoolini University, Solan, Himachal Pradesh (Passout)	M.Sc. Biotechnology	3	Dr. Ashish Warghat	Hands-on training on tissue culture of medicinal plants
148	Ms. Ashrey Baghla	Guru Nanak Dev University, Amritsar (Passout)	M.Sc. Microbiology	3	Dr. Dharam Singh	Hands-on training in molecular microbiology techniques for microbial bioprospection
149	Ms. Aayushi Chadha	Dr. YS Parmar University of Horticulture & Forestry, Nauni, Solan (Passout)	BSc. Horticulture	15 days	Dr.Ashish R. Warghat	Hands-on training on plant tissue culture techniques
150	Ms. Shivangi Sangrai	Central Research Institute, Kasauli, Solan, Himachal Pradesh (Passout)	M.Sc. Bioinformatics	3	Dr. Ravi Shankar	Deciphering splice variant specific binding patterns of plants transcription factors using PTFSpot and PTF-Vāc analysis
151	Ms. Sakshi Kapoor	Himachal Pradesh University, HP (passout)	M.Sc. Microbiology	1	Dr. Aparna Maitra Pati	Application of hydrolytic facultative anaerobes for the improvement of anaerobic digestion at low temperature
152	Mr. Ankit	Maharaja Agrasen University, Solan, Himachal Pradesh	M.Sc. Biotechnology	2	Dr. Vandana Jaiswal	Analysis of Morphological, physiological, biochemical and molecular responses to heat stress in buckwheat
153	Ms. Deepali	Maharaja Agrasen University, Solan, Himachal Pradesh	M.Sc. Biotechnology	2	Dr. Vandana Jaiswal	Insights into the heavy metal-associated isoprenylated plant protein (HIPP) gene family via genome wide-analysis in Rose
154	Ms. Aarya Kapoor	Thapar Institute of Enjineering & Technology, Patiala, Punjab	B.Tech. Biotechnology	6	Dr. Ram Kumar Sharma	Genetic diversity characterisation for trait improvement in medicinal plant

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155	Ms. Neha Sharma	Dr. B.Lal Institute of Biotecchnology, Rajasthan (Passout)	M.Sc. Biotechnology	3	Dr. Rohit Joshi	In-vitro propagation and phytochemical profiling of an aromatic plant *Lavandula hybrid* Balb. Ex Ging.
156	Ms. Anuradha	Himachal Pradesh university, Shimla, Himachal Pradesh	M.Sc. Botany	3	Dr. Ashish Warghat	Basics of plant tissue culture techniques and micropropagation of some important medicinal plants
157	Mr. Soham Sunil Gumaste	D.Y. Patil School of Biotechnology and Bioinformatics, Navi Mumbai.	B.Tech Biotechnology	1	Dr. Satbeer Singh	Basic Techniques of Molecular and Classical Plant Breeding along with Agronomic Research Practices
158	Ms. Mahika Singh	Shoolini University, Solan, Himachal Pradesh (passout)	M.Sc. Microbiology	6	Dr. Dharam Singh	Molecular and biochemical investigation of bacterial cellulolytic enzymes from western Himalayas for biomass degradation
159	Ms. Nitika Mahajan	SRM Institute of Science and Technology, Chennai, Tamil Nadu (Passout)	B.Tech. Biotechnology	3	Dr. Ravi Shankar	De Novo transcriptome assembly of *Nardostachys jatamansi*
160	Mr. Debmalya Chakraborty	Heritage Institute of Technology, Kolkata, West Bengal	B.Tech Biotechnology	1	Dr. Vandana Jaiswal	Hands-on training on plant molecular biology techniques
161	Mr. Shailesh Shinde	D.Y. Patil School of Biotechnology and Bioinformatics, Navi Mumbai, Maharashtra	B.Tech Biotechnology	1	Dr. Ramesh	Production technologies of medicinal and aromatic crops and research lab tools
162	Ms. Ankita Sharma	Himachal Pradesh university, Shimla, Himachal Pradesh	M.Sc. Microbiology	1	Dr. Shiv Shanker Pandey	Basic techniques in molecular biology
163	Ms. Kritika Mankotia	Shoolini University, Solan, Himachal Pradesh (passout)	M.Sc. Biotechnology	1	Dr. Ashish R. Warghat	Hands-on Training on Plant Tissue Culture
164	Mr. Faizan Bariwala	Pilai College of Arts, Commerce & Science, Mumbai, Maharashtra	M.Sc. Biotechnology	3	Dr. Rajiv Kumar	Molecular Cloning of *WRKY* gene from *Picrorhiza kurrooa*
165	Ms. Ismat Fatima Rupani	Pilai College of Arts, Commerce & Science, Mumbai, Maharashtra	M.Sc. Biotechnology	3	Dr. Vipin Hallan	Investigating the Impact of Tomato leaf curl Palampur virus Infection on the Growth, Morphology, and Pathogenicity of *Sclerotinia sclerotiorum*
166	Ms. Vedanti Kantilal Patil	Pilai College of Arts, Commerce & Science, Mumbai, Maharashtra	M.Sc. Biotechnology	4	Dr. Shiv Shanker Pandey	Evaluation of role of endophytes of *Rhodiola imbricata* in photosynthesis
167	Ms. Ruchika	GHG Khalsa College of Pharmacy, Ludhiana, Punjab	M. Pharmacy	6	Dr. Vikram Patial	*In vitro* evaluation of IHBT-VPG-01 in attenuating fructose-induced lipid accumulation in Huh7 cells
168	Ms. Hiral Khistaria	Shoolini University, Solan, Himachal Pradesh (Passout)	B.Sc. Biotechnology (Hons.)	6	Dr. Gaurav Zinta	Molecular cloning and characterisation of heat-inducible gene in *Arabidopsis thaliana*

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169	Ms. Kirtika Prashar	Dr. YS Parmar University of Horticulture & Forestry, Nauni, Solan	MBA Agirbuisiness and Management	1.5	Dr. Sukhjinder Singh	Conduct surveys of flower nurseries, lilium orchards and food processing units and gaining insight about the cost economics
170	Ms. Kajal Sandal	Sant Baba Bhag Singh University, Jalandhar, Punjab	M.Sc. Botany	3	Dr. Amit Chawla/ Dr. Vivek Dogra	Training on eco-physiological and molecular techniques for determination of freezing tolerance in high altitude plants
171	Ms. Shiva	Banaras Hindu University, Varanasi, Uttar Pradesh	Ph.D. Food Technology	6	Dr. Upendra Sharma	Process standardization for development of multi-herb based functional soup mix and gummies
172	Mr. Harshit Kapoor	IISER, Mohali, Punjab	BS-MS	3	Dr. Vipin Hallan	Hands-on training on protein-protein interaction and protein analysis
173	Ms. Shweta Shrey	Dr. YS Parmar University of Horticulture & Forestery, Nauni, Solan	MBA Agirbuisiness and Management	1.5	Dr. Sukhjinder Singh	Conduct surveys of flower nurseries, lilium orchards and food processing units and gaining insight about the cost economics
174	Ms. Ankita	NSCBM Govt College Hamirpur, Himachal Pradesh (Passout)	M.Sc. Chemistry	3	Dr. Upendra Sharma	Synthesis and characterisation of diversely substituted maleimides and benzamides
175	Ms. Harman	Chaudhary Devi Lal University, Haryana	M.Sc. Biotechnology	6	Dr. Poonam Kumari	Optimizing *in vitro* culture conditions for propagation of *Freesia hybrida*
176	Ms. Komalpreet Kaur	GHG Khalsa College of Pharmacy, Ludhiana	M.Pharmacy	7	Dr. Ankit Saneja	Development and characterization of α–Lipoic acid based gel for wound healing application
177	Ms. Avisha Sharma	Guru Nanak Dev University, Amritsar, Punjab (Passout)	M.Sc. Human Genetics	6	Dr. Ravi Shankar	De novo transcriptome assembly of *Ferula asafoetida*
178	Ms. Anushka Panwar	Hemvati Nandan Bahuguna Garhwal University, Srinagar, Uttarakhand	B.Sc. Non-Medical	6	Dr. Ravi Shankar	Development of NoSQL database server with MongoDB, PHP & Apache on Linux
179	Mr. Amit Kumar	GHG Khalsa College of Pharmacy, Ludhiana	M.Pharmacy	7	Dr. Yogendra S. Padwad	Therapeutic Potential and Lead Optimization of semi-synthetic molecules: antibacterial activity against diarrheal pathogens, mode of action and cellular assays
180	Ms. Isha Palwal	Central university of Punjab, Bathinda	M.Sc. Plant Sciences	3	Dr. Ravi Shankar	Computational identification of Transcription Factor Binding Regions in *Oryza sativa* after ChIP-Seq data analysis
181	Ms. Priya Joon	Panjab University, Chandigarh	Ph.D. Pharmacology	10	Dr. Damanpreet Singh	Molecular insights and *in vivo* efficacy of Rosmarinic acid in a zebrafish model of autism spectrum disorder

S. No	Student Name	Affiliation	Course	Duration (months)	Supervisor	Title of certificate
182	Ms. Ankita	NSCBM Govt College Hamirpur, Himachal Pradesh (Passout)	Msc. Chemistry	3	Dr. Pralay Das	Preparation of supported palladium nanoparticles as catalyst and its application in carbonylative cross-coupling reactions
183	Ms. Riya Sharma	CSK HPKV, Palampur, Himachal Pradesh	B.Tech Food Technology	5	Dr. Mahesh Gupta	Study the nutritional, functional and antioxidant properties of finger millet incorporated soup
184	Ms. Ankita Rani	Central University of Haryana, Haryana	M. Pharmacy	1	Dr. Dinesh Kumar	Extraction, fractionation, isolation of molecules from natural matrices along with chromatography (UPLC-PDA) and *In-vitro* biological assays
185	Ms. Nikita	Central University of Haryana, Haryana	M. Pharmacy	1	Dr. Dinesh Kumar	Extraction, fractionation, isolation of molecules from natural matrices along with chromatography (UPLC-PDA) and *In-vitro* biological assays
186	Ms. Disha Chauhan	Central University of Himachal Pradesh, Himachal Pradesh	Ph.D. Zoology	3	Dr. Vikram Patial	Hands-on training in *in-vitro*, *in-vivo* models and histopathological techniques
187	Mr. Aditya	Chandigarh College of Technology Landran (passout)	M.Sc. Biotechnology	4	Dr. Rohit Joshi	Micropropagation, physiological, biochemical and molecular profiling of medicinally important Himalayan herbs
188	Mr. Jagdish Bhuyan	NIPER Guwahati, Assam	M. Pharmacy	9	Dr. Damanpreet Singh	
189	Ms. Gauri Arora	DAV PG College, Muzaffarnagar, Uttar Pradesh	M.Sc. Microbiology	6	Dr. Sarita Devi/ Dr. Vidyashankar Srivatsan	➢ Isolation and characterization of micro-organism from traditional fermented food of Western Himalayas for their biotechnology applications/ ➢ Cultivation of microalgae for value added products

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 64 startups already completed the tenure and developed their prototypes. Currently 14 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 2024 to March 2025 at incubation facility at CSIR-IHBT, Palampur with their information as below:

S. No	Name of Incubates	Idea of Start-up and Start date	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. **09th Oct, 2024**	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 **16th Oct, 2024**	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 **16th Oct, 2024**	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 **21st Oct, 2024**	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 **21st Oct, 2024**	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 **29th Oct, 2024**	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 **21st Nov, 2024**	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. **05th Nov, 2024**	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. **22nd Oct, 2024**	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 **05th Nov, 2024**	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, 451 students were registered for Ph.D. under AcSIR at CSIR-IHBT in the faculty of Biological Sciences and Chemical Sciences **(Fig. 1)** and 175 students have been awarded their doctoral degrees.

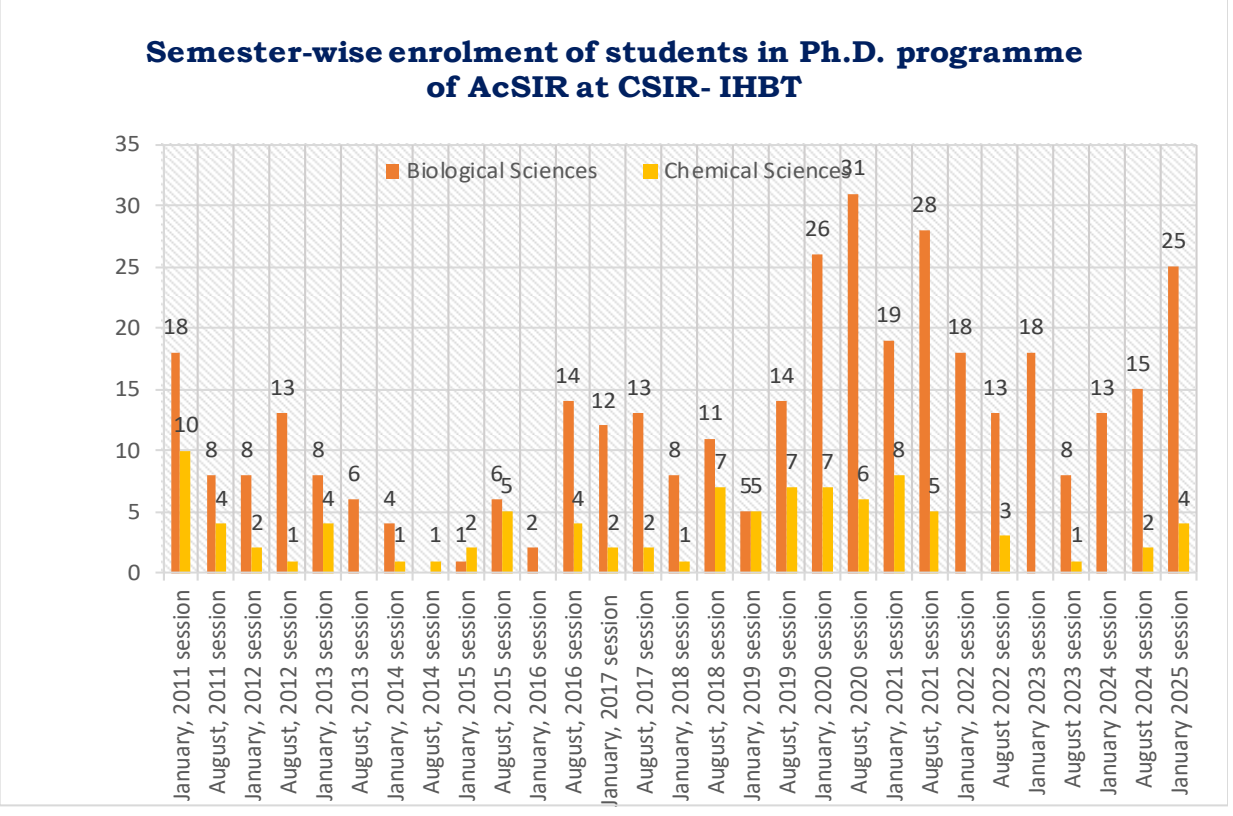


Fig. 1 Semester-wise enrolment of students in Ph.D. programme of AcSIR at CSIR- IHBT.

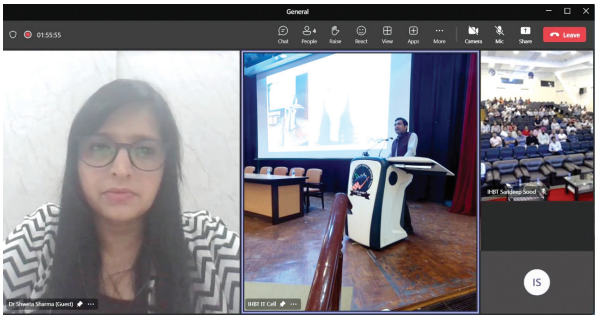
From 1st April 2024 to 31st March 2025, 33 students, successfully defended their thesis during the viva voce examinations and were awarded doctoral degree as per the following details:

S. No.	Registration No.	Name of the Student	Faculty	Supervisor
1	10CC18A33021	Arvind Singh Chauhan	Chemical Sciences	Dr. Pralay Das
2	10CC20J33033	Rohit Kumar	Chemical Sciences	Dr. Upendra Sharma
3	10CC18A33020	Ajay Kumar Sharma	Chemical Sciences	Dr. Pralay Das
4	10CC19J33002	Sheetal	Chemical Sciences	Dr. Pralay Das
5	10BB21J33033	Sareeka Kumari	Biological Sciences	Dr. Rakshak Kumar
6	10CC18A33019	Dinesh Kumar	Chemical Sciences	Dr. Dinesh Kumar
7	10BB18A33017	Mohini Verma	Biological Sciences	Dr. Amitabha Acharya
8	10BB19J33010	Aakriti Sharma	Biological Sciences	Dr. Gireesh Nadda
9	10BB20A33024	Nilofer	Biological Sciences	Dr. Aparna Maitra Pati
10	10CC20A33004	Prithvi Pal Singh	Chemical Sciences	Dr. Upendra Sharma
11	10CC19J33003	Yamini	Chemical Sciences	Dr. Pralay Das
12	10BB20J33013	Aman Thakur	Biological Sciences	Dr. Rakshak Kumar

S. No.	Registration No.	Name of the Student	Faculty	Supervisor
13	10CC19A33037	Sumit	Chemical Sciences	Dr. Upendra Sharma
14	10CC19A33030	Anmol	Chemical Sciences	Dr. Upendra Sharma
15	10CC20J33032	Nitisha Sendri	Chemical Sciences	Dr. Pamita Bhandari
16	10BB20J33012	Kishor Chandra Kandpal	Biological Sciences	Dr. Amit Kumar
17	10BB18A33012	Anjali Chaudhary	Biological Sciences	Dr. Kunal Singh
18	10CC20J33038	Shinde Bhagatsing Devidas	Chemical Sciences	Dr. Pamita Bhandari
19	10CC20J33037	Shiv Shankar Gupta	Chemical Sciences	Dr. Upendra Sharma
20	10BB20J33023	Yog Raj	Biological Sciences	Dr. Rakesh Kumar
21	10CC19A33033	Manisha	Chemical Sciences	Dr. Upendra Sharma
22	10BB17A33002	Ashrita	Biological Sciences	Dr. Ashish R. Warghat
23	10BB20J33019	Ankita Dhiman	Biological Sciences	Dr. Rituraj Purohit
24	10BB18A33010	Pooja	Biological Sciences	Dr. Kunal Singh
25	10BB18A33004	Kamini Kapoor	Biological Sciences	Dr. Vipin Hallan
26	10CC21A33006	Shashi Kumar	Chemical Sciences	Dr. Dinesh Kumar
27	10BB19A33007	Manish Kumar Sharma	Biological Sciences	Dr. Amit Chawla
28	10BB20J33008	Amna Devi	Biological Sciences	Dr. Ram Kumar Sharma
29	10CC20J33034	Ankita Thakur	Chemical Sciences	Dr. Upendra Sharma
30	10CC19A33032	Kajal Kalia	Chemical Sciences	Dr. Ankit Saneja
31	10BB19A33018	Satyakam	Biological Sciences	Dr. Rajiv Kumar
32	10CC17A33017	Shankar Ram	Chemical Sciences	Dr. Pralay Das
33	10BB20J33030	Ritu	Biological Sciences	Dr. Ravi Shankar

Rashtriya Boudhik Sampada Mahotsav

Rashtriya Boudhik Sampada Mahotsav was celebrated by the Institute on 10.05.2024. Dr. Shweta Sharma, Sr. Associate Khurana, and Khurana delivered a lecture on IPR. She explained the basics of IPR, patent search, and drafting of patent claims, and explained how innovations in biological sciences could be patented. Dr. Sudesh Kumar Yadav, Director CSIR-IHBT presided over the function and offered vital suggestions to ease the patenting process and popularize innovation and IPR in academic institutions.



National Technology Day

National Technology Day was celebrated by the Institute on 13.05.2024 at S.S. Bhatnagar Auditorium. Dr. Shirshendu Mukherjee Mission Director Program Management Unit, DBT-BIRAC, New Delhi, delivered a keynote lecture on “Our Innovation Ecosystem: For Atmanirbhar Bharat”. Before that, Dr. Sudesh Kumar Yadav Director, CSIR-IHBT, addressed the August gathering and gave a brief presentation about the institutional activities. Chief guest Prof. (Dr.) Arun Kumar Sinha Former Pro Vice-Chancellor, of Ranchi University, Ranchi, Jharkhand also addressed the gathering to motivate the younger generation for innovation and technology in science. Besides thi s signing of MoUs and release of the book were also done on this occasion. The function was attended by the CSIR-IHBT staff, students of career point university, and superannuated employees. Tree plantation was also done by the chief guest and keynote speaker in the presence of the Director and scientists of the institute. On this occasion signature campaign was also initiated for cleaning the campus.

World Environment Day

CSIR-IHBT celebrated World Environment Day on 05.06.2024. On this occasion, Professor Sudesh Yadav, School of Environmental Sciences, Jawahar Lal Nehru University, New Delhi delivered a lecture on Sustainability and LiFE”.

Yoga Day

A yoga session was organized on 20.06.2024 at CSIR-IHBT, Palampur, as a countdown event for the International Day of Yoga (IDY). The event saw active participation from staff and scholars under the guidance of the Director, CSIR-IHBT.

CSIR-IHBT Foundation Day

CSIR-IHBT celebrated its 42nd Foundation Day on 02.07.2024. The chief guest was Hon'ble DG CSIR and Secretary DSIR GoI, Dr. (Mrs.) N. Kalaiselvi. The honored guest was H.E. Anisa K. Mbega, High Commissioner, United Republic of Tanzanian High Commission. Prof. Rekha S. Singhal, Head of the Department of Food Engineering and Technology at the Institute of Chemical Technology (ICT), Mumbai, gave the keynote address. Dr. Sudesh Kumar Yadav, the Director, gave a presentation on the accomplishments of the Institute during the event.

- The CSIR-IHBT hosted the "Pushp Krishi Mela" as part of the CSIR Floriculture Mission II to celebrate the Institute's 42nd foundation day on 02.07.2024, at its premises in Palampur. The event was inaugurated by the Chief Guest, Dr. (Mrs.) N. Kalaiselvi, Hon'ble DG CSIR and Secretary DSIR, Government of India. Distinguished guests included H.E. Anisa K. Mbega, the High Commissioner from the United Republic of Tanzania, and Prof. Rekha S. Singhal, the Head of the Department of Food Engineering and Technology at the Institute of Chemical Technology (ICT), Mumbai. Dr. Sudesh Kumar Yadav, Director, CSIR-IHBT, welcomed the guests and highlighted the successes of the CSIR-Floriculture Mission II. The Hon'ble DG CSIR praised the mission's accomplishments, noting the contribution of IHBT in providing tulip blooms for the Ram Mandir consecration ceremony in Ayodhya on January 22 of this year. The DG CSIR also launched a brochure titled "Impact of CSIR-Floriculture Mission in Himachal Pradesh."

CSIR-IHBT celebrated 78th Independence Day

CSIR-IHBT celebrated 78th Independence Day on 15.08.2024 with great enthusiasm. Dr. Sudesh Kumar Yadav, Director CSIR-IHBT addressed August gathering on this occasion and highlighted the achievements and new initiatives of the Institute.Cultural programmes and sports activities for the wards and family members of the Institute were also organized on this occasion. The staff, students, and family members participated in the fun-filled activities. The magazine of the Institute "Manthan" was also released on this occasion.

CSIR-IHBT celebrated Himalaya Day

CSIR-IHBT celebrated Himalaya Day on 09.09.2024. On this occasion, Dr. Lal Singh, Director, Himalayan Research Group (HRG), Shimla, Himachal Pradesh delivered a lecture on "Sustaining the Himalayas: Innovations and Pathways for a Resilient Future".

CSIR-IHBT celebrated Teachers' Day

CSIR-IHBT celebrated Teachers' Day enthusiastically by organizing Student Seminar Series on 05.09.2024. This year's theme, Science, Society, and Sustainability, brought together a day full of insightful scientific sessions, including oral/flash talks and poster presentations.The event was presided over by Dr. Sudesh Kumar Yadav, Director, CSIR-IHBT, and attended by faculty and research scholars of CSIR-IHBT. As the Chief Guest, Prof. Manoj Kumar Dhar, Director of AcSIR, graced the occasion.Inspiring lectures were delivered by our esteemed alumni Dr. Dhiraj Vyas, Dr. Som Dutt, and Dr. Vinod Pathania. At the same time, Dr. Anil Sood, Dr. Bikram Singh, and Dr. R.K. Sud added their gracious presence to the occasion.

हिंदी दिवस

सी.एस.आई.आर – हिमालय जैवसंपदा प्रौद्योगिकी संस्थान में 19.09.2024 को हिंदी दिवस का आयोजन किया गया तथा 30.08.2024 से प्रारंभ हुए हिंदी पखवाड़े का समापन हुआ। इस अवसर पर सीएसआईआर– राष्ट्रीय विज्ञान संचार एवं नीति अनुसंधान संस्थान (निस्पर), नई दिल्ली से विज्ञान प्रगति के संपादक डा. मनीष मोहन गोरे ने हिंदी में विज्ञान लेखन की बातें: कुछ जानी कुछ अनजानी' विषय पर अपनी प्रस्तुति दी। अपनी प्रस्तुति में उन्होने विज्ञान लेखन से जुड़ी बारिकियों, विज्ञान संचार के उद्देश्यों और सामाजिक लाभों के बारे में चर्चा की। उन्होंने वैज्ञानिको से अपील किया कि वे अनुसंधान के साथ–साथ अपने प्रयोग और शोध के बारे में जन सामान्य से भी संवाद स्थापित करें। ऐसे प्रयासों से आम जन में विज्ञान को लेकर एक समझ विकसित होगी तथा उनका नजरिया तार्किक होगा।संस्थान के निदेशक डा. 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 का एक वार्षिक प्रकाशन के रूप में तैयार करें। साथ ही शोध एवं विकास संबन्धी उपलब्धियों को जन–जन तक पंहुचाने की दिशा में संस्थान द्वारा अंग्रेजी में प्रकाशित संस्थान की शोध उपलब्धियों की सफलता की कहानियों को हिंदी अनुवाद उपलब्ध कराने की कृपा करें ताकि अंतिम संपादन करके इसे प्रकाशित किया जाए। 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 विभिन्न प्रतियोगिताओं के विजेताओं को पुरस्कृत भी किया गया।

CSIR Foundation Day

Institute celebrated the 83rd CSIR Foundation Day on 17.10.2024. Dr Rajendra S Paroda (Padma Bhushan), Chairman, TAAS & Former Secretary, DARE & DG, ICAR was the Chief Guest, and Dr. Anil P Joshi (Padma Bhushan & Padma Shri), Founder, Himalayan Environmental Studies and

Conservation Organization (HESCO), Dehradun, Uttarakhand was the Guest of Honour for the day. Dr. R S Paroda delivered a lecture on the topic "Managing Agrodiversity of Northern Himalayas". Dr. Joshi addressed the audience with his wise words. Dr. Sudesh K Yadav, Director CSIR-IHBT apprised the August gathering about recent institutional achievements in different scientific and technological fields. A workshop entitled "Sustaining horticultural production under the climate change scenario in the Himalayas" was inaugurated and a booklet on the same was also released on this occasion.

Ayurveda Day

Institute celebrated Ayurveda Day on 29.10.2024 Dr. Vijay Chaudhary, Principal cum Dean, RG Govt. PG Ayurvedic College, Paprola, will deliver a lecture on the topic "Ayurveda Innovations for Global Health".

World Meditation Day

CSIR-IHBT celebrated World Meditation Day on 21.12.2024. On this occasion, Ms Sumati Mohan, a volunteer Yoga Teacher from Arts of Living, Palampur, deliberated on the meditation and interacted with CSIR-IHBT staff and their family members by demonstrating a meditation video of Sri Sri Ravi Shankar ji. It was an enriching experience for all staff members. As concluded by the Director, Dr. Sudesh Kumar Yadav, mediation has a profound impact on enhancing productivity and creativity, in addition to bringing out positivity in an individual while following the principle of focus in every sphere of day-to-day tasks in a meditative manner.

52nd Shanti Swarup Bhatnagar Memorial (SSBM) (Outdoor) Final Tournament

Organized 52nd Shanti Swarup Bhatnagar Memorial (SSBM) (Outdoor) Final Tournament (Cricket & Volleyball from 07-10 February 2025. The programme was attended by Dr. Sanjeev Khosla, President SPB, CSIR, Dr. Sudesh Kumar Yadav, Director, CSIR-IHBT, Himachal Kabaddi Team Players Ms. Jyoti and Bhavna, Sh. Hem Singh, Former National Volleyball Player, Maj Gen K K Singh, General Commanding Officer, Holta Palampur, all IHBT staff and family members, including research scholars of CSIR-IHBT. It was followed by a cultural programme in the evening, wherein Himachali Natti King Kuldeep Sharma performed an extraordinary performance and made all players and audiences dance to his songs.

National Science Day

Institute celebrated National Science Day on 28.02.2025 with great enthusiasm.

International Women's Day

Institute celebrated International Women's Day from 3rd March to 9th March 2025. CSIR-IHBT organized aerobics sessions for female research scholars and staff. Approximately 70 participants took part in it. As part of the celebrations of International Women's Day various activities and events were conducted to honor and empower women.

- Sports event for female research scholars, staff, and their wards in honor of International Women's Day. 30 females participated in this sports event on 04.03.2025.
- Professor (Dr.) Rashmi Srivastava from Rajiv Gandhi Govt. Post Graduate Ayurvedic College Paprola delivered a talk on "Diet and Drugs for Women's Health" on 05.03.2025.
- A talk on Mental Health & Wellness on 07.03.2025. Dr. Vikesh Gupta, Assistant Professor, RPGMC Kangra (HP) delivered a talk on Women Mental Health Matters-Empowering Women's Mental Wellbeing: Strategies for Stress Relief.
- A Yoga session for female scholars and family members on 08.03.2025.
- A Cyclothon and Walkathon on 09.03.2025. Scientists, staff members, and students enthusiastically participated in the events. The concluding session was hosted by the Ladies Club and Staff Club, with Mrs. Kavita Yadav, President of, the Ladies Club, CSIR-IHBT, as the chief guest. In her inspiring address, Mrs. Yadav applauded the dedication of women scientists, staff, students, and their families for their invaluable contributions to the institute's scientific achievements. She then led the Walkathon alongside the women participants, marking a symbolic moment of unity and empowerment. The week-long celebrations concluded with a group photograph of all the women with Mrs. Yadav at the tulip garden.

Activities:

- Organ Donation Pledge was administered by the Director, CSIR-IHBT to the staff and scholars to celebrate Indian Organ Donation Day on 02.08.2024.
- Fit India Pledge was administered by the Director, CSIR-IHBT to the staff and scholars to celebrate National Sports Day on 29.08.2024.

स्वच्छता ही सेवा 2024 अभियान

- "स्वभाव स्वच्छता–संस्कार स्वच्छता" स्वच्छता ही सेवा 2024 अभियान के तहत सीएसआईआर–आईएचबीटी में डॉ सुदेश कुमार यादव, निदेशक की अध्यक्षता में स्वच्छता शपथ ली गई। सभी अधिकारियों/कर्मचारियों ने भाग लिया।
- Under the 'Swachhata hi Seva' (SHS) campaign 2024, a Tree Plantation drive named 'Ek Ped Maa Ke Naam' was conducted in the North East Lawn of CSIR-IHBT premises on 18.09.2024. Dr. Sudesh Kumar Yadav, Director, CSIR-IHBT along with other staff members planted saplings.
- Under the leadership of Director CSIR-IHBT and with the active participation of our dedicated staff, we planted 31 trees of Michelia champaca (Swarna Champa) today under एक पेड़ माँ के नाम campaign in Swachhta hi Sewa 2024. This initiative not only strengthens our commitment to a greener planet but also serves as a tribute to the roots that sustain us.
- A cleanliness drive was conducted on 19.09.2024 in CSIR-IHBT under 'Swachhata Hi Sewa Campaign (SHS). Staff and students actively participated in cleaning their respective workplaces across the Institute.
- Under Swachhata Hi Seva Campaign (SHS)-2024, Safai Mitra Suraksha Shivir was organized on 24.09.2024 for CSIR -IHBT cleaning staff at Dispensary. The Routine health checkup which included checking of Pulse, Blood Pressure, Weight & Dental hygiene of the cleaning staff along with a short talk on personal hygiene.

Under the Swachhata Hi Seva Campaign (SHS) 2024, CSIR-IHBT organized an awareness event, the Swachhata Samvad Programme, in Bharmat Village on 30.09.2024. The campaign focused on educating the community about Compost Making: Waste to Wealth. Dr. Vipul Gupta, Sr. Medical Officer also provided guidance on maintaining personal hygiene. The event was attended by Smt. Poonam Bali (Ex-Mayor M.C. Palampur), Harmesh Bali, and many people from the village.

- राष्ट्रीय स्वैच्छिक रक्तदान दिवस, 01.10.2024 के अवसर पर, संस्थान के निदेशक डॉ. सुदेश कुमार यादव ने रक्तदान के महत्व और इसकी आवश्यकता पर अपने विचार सभी कर्मचारियों के समक्ष प्रस्तुत किए। उन्होंने समस्त स्टाफ और अध्येताओं को रक्तदान करने की शपथ भी दिलाई।
- दिनांक 02.10.2024 को संस्थान में "स्वच्छ भारत दिवस "मनाया गया। इस अवसर पर संस्थान के निदेशक डॉ. सुदेश कुमार यादव की अगुवाई में समस्त कर्मियों, अध्येताओं ने संस्थान परिषद में व्यापक श्रमदान किया। इस अवसर पर चल रहे" स्वच्छता ही सेवा" अभियान 2024 (17 सितंबर से 2 अक्टूबर) का समापन समस्त सफाई कर्मियों को सम्मानित कर किया गया।
- राष्ट्रीय एकता दिवस की शपथ दिनांक 29.10.2024 को सी.एस.आई.आर.–आई.एच.बी.टी. पालमपुर में ली गयी। इस अवसर पर डॉ. सुदेश कुमार यादव, निदेशक, सीएसआईआर–हिमालय जैवसंपदा प्रौद्योगिकी संस्थान, पालमपुर ने संस्थान के कार्मिकों व अध्येताओं को राष्ट्रीय एकता की शपथ दिलाई।
- To mark the celebration of National Unity Day on 31.10.2024, CSIR-IHBT has organized a "Unity Run", in the institute campus on 30.10.2024. National Unity Day is celebrated on October 31st every year to honour the birth anniversary of Sardar Vallabhbhai Patel, the first Deputy Prime Minister and first Home Minister of India. Staff members and research scholars of CSIR-IHBT participated in the "Unity Run". This event was in continuation of the National Unity pledge that took place on 29.10.2024 in the presence of Dr. Sudesh Kumar Yadav, Director, CSIR-IHBT, staff members, and research scholars.

As a part of Vigilance Awareness Programme 2024, the institute organized

- Nukkad Naatak on the theme "Culture of Integrity for Nation's Prosperity".
- Essay and Slogan writing competition for the staff and students of the institute on 11 November 2024. Also, a drawing competition was organized for the wards of staff and students of CSIR-IHBT.

STUDENT SEMINAR SERIES
&
FACULTY SEMINAR SERIES

The eighth student seminar series-2024 on the theme *"Science, Society, and Sustainability"* was organized by the research scholars of the institute on September 5, 2024 in honor of Dr. Sarvepalli Radhakrishnan's birthday, recognizing teachers' contributions in shaping life.

The seminar featured a total of 20 oral and flash presentations in three themes viz., SSS-01: Agriculture, Food & Animal Science; SSS-02: Biodiversity & Biotechnology; and SSS-03: Chemistry & Natural Products, where students showcased their research work. Additionally, competitions for painting, photography, videography, and memes were held, along with an exhibition on scientific achievements.

Prof. Manoj Kumar Dhar, Director AcSIR, was the chief guest of the occasion. He emphasized teamwork and encouraged young minds to think about future problems, initiate solutions through science, and bring innovation into research. Dr. Sudesh Kumar Yadav, Director CSIR-IHBT, extended Teacher's Day greetings to all present and congratulated the scholars on putting up the show. He shed light on the institute's achievements and encouraged fostering collaborations.

Former institute scientists Dr. Anil Sood, Dr. Bikram Singh, and Dr. R.K. Sud also addressed the gathering and shared their thoughts. Dr. Som Dutt, Principal Scientist at ICAR-CPRI, Shimla, Dr. Dheeraj Vyas, Senior Principal Scientist at CSIR-IIIM, Jammu, Dr. Vinod Pathania, Professor at Central University of Punjab, Bathinda, all alumi of the institute delivered invited talks and motivated students towards excellence.

A Global Alternative Model, a DNA structure made from waste bottles, and a tree model depicting Sustainable Development Goals using newspapers were the center of attraction.

On this occasion, academic and research agreements were also signed. Winners of various competitions and seminar presentations were awarded prizes. The symposium concluded with a cultural evening.

In line with the suggestion of our Director, we initiated a new activity titled the **"Faculty Seminar Series."** This initiative was primarily designed to help research scholars become familiar with the diverse range of research activities being conducted across the Institute, beyond their own laboratories. The series was coordinated by Dr. Rajesh Kumar Singh and Dr. Vandana Jaiswal, and it officially commenced on 18th April 2024.

As part of this activity, three scientific talks were organized every Thursday, each delivered by a different faculty member who shared their most recent research findings. Throughout the duration of the series, all scientists from the Institute participated, presenting their work to an engaged audience of peers and scholars. Each session was followed by in-depth discussions and brainstorming, reflecting the active involvement and enthusiasm of both faculty members and students.

The Faculty Seminar Series concluded successfully in September 2024, and it proved to be highly beneficial for both faculty and scholars by fostering a deeper understanding of the wide array of research endeavours at CSIR-IHBT.

Following the success of the Faculty Seminar Series, we also launched the "Post-Doctoral Seminar Series," specifically aimed at post-doctoral fellows who had secured prestigious, nationally competitive fellowships. This series featured a total of 16 presentations by fellows from programs such as Ramalingaswami, DST-INSPIRE Faculty, CSIR-SRA, and others.

This platform provided post-doctoral researchers with the opportunity to present their work at the institutional level. Much like the faculty seminar, each session encouraged lively discussions and valuable feedback, greatly enriching both the presenters' and the audience's understanding.

PATENTS / PUBLICATIONS

INTELLECTUAL PROPERTY

PATENTS FILED

1. 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. (NFNO0233NF2024/IN Filing Date 30-Jan-2025, Application No. 202511008627).
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BOOKS/ BOOK CHAPTER

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THESIS/DISSERTATIONS/REPORTS

Aakriti Sharma (2024) Identification, Characterization and Bioactivity Evaluation of *Ophiocordyceps* sp. from Western Himalaya. AcSIR program. Supervised by Dr. Gireesh Nadda.

Ajay Kumar Sharma (2024) Methodology Development for Supported Metal-Catalyzed Carbonylation Reactions and Phenol-Based Chemosensor Synthesis. Supervised by Dr. Pralay Das.

Amna Devi (2025) Genomic resource creation for unveiling specialized metabolites biosynthesis and genetic diversity characterization in Valeriana jatamansi Jones Supervised by Dr. Ram Kumar Sharma.

Ankita Thakur (2025) Development of Catalytic Methodologies for C-H Functionalization of Six-Membered N-Heterocycles. AcSIR program. Supervised by Upendra Sharma.

Anmol (2024) Phytochemical investigation of traditionally important Himalayan medicinal plant Aconitum heterophyllum Wall. AcSIR program. Supervised by Upendra Sharma.

Arvind Singh Chauhan Arvind Singh Chauhan (2024) Sustainable approaches for the synthesis of furan analogues from biomass derived carbohydrates. Supervised by Dr. Pralay Das.

Devesh Chandra (2024) Synthesis and C-H functionalization of N-heterocyclic scaffolds. AcSIR program. Supervised by Upendra Sharma.

Diksha Parmar (2024) Synthesis of Six-Membered N-Heterocyclic Derivatives via Transition Metal Catalyzed C-H Activation. AcSIR program. Supervised by Upendra Sharma.

Dinesh Kumar (2024) Exploration of Trillium govanianum for its Chemistry and Therapeutic Potential. AcSIR program. Supervised by Dr. Dinesh Kumar Kumar.

Kamini Kapoor (2025) Understanding the role of Glycine rich protein in cucumber Mosaic virus pathogenesis. Supervised by Dr. Vipin Hallan.

Kiran (2024) Molecular characterization of transgenic tea plants transformed with CRISPR Cas9 vector and protoplast isolation from tea [*Camellia sinensis* (L.) O. Kuntze]. Department of Biotechnology, Chandigarh Group of College (CGC) Landran, Mohali, Panjab. Supervised by Dr. Shiv Shanker Pandey.

Kishor Chand Kandpal (2025) Hyperspectral Remote Sensing and Artificial Intelligence for Identification of Medicinal Plants and Non-invasive Estimations of their Biochemical and Biophysical Parameters. AcSIR program. Supervised by Dr. Amit Kumar.

Manisha (2025) Synthesis of N-Heterocyclic Derivatives via Transition Metal Catalyzed C-H Functionalization. AcSIR program. Supervised by Upendra Sharma.

Nitisha Sendri (2024) Phytochemical investigation of commercially important polyphenols from Rhododendron arboreum Sm. AcSIR program. Supervised by Dr. Pamita Bhandari.

Pradeep Kaur (2024) Nutritional, functional and sensory characterization of chlorella- Fortified Instant Pasta Formulations. Chandigarh University. Supervised by Dr. Vidyashankar Srivatsan.

Prithvi Pal Singh (2024) Phytochemical Investigation of *Trillium govanianum* Wall. ex D.Don. AcSIR program. Supervised by Upendra Sharma.

Ritu (2025) Computational analysis of plant lncRNAs and their impact on genomic systems. Supervised by Dr. Ravi Shanker.

Rohit Kumar (2024) Transition Metal Catalyzed Functionalization of C(sp2)-H and C(sp3)-H Bonds for C-C and C-N Bond Formation. AcSIR program. Supervised by Upendra Sharma.

Shankar Ram (2025) Methodology Development for heterogeneous palladium catalyzed carbonylation strategies using oxalic acid as C1 source. Supervised by Dr. Pralay Das.

Sharadha M Yadav (2024) Solid State Fermentation using Yeast on spent algal biomass. Good Food Institute, India, SPARK Fellow. Supervised by Dr. Vidyashankar Srivatsan.

Sheetal (2024) Methodology development for transition metal-catalyzed amidation reactions and heterocycles synthesis. Supervised by Dr. Pralay Das.

Shinde Bhagatsing Devidas (2024) Phytochemical Investigation of Juglans regia L. and Carya illinoinensis (Wangenh.) K. Koch for Biological Activity. AcSIR program Supervised by Dr. Pamita Bhandari.

Shiv Sankar Gupta (2024) C(sp2)-H Bond Functionalization of N-Heterocycles. AcSIR program. Supervised by Upendra Sharma.

Sumit (2024) Transition Metal catalysed C-H Functionalization of N-Heterocycles for C-C and C-S Bond Formation. AcSIR program. Supervised by Upendra Sharma.

Surekha Kumari (2024) Phytochemical Investigation of Cissampelos pareira for Bioactive Molecules. Supervised by Upendra Sharma.

Vedanti Kantilal Patil (2025) Evaluation of role of endophytes of *Rhodiola imbricata* in photosynthesis. Pilai College of Arts, Commerce & Science, Mumbai, Maharashtra. Supervised by Dr. Shiv Shanker Pandey.

Yamini (2024) Methodology development for the synthesis of bioactive benzocycloheptene and 2-alkyl benzimidazole analogues. Supervised by Dr. Pralay Das.

Yog Raj (2025) Sculpturing *Hypericum perforatum* L. rhizosphere for enhanced biomass and secondary metabolite production under the western Himalaya. Supervised by Dr. Rakesh Kumar.

CONFERENCE/TRAINING/WORKSHOP/SYMPOSIUM PRESENTATIONS

Anmol and Sharma U (2025) Phytochemical Analysis of Aconitum heterophyllum Wall. (Commercially Important High Altitude Himalayan Medicinal Plant): Marker Compound Isolation and Quality Assessment using Targeted and Non-targeted Metabolomics. Conference on High Elevation Plant Adaptation in Changing Environment (EMBO-HEPACC 2025)., CSIR-IHBT, Palampur, India. February 25-28.

Bains R and Das P (2024) 1st international Conference on 'Molecules to Materials: Chemistry for Sustainable Future (M2ChemsF) at NIT Hamirpur, Himachal Pradesh. November 21-22.

Chandra D and Sharma U (2024) Enabling C-H Functionalization of Isoquinolone Derivatives via Native Directing Group Strategy, International Conference on Advances in Chemical and Applied Sciences for Sustainable Development (ACASSD-2024), JECRC University, Jaipur. March 29-30.

Devi M, Kumar A and Dkhar J (2025) Antifungal activity of a defensin peptide from *Nepenthes khasiana*. In: 10th Indian Peptide Symposium, IISER Pune. February 26-28.

Devi M, Kumar A, and Dkhar J (2024) Exploring the potential of *Nepenthes khasiana* defensin as a natural biocontrol agent. In: International Conference on Innovations in Biotechnology for Sustainability (IBS-2024), Jawaharlal Nehru University, New Delhi, India. November 23-25.

Dhiman K and Dkhar J (2024) Endophytic microbes from *Nepenthes khasiana* enhance Arabidopsis growth under phosphate-deficient conditions. In: International Conference on Innovations in Biotechnology for Sustainability (IBS-2024), Jawaharlal Nehru University, New Delhi, India. November 23-25.

Dhiman K and Dkhar J (2024) Exploring the role of *Nepenthes khasiana* endophytes in organic phosphate mineralization and plant growth promotion. In: Annual International Conference of "The Association of Microbiologists of India", Guru Jambheshwar University of Science and Technology, Hisar, Haryana. November 14-17.

Dkhar J (2025) Histology in Plant Tissue Culture. In: Capacity Building Program on Plant Tissue Culture at CSIR-IHBT, Palampur. January 24.

Dogra V (2025) Carotenoids underline photoprotection and generate retrograde signals to sustain photoinhibitory stress in C4 model plant Setaria italic. Oral presentation at EMBO-HEPACC conference held at CSIR-IHBT. February 25-28.

Dogra V (2025) Emerging roles of chloroplast in defense and immunity. Oral presentation in New Vistas in Plant Pathological Research held at CSK HPKV, Palampur, November 13-14.

Dutta M, Mali S, Raturi V, Goel K, Vishal, Kumar R, Acharya V and Zinta G (2025) Cytosolic ASCORBATE PEROXIDASE 2 in heat-induced redox regulation to improve physiological fitness and tuber yield in potato (Solanum tuberosum L.). EMBO Workshop on High Elevation Plant Adaptation in a Changing Climate (HEPACC), CSIR–Institute of Himalayan Bioresource Technology, Palampur, India. February 25-28.

Ghosh D, Twinkle, Thakur S and Dogra V (2025) FtsH6 protease regulates protein quality control of PSII-LHC and plastid gene expression under heat stress in plants. Oral presentation at Gordon Research Conference on Chloroplast Biotechnology, held in Florence, Italy. March 30-April 04.

Godara R, Mohapatra S, Vaishanvi S and Dogra V (2025) Plastidial-oxylipins regulate the interplay of light and defence responses governing plant development under changing climate. Poster presentation in EMBO-HEPACC conference held at CSIR-IHBT, February 25-28.

Goel A, Das P and Padwad Y (2024) Delivered oral presentation entitled "Benzosuberene-alkyl sulfones halt mitotic clonal expansion, encourages the mitochondrial uncoupling for non-shivering thermogenesis and improve energy metabolism by rejuvenating brown adipose tissue" for the 54th Annual conference of the Indian Pharmacological Society (IPSCON-2024" held at AIIMS New Delhi. November 27-30.

Gupta SS and Sharma U (2024) Reactivity Tuner Assisted SEAr reaction For p-C-H Halogenation of Indolines and Anilines, International Conference on Advances in Chemical and Applied Sciences for Sustainable Development (ACASSD-2024), JECRC University, Jaipur. March 29-30.

Hallan V, Chaudhary S, Tamang A, Sharma K, Selvaraj V, Kumar S and Kumar R (2025) Impact of Climate Change on the Incidence and Transmission of Apple Scar Skin Viroid. Submission 179, page 177; oral presentation at the EMBO Workshop on High Elevation Plant Adaptation in a Changing Climate (HEPACC), Palampur, India. February 25–28.

Joshi R, Kumari A, Nath J, Patial M, Kumari K and Devi K (2025) Delivered oral presentation Creeping with Changing Climate: Micropropagate to Invade in High Altitudes. EMBO Workshop organized by CSIR-IHBT, Palampur on "High Elevation Plant Adaptation in a Changing Climate (HEPACC)" in Palampur. February 25-28.

Kumar D (2024) Resource Person, and delivered a lecture during training and demonstration programme for other stakeholders on cultivation and conservation of important temperate medicinal plants for livelihood generation. June 28.

Kumar R (2024) Saffron (*Crocus sativus* L.) Production beyond Kashmir: Efforts and Challenges.

Kumari A (2024) Attended International Conference on Green Hydrogen (ICGH-2024) organized by Ministry of New and Renewable Energy at Bharat Mandapam, New Delhi. September 11-13.

Kumari S and Sharma U (2024) Exploration of phytochemicals responsible for antimalarial activity

of Cissampelos pareira L. International Conference on Advances in Chemical and Applied Sciences for Sustainable Development (ACASSD-2024), JECRC University, Jaipur. March 29-April 03.

Mohapatra S, Mishra A, Godara and Dogra V (2025) Chloroplast-derived oxidized flavonoid mediated retrograde signalling in tea under drought. Poster presentation at Gordon Research Conference on Plant Proteolysis, held in Florence, Italy. Jan 19-24.

P. S. Bora and U Sharma (2025) Unique Adaptive Defense Metabolites in the High-Altitude Himalayan Medicinal Plant *Fritillaria cirrhosa* D.Don: A Biochemometric-Guided Exploration of Bioactive Steroidal Alkaloids, Conference on High Elevation Plant Adaptation in Changing Environment (EMBO-HEPACC-2025), , 2025, CSIR-IHBT, Palampur, India. February 25-28.

Raturi V, Ranjan A, Pandey K, Sreeprakash A, Sen S, Kumar R, Acharya V and Zinta G (2025) Interplay between warm temperature and heat signals in Arabidopsis thaliana from diverse ecological niches. EMBO Workshop on High Elevation Plant Adaptation in a Changing Climate (HEPACC), CSIR–Institute of Himalayan Bioresource Technology, Palampur, India. February 25-28.

S Puri and U Sharma (2025) Chemometric-guided Isolation of New Oleanane-type Triterpenoid Saponins as AChE Inhibitors from Achyranthes bidentata Blume seeds: In vitro, In silico and Quantitative studies, Conference on Current Trends in Drug Discovery Research (CTDDR-2025). CSIR-CDRI, Lucknow, India (Oral Presentation) February 19-22.

S Rav, Gupta SS and Sharma U (2024) Ru(II)-Catalyzed C-H Amidation of Medicinally Relevant Benzodiazepine Scaffolds, Conference on Advances in Chemistry for Energy and Environment (CACEE -2024), TIFR, Mumbai, India. December 16-20.

Sachin and Sharma U (2024) Co(III)-Catalyzed Site-Selective C8-Allylation and Vinylation of Isoquinolones with Allyl acetate and Vinyl acetate, Conference on Advances in Chemistry for Energy and Environment (CACEE -2024), , TIFR, Mumbai, India. December 16-20.

Samkaria S and Kumari P (2024) Oral presentation on the topic “Enhancing Growth and Phytochemicals in Edible Flowers of Calendula officinalis L. with Salicylic Acid Foliar Spray” In National Conference on “Smart Farming Solutions for Ornamental Horticulture” at MHU, Karnal. November 08-09.

Sood M and Kumari P (2025) Oral Presentation on the topic “Precision Farming in Floriculture: Enhancing Yield, Efficiency, and Sustainability” In National conference on sustainable food security Organised by Dept of Botany, DDU Gorakhpur University, Gorakhpur, UP. March 11.

Srivatsan V (2024) Quality control and Regulatory aspects in seabuckthorn processing (Organized by Department of Industries and Commerce, UT of Ladakh, Leh. November 11.

T. Sharma, M. Sharma and U. Sharma*. Co(III)-Catalyzed Functionalization of Isoquinolones with Naphthoquinones, Conference on Advances in Chemistry for Energy and Environment (CACEE -2024) TIFR, Mumbai, India. December 16-20.

Tamang A, Swarnkar M, Kumar P, Kumar D, Pandey SS and Hallan V (2025) Unraveling the endomicrobiome of high-altitude medicinal plant Picrorhiza kurrooa: Insights into endophyte-associated secondary metabolite biosynthesis. Oral presentation at the EMBO Workshop on High Elevation Plant Adaptation in a Changing Climate (HEPACC), Palampur, India. February 25–28.

Twinkle, Thakur S and Dogra V (2025) Rubisco Activase is a dual localized chaperone that activates Rubisco and protects photosystem proteins under photoinhibitory conditions. Oral presentation in EMBO-HEPACC conference held at CSIR-IHBT. February 25-28.

हरि शरण, पाण्डेय प्रतिभा और सिंह सतबीर (2024) कैमोमाइल (*मैट्रिकेरिया कैमोमिला*) जीन–प्ररूपों की आनुवंशिक विविधता का लक्षणप्ररूपी मूल्यांकन. राष्ट्रीय हिंदी विज्ञान सम्मेलन–2024. p-76.

CONFERENCE/TRAINING/WORKSHOP/SYMPOSIUM ATTENDED

Kumar R (2024) Sustainability of *Crocus sativus* L. cultivation in the world in the Era of Climatic change. May16-17.

Patial V (2024) A mini webinar on “Opportunities and Mechanisms of Scientific Cooperation and Higher Education with European Union, France and CNRS” at AIIMS Bilaspur. August 31.

Kumari P (2024) National Conference on “Smart Farming Solutions for Ornamental Horticulture” at MHU, Karnal. November 08-09.

Patial V (2024) Veterinary Pathology Congress-2024 (IAVPCON 2024) held at SKAUST, Jammu. November 28-30.

Bhargav B, Singh S and Kumar R (2024) India International Science Festival (IISF) at IIT Guwahati. November 30- December 03.

Padwad Y (2025) Benzosuberene Sulfone analogues (BSAS-1) induce beiging in differentiated white adipocytes" delivered Oral presentation in invited talk in 13th Annual International Conference of Indian Academy of Biomedical Sciences (IABSCON-2025) helds at AIIMS, Bhopal. February 11-13.

Patial V (2025) National Symposium on “Translating One Health into Action in Combating Emerging Diseases, Drug Resistance and Ensuring Food Safety under Changing Climatic Scenario” organized by College of Veterinary & Animal Sciences, SVPUAT, Modipuram, Meerut, U.P. February 20-21.

Choudhary D, Gehlot A, Kumar A, Dhrek MS, Kumar D and Bhushan S (2025) Valeriana jatamansi adventitious root cultures as a sustainable source of high value metabolites. EMBO Workshop on High Elevation Plant Adaptation in a Changing Climate (HEPACC) at CSIR-IHBT, Palampur. February 25-28.

Chauhan R (2025) Annual Group Meeting of All India Coordinated Research Project (AICRP) on Medicinal &

Aromatic Plants held at ICAR-DMAPR, Anand (Gujarat). February 24-26.

Pandey SS (2025) EMBO Workshop on High Elevation Plant Adaptation in a Changing Climate (HEPACC) at CSIR-IHBT, Palampur. February 25-28.

Kumar R and Sharma M (2025) FAFAI International Convention & Expo 2025 in New Delhi, India. Organized by Fragrance and Flavour Association of India (FAFAI). March 05-07.

Kumari P (2025) National conference on sustainable food security Organized by Dept of Botany, DDU Gorakhpur University, Gorakhpur, UP. March 11.

Chauhan R (2025) Sustainable Science and Technology for Viksit Bharat (SSTV-2025), organized by CSIR-IMMT, Bhubaneswar, Odisha. March 06-07.

Choudhary D, Gehlot A, Kumar M, Kumar D and Bhushan S (2025) Sustainable sourcing of phytochemicals: Essential oil production from adventitious root cultures of Valeriana jatamansi. National Conference on Sustainable Science and Technology for Viksit Bharat (SSTV-2025) at CSIR-IMMT, Bhubaneswar, Odisha. March 06-07.

Sharma M (2025) Participated in the 26th FAFAI International Convention & Expo 2025 held at the Yashobhoomi India International Convention and Exhibition Centre (IICC) Sector 25, Dwarka, New Delhi. March 05 to 07.

CONFERENCE/TRAINING/WORKSHOP/MEETING ORGANIZED

Kumari P (2024) Organized one-day awareness cum training programme on dehydration technology of flowers at Neugal Sr. Sec. Public School, Bindraban (Palampur) district Kangra. May 3.

Chauhan R (2024) Organized thirteen (13) training programs under CSIR-Phytopharmaceutical Mission-III in different locations of Himachal Pradesh viz., Holi, Chamba (20.06.2024), Salooni, Chamba (21.06.2024), Jobrang, Lahaul & Spiti (09.10.2024), Madgran, Lahaul & Spiti (09-10-2024), Koksar, Lahaul & Spiti (16-10-2024), Tosh, Kullu (21-10-2024), Kibber, Lahaul & Spiti (08-11-2024), Chicham, Lahaul & Spiti (10-11-2024), Pangi, Kinnaur (11-11-2024), Bharmour, Chamba (04-12-2024), Samra, Chamba (05-12-2024), Chhatri, Mandi (18-02-2025).different villages of district Kullu, Mandi, Chamba, Kinnaur and Lahaul & Spiti.

Kumar A (2024) Organized World Environment Day on this occasion, Professor Sudesh Yadav, School of Environmental Sciences, Jawahar Lal Nehru University, New Delhi delivered a lecture on Sustainability and LiFE". June 5.

Chauhan R (2025) Organized two training-cum-exposure visit programs at IHBT, Palampur for the representatives of Farmers Produce Company formed by Govt. of Himachal Pradesh for Districts Chamba & Shimla (Nankhari). August 30, September 30.

Kumar R (2024) Agro and process technology of aromatic plants for the farmers of Feast Khasi Hills and West Jaintia Hill, Meghalaya. September 03-04.

Kumar A (2024) Organized Himalaya Diwas on this occasion, Professor Lal Singh, CEO, Himalayan Research Group (HRG), Shimla delivered a lecture on “Sustaining the Himalayas: Innovations and Pathways for a Resilient Future”. September 09.

Kumari P (2024) Organized one-day training cum awareness programme on Dry flower technology at Gram Panchayat Kailashpur (Panchrukhi, District Kangra.) October 25.

Chauhan R (2024) Organized One Week One Theme (as a team) at CSIR-IHBT, Palampur. November 05.

Kumar A (2024) Organized curtain raiser event for India International Science Festival (IISF) 2024 at CSIR-IHBT, Palampur. November 08.

Srivatsan V (2024) Attended the symposium Workshop on Seabuckthorn One District One Product organized by Department of Industries and Commerce, UT of Ladakh at Leh. November 11.

Kumar A and Bhushan S (2024) Organized “ideas for vikshit Bharat 2027 S&T Hackathon, IISF 2024” at IIT, Guwahati. November 30- December 04.

Kumari P (2024) Organized one-day training cum awareness programme on Dry flower technology at (Bhunad gram panchayat, Salooni, Chamba). December 6.

Chauhan R (2024) Organized seven (07) training program under Aroma Mission-III, at CSIR-IHBT, Palampur and on 30.08.2024, 13.09.2024, 03.12.2024, 03.12.2024, 11.02.2025 and Nankhari, Shimla (11.11.2024) and Hamirpur (12.12.2024) different districts of Himachal Pradesh.

Agnihotri VK (2024) Oragnized a training program entiteled “QC and Standardization of Electrohomeopathic medicines & botanical studies” at CSIR-IHBT, Palampur. December 17-19.

Saneja A (2025) Organized 6 Days Capacity Building Program for future emerging technologies: Nanotechnology in Ayurveda: Empowering Ayurvedic Doctors/Scientists/ Academician with Nanotechnology Skills funded by Ministry of Ayush, January 05-11

Kumar R (2025) Improved agro and process technology of aromatic plants and low chilling apple at Hmuifang, Sihphir, Mualpheng, Tlungvel, and Tawizo Thenzawl villages of Mizoram. January 16-18.

Joshi R (2025) Co-ordinator in Ministry of Micro, Small and Medium Enterprises, Government of India (MSME) funded Advanced Entrepreneurship Skill Development Program (E-SDP) entitled “Capacity building program on plant tissue culture” as for Empowering Masters/PhD scholars/ Industrial personnels/ Entrepreneurs/ Centre and State Government officers with Plant Tissue Culture Skills. January 20-24.

Srivatsan V and Gupta M (2025) Organized an International conference entitled "Millet Fusion: Cultivating Sustainability, Nourishing Nations” in collaboration with Amity University at Noida. January 22-24.

Agnihotri VK (2025) Oragnized a training program entiteled “Orientation, QC and Standardization of

Electrohomeopathic medicines & botanical studies" at CSIR-IHBT, Palampur. Janruary 29-30.

Shanker R (2025) the second season of National Bioinformatics Workshop, Deep Bioinformatics Boot Camp supported by DBT, India. February 17-21.

Bhargava B and Singh SS (2025) Organized a Tulip Festival and National Symposium on Ornamental Bulbous Plants. February 18-19.

Chauhan R (2024-25) Organized four exposure-cum-training program at IHBT to the progressive farmers of Distt. Mandi under HPCDP Phase II JICA-ODA under DPMU, Mandi. December 03; February 11; March 04 and 06.

Kumari P (2025) Organized two days "Capacity Building program for Village Forest Management Societies (VFMS) member/ forest field staff on value addition on natural resources-based products" at CSIR-IHBT, Palampur. March 18 to 19.

Joshi R (2025) Co-ordinator in "Two days Capacity Building program for Village Forest Management Societies (VFMS) member/ forest field staff on value addition on natural resources-based products" at CSIR-IHBT, Palampur. March 18-19.

TRAININGS IMPARTED

Mansuri Aadil Aftab (2024) Fundamentals of Molecular Plant Stress Biology Techniques. Supervised by Dr. Gaurav Zinta. (May 2024 to Jun 2024).

Navya Dewan (2024) Cloning of AtHSFA2 into pET(28)a+ Vector for Protein Expression. Supervised by Dr. Gaurav Zinta. (May 2024)

Saumyaa Thanvi (2024) Fundamentals of Molecular Plant Stress Biology Techniques. Supervisor: Dr. Gaurav Zinta. (May 2024-Jun 2024).

Sherathiya Bansal Manojbhai (2024) Hands-on training on general lab practices: Synthesis, isolation and characterization of the synthesized organic compounds. From Gujrat Arts and Science College, Ahmedabad, Gujrat, Supervised by Dr. Pralay Das (June 03 to July 03).

Aishwarya Shirahatti (2024) Hands on training in laboratory animal experimentation, histopathology and molecular techniques. Supervised by Dr. Vikram Patial (01 June to July 31).

Ayshu kumar Paswan (2024) Hands on training in laboratory animal experimentation, histopathology and molecular techniques. Supervised by Dr. Vikram Patial. (01 June to July 31).

Aparna Sreeprakash (2025) Project: Ambient High Temperature and Heat Stress Signaling in Arabidopsis. Supervised by Dr. Gaurav Zinta. (Aug 2024 to May 2025).

Ammardeep Naik (2025) Crosstalk Between HSFA2 and DNA Methylation Factors Under Heat Stress. Supervised by Dr. Gaurav Zinta. (Dec 2024 to May 2025).

Rahul Choudhary (2025) Project: Biochemical and Molecular Analysis of Plant Stress Responses. Supervised by Dr. Gaurav Zinta. (Oct 2024 to Apr 2025).

LECTURES INVITED/DELIVERED

Dr Upendra Sharma (2024) Delivered a talk in International Conference on Sustainable Development in Chemical and Material Science (SDCMS) at Central University Jammu, Jammu, India, April 04-05.

Dr Vipin Hallan (2024) Delivered a lecture Understanding the role of host and vector proteins binding with apple scar skin viroid; lead lecture at IPS North Zone and National Symposium of Himalayan Phytopathological Society on "New Vistas in Plant Pathological Research," Palampur, India.

Dr. Ankit Saneja (2024) Delivered lecture entitled "Preclinical Screening of Anticancer Drug Formulations" in Hands-on training on the basics of laboratory animals, available alternatives, and histopathological techniques in preclinical research held at CSIR Institute of Himalayan Bioresource Technology, Palampur. April 16.

Dr. Damanpreet Singh (2024) Delivered a lecture entitled "Zebrafish as an Alternative Model Organism for Mammalian Diseases" in ANRF-Funded Workshop on "Hands-on Training on the Basics of Laboratory Animals, Available Alternatives, and Histopathological Techniques in Preclinical Research" CSIR-IHBT, Palampur. 18 April.

Dr Pamita Bhandari (2024) Delivered a talk on Valorization of agroforest waste of Carya illinoinensis (Wangenh.) K. Koch and Juglans regia (L.) for amelioration of cognitive deficit on 2nd National Conference on Natural Products/ AYUSH System of Medicine organized by Experimental Pharmacology Laboratory (EPL), Department of Pharmacology, PGIMER, Chandigarh. April 19-21.

Dr. Amit Chawla (2024) delivered an invited lecture in the National Seminar entitled "Exploring the History of Traditional Medicines in the Himalayas" organized during 10-11 May 2024 by Shoolini University, Solan, H.P. on the topic "Conservation of Threatened Medicinal Plants". May 11.

Dr. Ashok Singh (2024) Delivered a lecture on "Ucch Tungta Khasetron me upyogi jaev vividhtta suervekshan, sanrakshan v pravandhan" in a one-day training program to the school students, faculty staff, Govt. Senior Secondary School Bhekhali, Kullu. May 21.

Dr Rohit Joshi (2024) Delivered a lecture on Challanges opportunities and advancements in developing climate resilient crops. Value added course organized by Institute of Agriculture and Natural Sciences, Deen Dayal Upadhyaya Gorakhpur University entitled "Current Interventions in Agriculture and Allied Research" 24-30th May.

Dr Upendra Sharma (2024) Delivered a talk in 30th International conference on Organometallics Chemistry (ICOMC24) at The Jaypee palace, Agara, India during July 14-18th, 2024. July 14.

Dr Amitabha Acharya (2024) Delivered a lecture on Understanding Protein Corona formation at the Nano-Bio Interfaces and Assessment of their Biological Implications in International Conference on "Engineered Materials for Sustainable Development (EMSD-2024)", Jointly organized by Physics Department, Punjab

Engineering College, Chandigarh and National Agri-Food Biotechnology Institute, Mohali Punjab. July 26.

Dr. Ankit Saneja (2024) Delivered Invited talk entitled "Exploring Sustainable Food Packaging: Incorporating Nanomaterials into Chitosan-Alginate Films for Mushroom Preservation" in Engineered Materials for Sustainable Development Conference at PEC Chandigarh. July 26.

Dr Rohit Joshi (2024) Delivered a lecture on Plant Stress Physiology: Genetic Engineering for sustainable Agriculture on 08-07-2024. In ANRF-SERB Research Internship Vritika "Trait based phenotyping for plant-environment interaction" organized by Department of Plant Physiology, ICAR-IARI, New Delhi, 01-31st July, 2024.

Dr. Amit Chawla (2024) Delivered an invited lecture on "Satellite Remote Sensing: Knowing Earth from Space" on the occasion of National Space Day organized by GGDSD College, Rajpur, Palampur. August 23.

Dr. Amit Chawla (2025) Delivered an invited talk (online) "Elevational patterns of plant diversity in the western Himalaya "in National Seminar on Nature and Society (NSNS-2024) organized by Government Arya Degree College, Nurpur. September 02.

Dr Amitabha Acharya (2024) Delivered a lecture on Targeted Drug Delivery using Nanoscale Materials: A Step Towards Personalized Medicine in International Conference on "Innovation in Mesoscience & Nanotechnology: A Futuristic Paradigm", Jointly organized by Laureate Institute of Pharmacy, Jawalamukhi and University Sultan Zainal Abidin, Malaysia. September 14.

Dr Sukhjinder Singh (2024) Delivered a talk entitled, "Role of Technology Transfer in Entrepreneurship Development" during interactive session, "Technology Transfer and Entrepreneurship Development " organized by The Golden Jubilee Centre for Entrepreneurship and Innovation (GJCEI) at Guru Nanak Dev University, September 27.

Dr. Amit Chawla (2024) Delivered two Invited Lectures in "One Week Short-term Course on Climate Change and Environment (Multidisciplinary)" conducted by the UGC-Malaviya Mission Teacher Training Centre (MMTTC), Guru Nanak Dev University, Amritsar and Delivered another lectures on the topics "Climate Change Impacts on Vegetation of Himalaya" and" Satellite Remote Sensing: An Integral Tool in Biodiversity Management". September 28.

Dr. Damanpreet Singh (2024) Delivered a talk on "Unlocking Potential: The Role of Genomics in Transforming Drug Discovery" in a Faculty Development Program on New Horizons and Paradigm in Pharmacology and Toxicology Research organized by School of Pharmacy, Chitkara University, Himachal Pradesh. September 20.

Dr Rohit Joshi (2024) Delivered a lecture on From tissue culture to biotechnology: scientific revolutions for abiotic stress tolerance on 15-10-2024. In Industry collaborated workshop on "Recent advances in plant tissue culture and genetic transformation in crop plants" organized by Department of Biotechnology, Chandigarh University, Chandigarh, 14-16th October, 2024.

Dr. Damanpreet Singh (2024) Delivered a talk entitled "Integrating Multiomics to Identify Novel Therapeutic Biomarkers: A Special Reference to Epilepsy" as a resource person at at the International Conference on "Advancing Pharmaceutical and Health Sciences: Merging Innovation, Research, and Academia" (APHS: MIRA) organized by Career Point University, Hamirpur in association with APTI. November 21.

Dr Rakesh Kumar (2024) Delivered a lead talk entitled "Aromatic crop cultivation in Himalayas: A path to sustainable agriculture and economic resilience" in National Seminar on Medicinal and aromatic Plants in perspective of Health and Wealth held at Anand Gujrat. October 22-23.

Dr. Ashok Singh (2024) Delivered a lecture on "Ucch tungta khasetron me upyogi padap jaev vividtta, servekshan, sanrakshan" in a meeting to the farmers, societies of tribal area, Udaipur sub-division Lahaul Valley, organized by RCFC North Region (NMPB) Jogindernagar Mandi. October 23.

Dr Gireesh Nadda (2024) Delivered a lecture in Children Science Congress at PM Shri Govt Sr. Sec. School, Bhuthi, Kullu. November 06.

Dr. Amit Chawla (2024) Delivered an Invited Lecture during Refresher Course in Life Sciences, organized by Dept. of Botany, and University-HRDC, University of Jammu. on the topic "Climate Change Impacts on Vegetation of Himalaya". November 20.

Dr Amitabha Acharya (2024) Delivered a lecture on Biogenic Functional Silica Nanomaterials for Sustainable Biological Applications, in Ist International Conference on "Molecules to Materials: Chemistry for Sustainable Future (M2ChemSF-2024)" at Department of Chemistry, National Institute of Technology (NIT), Hamirpur. November 21.

Dr Upendra Sharma (2024) Delivered a talk in 31st International conference on Molecules to Materials: Chemistry for Sustainable Future (M2ChemSF) at NIT, Hamirpur, India during November 21st-22nd, 2024. November 22.

Dr Sukhjinder Singh (2024) Delivered lecture on Technologies available at CSIR-IHBT Palampur 'IISF 2024" (28th, November -05th, December 2024) at IIT Guwahati. Also showcased the CSIR-IHBT technologies (Agro technology, Biotechnology, Chemical Technology, and Food and Nutraceuticals Technology etc.), Nov 28 to Dec 05.

Er Mohit Sharma and Dr Upendra Sharma (2024) Delivered a lecture on Natural fiber from underutilized Himalayan Bioresources for various applications at One Week National Level Workshop on "Role of Natural Fibers in Sustainable Development" organized by Department of Mechanical Engineering, Sandip Institute of Technology and Research Centre, Nashik. December 02-07.

Dr Upendra Sharma (2024) Delivered a talk in 37th International Symposium on C-H Activation (ISCHA-2024) at IIT Bombay, India during 6th-9th December 2024. December 6.

Dr Kunal Singh (2024) Delivered a lecture on he microRNAs and their tentative targets play role in Arabidopsis interaction with fungal endophytes. In: National Conference on Advances and Perspectives in Cryptogam Research (Organized by Indian Lichenological society and CSIR-NBRI at NBRI campus, Lucknow, UP), December 09.

Er Mohit Sharma (2024) Delivered an Online lecture was given on Post-harvest management, raw material handling, drying, storing and value addition of medicinal & aromatic plants at A Farmers' Training Program on identification, cultivation, conservation, sustainable utilization, post-harvest management & marketing of important herbs & medicinal plants of Kangra region under the Central Sector Scheme of National Medicinal Plants Board, Ministry of Ayush. December 10-11.

Dr Vijai Kant Agnihotri (2024) Delivered a lecture entitled "Introduction to AAS (Atomic Absorption Spectroscopy)" delivered in a training program on QC and Standardization of Electrohomeopathic medicines & botanical studies at CSIR-IHBT, Palampur on 17-19 December 2024 CSIR-IHBT, Palampur. December 17.

Dr Vijai Kant Agnihotri (2024) Delivered a lecture entitled "Theoretical background of instruments used for analytical works (GC, GC-MS, HPLC, and NMR, etc" delivered in a training program on QC and Standardization of Electrohomeopathic medicines & botanical studies" at CSIR-IHBT, Palampur on 17-19 December 2024, at CSIR-IHBT, Palampur. December 17.

Dr Sarita Devi (2024) Delivered a lecture on "Introduction to Fermentation Technology" in a Training programme on "QC and Standardization of Electrohomeopathic medicines & botanical studies" at CSIR-IHBT, Palampur. December 17-19.

Dr Amitabha Acharya (2024) Delivered a lecture on Carbon Nanomaterial Based Nanozymes and Nanoenzymes for Therapeutic Applications in International Conference on "Frontiers in Nanomaterials Sciences: Aspects in Biotechnology and Chemical Engineering (FINS, 2K24)" Jointly organized by Department of Chemistry and the Department of Chemical Engineering & Technology at the National Institute of Technology Patna. December 22.

Dr. Amit Chawla (2024) Delivered a lecture "Elevational patterns of plant diversity in the western Himalaya" at Department of Plant Sciences in Central University of Himachal Pradesh, Shahpur. December 24.

Dr Vikram Patial (2025) Delivered an invited talk on "Preclinical safety and efficacy evaluation of natural products" in a Capacity building program for Future Emerging Technologies "Nanotechnology in Ayurveda" at CSIR-IHBT. January 06-11.

Dr Poonam Kumari (2025) Delivered a lecture on Floriculture in Capacity Building Programme for B.Sc. Agriculture students from Banaras Hindu University, Varanasi (UP) on "Exposure visit cum hands-on training to different Agrotechnologies of Floriculture, Aromatic, Medicinal, Spices and Plantation Crops" at CSIR-IHBT, Palampur. January 07.

Dr Vijai Kant Agnihotri (2025) Delivered a lecture entitled "Analysis of Ayurvedic Medicines" delivered in the Capacity Building Program for Future Emerging Technologies, "Nanotechnology in Ayurveda Empowering Ayurvedic Doctors/Scientists/Academicians with Nanotechnology Skills Organized at CSIR-IHBT, Palampur. January 08

Dr. Damanpreet Singh (2025) Delivered a lecture entitled "Bridging Ancient Wisdom with Modern Science: Advanced Tools for Validating Traditional Medicine" Ministry of AYUSH Funded "6-day Capacity Building Program for Future Emerging Technologies on Nanotechnology in Ayurveda", CSIR-IHBT, India. January 07.

Dr Shashi Bhushan (2024) Delivered a lecture entitled "From Ayurveda to Evidence-Based Practice: Validating Nutraceuticals Through R&D" in a Capacity building program for Future Emerging Technologies "Nanotechnology in Ayurveda" at CSIR-IHBT. January 09.

Dr Shiv Shanker Pandey (2025) Delivered an expert lecture on "Effect of exogenous elicitors on *in vitro* plant development" in the Capacity Building Program On Plant Tissue Culture at CSIR-IHBT, Palampur. January 23.

Dr Shiv Shanker Pandey (2025) Delivered a talk on "Endophytes of Himalayan medicinal plants pivotal to plant secondary metabolite biosynthesis and stress tolerance" in EMBO Workshop on High Elevation Plant Adaptation in a Changing Climate (HEPACC) at CSIR-IHBT, Palampur. February 25.

Dr. Amit Chawla (2025) Delivered a lecture on "Electro-homeopathy plants of western Himalaya" in the training programme "Quality control, standardization and botanical studies of electro-homeopathic drugs" at CSIR-IHBT. December 19 & January 29.

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. January 29-30.

Dr Vijai Kant Agnihotri (2025) Delivered a lecture entitled "Theoretical background of instruments used for analytical works GC, GC-MS, HPLC, AAS, and NMR, etc" delivered in a training program on "QC and Standardization of Electrohomeopathic medicines & botanical studies" at CSIR-IHBT, Palampur. on 29-30 January CSIR-IHBT, Palampur. January 30.

Dr Sukhjinder Singh (2025) Delivered online talk on "Business opportunities in Medicinal & Aromatic plants sectors Including floriculture and the technologies available at CSIR-IHBT Palampur" in the "Entrepreneurship Development Program on Medicinal and Aromatic plants organised at Bhopal under the sponsorship of Department of Science & Technology, Government of India, February 07.

Dr Amitabha Acharya (2025) Delivered a lecture on Nanomaterials as Next Generation Theragnostic Probe for Bacterial Infection in Two Days International Conference on The Evolving Healthcare Landscape: Challenges and Opportunities Across Different Verticals at Shiva

Institute of Pharmacy Chandpur, Bilaspur (H.P.) -174004 (February 15-16, 2025) on February 16.

Dr Gaurav Zinta (2024) Delivered a lecture on Regulatory Networks of Heat Sensitivity and Saponin Bitterness in Chenopodium quinoa. National Conference of Plant Physiology, ICAR-CPCRI, Kasaragod, Kerala, India. February 17-19.

Dr Gaurav Zinta (2025) Delivered a lecture on Dynamics of CO2 Assimilation and Evolution Pathways in Cold Region Crops Under Heatwaves, EMBO Workshop on High Elevation Plant Adaptation in a Changing Climate (HEPACC), CSIR–Institute of Himalayan Bioresource Technology, Palampur, India. February 25-28.

Dr Rakesh Kumar (2025) Delivered a talk entitled "Transforming Agriculture: Precision Farming and Drone Solutions for Sustainable Growth" in the training program on Application of Drone Technology for Smart Agriculture and Precision Farming' being organised in association with CSIR-Central Institute of Medicinal and Aromatic Plants (CIMAP), Lucknow, at CSIR-HRDC, Ghaziabad. February 19-21.

Dr Vikram Patial (2025) Delivered an invited talk on "Natural Products as Alternative Strategies in Animal Healthcare: Advances and Opportunities" in National Symposium on "Translating One Health into Action in Combating Emerging Diseases, Drug Resistance and Ensuring Food Safety under Changing Climatic Scenario" organized by College of Veterinary & Animal Sciences, SVPUAT, Modipuram, Meerut, U.P. February 20-21.

Dr. Ankit Saneja (2025) Delivered Invited talk entitled "The Science of Nutraceutical Formulations: Unlocking the Potential of Functional Foods" in A-ESDP on Functional Foods, Nutraceuticals and Their Safety at National Agri-Food and Biomanufacturing Institute (NABI), Mohali. February 22.

Dr Pamita Bhandari (2025) Delivered a talk on Himalayan Plant Based Natural Colorants: An Emerging Window for Food Industry on Tulip Festival and National Symposium on ornamental Bulbous Flowers at CSIR-IHBT. February 18-19

Dr Pamita Bhandari (2025) Delivered a talk on Characterization and Natural Variability of Polyphenols in Western Himalayan Rhododendron arboretum. EMBO workshop on High elevation Plant Adaptation in a Changing Climate at CSIR-IHBT. February 25-28.

Dr Sukhjinder Singh (2024) Delivered talk on Research Writing and Research Methodology in Higher Education (Multidisciplinary) Theme (24th February to 02nd March 2025) in 'International One Week Faculty Development Programme' sponsored by Purushottam Khaparde Health & Education Society's Arts & Commerce College Nagpur Maharashtra, India in collaboration with Cape Comorin Trust, India in Associated with Harvest an International Multidisciplinary and Multilingual Research Journal, Feb 24 to March 02.

Dr. Damanpreet Singh (2025) Delivered a keynote lecture entitled "Regulatory Landscape and Innovation: Empowering Startups in Indian Pharmaceutical Sector" as a resource person on the theme "Entrepreneurship and Startups in Pharma and Pharmacy Practice: Encouraging Innovation, Incubation Centers and Pharmaceutical Startups" during Pharma Anveshan-2025 at the Laureate Institute of Pharmacy, Himachal Pradesh. March 06.

Dr Kunal Singh (2025) Delivered a lecture on A TIR-NBS-LRR gene StTNLC7G2T1 improve plant resistance against fungal and bacterial pathogens. In National symposium on Molecular Intricacies on Plant Associated Microbes-2025 (Organised by IIT Mandi at Mandi, HP). March 07.

Dr. Amit Chawla (2025) Delivered an invited talk "Ecological Carrying Capacity Framework: Policy Instrument and Tool for Sustainable Management of Protected Areas of India"on 7th March 2025 in National Conference on Environment (NCE 2025) organized by Government Arya Degree College, Nurpur. and sponsored by HIMCOSTE, Shimla. March 07-08.

Dr Sukhjinder Singh (2025) Delivered talk on "CSIR-IHBT Technologies" during "Stakeholder Meet on dimensions of CSIR Technologies on Andaman and Nicobar Islands" at Jwaharlal Nehru Rajkeeya Mahavidyalaya Andaman Nicobar jointly organized by CSIR-NiScPR, VIBHA and JNRM, March 11-13.

Dr Poonam Kumari (2025) Delivered lecture on Value addition of flowers through dehydration technology at 10-11 am on 19.3.25 in two days "Capacity Building program for Village Forest Management Societies (VFMS) member/ forest field staff on value addition on natural resources-based products" at CSIR-IHBT, Palampur. March 18 to 19.

Dr. Damanpreet Singh (2025) Delivered a lecture entitled "Innovating Drug Discovery: The Power of AI and Zebrafish Models" as a key note speaker in an international conference on "AI-Solutions for Pharmaceutical, Bio-Sciences, and Environmental Management Sri Sai University, Palampur H.P." Organized by the Sri Sai University, Palampur Himachal Pradesh. March 23.

Dr Sukhjinder Singh (2025) Delivered talk entitled 'Importance of Research in the Areas of Green Technologies and Sustainable Innovations" during Green Technologies and Sustainable Innovations in Multidisciplinary Research Theme (25th March to 31st March 2025) in 'International One week Faculty Development Programme' sponsored by Purushottam Khaparde Health & Education Society's Arts & Commerce College Nagpur Maharashtra, India in collaboration with Cape Comorin Trust, India in Associated with Harvest an International Multidisciplinary and Multilingual Research Journal, March 29.

RADIO/TELEVISION TALK

U Sharma (2024) Delivered a talk in 2-Week Refresher Course on Physical, Chemical & Material Sciences (RC-351) organised by Himachal Pradesh University, Shimla, India during November 18th-30th, 2024 (26th November, 2024).

Acharya A (2024) Delivered a talk Nano-biocomposites as antibacterial and wound healing agents in Short Term Course (e-STC) on "Chemistry for Energy, Environment and Biomedical Applications" at Department of Chemistry, NIT Hamirpur. December 18.

U Sharma (2024) Delivered a talk in 2-Week Refresher Course on Refresher Course on Physical & Chemical Sciences organised by Central University of Jammu, India during November 10th-23rd, 2024 (10th December, 2024).

U Sharma (2025) Delivered a talk in National Conference on Green and Sustainable Approaches in Chemical Sciences (GSACS-2025), 24-25 March, 2025, BBAU, Lucknow. March 25.

ABSTRACT PRESENTED

Srivatsan V (2024) Development and deployment of microalgae fortified low coast functional foods for combating anaemia and protein deficiency among Indian children in 8th Congress of International Society for Applied Phycology, Porto, Portugal. June 16-21.

Samkaria S, Sharma S and Kumari P (2024) Enhancing growth and phytochemicals in edible flowers of (Calendula officinalis L.) with salicylic acid foliar spray. In National Conference on "Smart Farming Solutions for Ornamental Horticulture" at MHU, Karnal. pp 168. November 08-09.

Kumar A and Kumar A (2024) Bioprospecting Lytic polysaccharide monooxygenases for industrial applications. International conference on innovation in Biotechnology for sustainability jointly organized by the Jawaharlal Nehru University, New Delhi and the Biotech Research Society, New Delhi. November 23-25.

Chauhan M and Kumar A (2024) A low-temperature induced novel isozyme of *Camellia sinensis* mitochondrial superoxide dismutase (CsMSD) is highly thermostable and exhibits peroxidase activity. International Conference on Innovations in Biotechnology for Sustainability (IBS-2024), Biotech Research Society and Jawaharlal Nehru University, New Delhi. November 23-25.

Chauhan M, Himanshu and Kumar A (2025) Structural-functional investigations of a thermotolerant mitochondrial superoxide dismutase of *Camellia sinensis* (*Cs*MSD). European Molecular Biology Organization (EMBO) Workshop on High Elevation Plant Adaptation in a Changing Climate (HEPACC), CSIR-Institute of Himalayan Bioresource Technology (CSIR-IHBT), Palampur. February 25-28.

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*. EMBO Workshop on High Elevation Plant Adaptation in a Changing Climate (HEPACC), CSIR Institute of Himalayan Bioresource Technology, Palampur. February 25-28.

Kumar A, and Kumar A (2025) Comprehensive Genomic and Transcriptomic Analysis of *Trichoderma harzianum* for the Identification of Lytic Novel Polysaccharide Monooxygenases (LPMOs). EMBO workshop on High Elevation Plant Adaptation in a Changing Climate (HEPACC), CSIR-Institute of Himalayan and Bio-resource Technology, Palampur. February 25-28.

Sood M and Kumari P (2025) Precision Farming in Floriculture: Enhancing Yield, Efficiency, and Sustainability. In National conference on sustainable food security Organised by Dept of Botany, DDU Gorakhpur University, Gorakhpur, UP. pp 56-57. March 11.

Thakur K and Kumar V (2025) Floristic diversity of Dhauladhar Wildlife Sanctuary, Himachal Pradesh, India. In: Sustainable Food Security [SFS 2025] (organized by Dept. of Botany, DDU Gorakhpur University, UP). March 11.

Kumar R and Kumar V (2025) Diversity and distribution of genus Cremanthodium Benth. in the Indian Himalaya. In: Sustainable Food Security [SFS 2025] (organized by Dept. of Botany, DDU Gorakhpur University, UP). March 11.

AWARDS AND RECOGNITIONS

Agnihotri VK (2025) Selected as an official Nominator for VinFuture prize.

Bains R and Das P (2024) Best oral presentation award to Mr. Rohit Bains for "Development of innovative methods for the valorization of lignocellulosic biomass into value-added compounds" has been presented in 1st International Conference on "Molecules Materials: Chemistry for Sustainable Future (M2ChemSF)" by Department of Chemistry, NIT, Hamirpur. November 21-22.

Bhandari P (2024) Awarded the 2nd best presentation award at 2nd National Conference on Natural Products/ AYUSH System of Medicine at PGIMER Chandigarh. April 19-21.

Bhargava B (2024) Received Fellow of the Indian Society of Ornamental Horticulture (ISOH).

Chandel A and Bhargava B (2024) Awarded best poster award in "Tulip Festival and National Symposium on Ornamental Bulbous flowers" organized by Indian Society of Ornamental Horticulture on Exogenous Application of Gibberellic acid modulates the Growth, Flowering, and Longevity of Calla lily held at CSIR-IHBT Palampur on February 18-19.

Chandel A and Bhargava B (2024) Awarded best poster award in the "National Conference on Smart Farming Solutions for Ornamental Horticulture" for Lemon Grass Essential Oil Improves Gladiolus Grandifloras Post-Harvest Life by Modulating Water Relations, Microbial Growth and Biochemical Activity and Gene Expression at MHU, Karnal (Haryana). November 08-09.

Goel A and Padwad Y (2024) Awarded in the Diabetes symposium on "Emerging Therapeutics Strategies for the Treatment of Diabetes and Diabetic Complications" on the occasion of World Diabetes Day, organized by the department of pharmacology and Toxicology, NIPER S.A.S Nagar, Mohali. November 14.

Joshi R Academic Editor: PloS ONE (ISSN: 1932-6203) April 01.

Joshi R Editor, International Journal of Agricultural Science and Food Technology (ISSN: 2455-815X). April 01.

Joshi R Editorial Board Member: Biotechnology and Bioinformatics Journal. April 01.

Joshi R enlisted in top 2% global scientist list by Stanford University and Elsevier. Sept 22.

Joshi R External examiner for Viva voce examination of PhD thesis of South Asian University, New Delhi. September 27.

Joshi R Guest Editor of special issue "Molecular Genetics in plant responses to abiotic stress" in MDPI journal "Biology". Dr Abhishek Bohra, Dr Rajeev Varshney (2023-2024)

Joshi R Master's thesis evaluation of DAV University, Jalandhar. Oct 08.

Joshi R Review Editor, Frontiers in Plant Science, Plant Abiotic Stress. April 01.

Joshi R Review Editor, Pantnagar Journal of Research, Plant Physiology Section. April 01.

Joshi R Reviewing Board of 44 peer-reviewed journals and reviewed 98 Manuscripts. April 01 to March 31.

Joshi S (PI: Dr Rohit Joshi), DBT SRF, on securing first position in "Flash Talk" entitled "Nardostachys jatamansi (D.Don) DC.: An Untapped, Cold Adapted and Critically Endangered Himalayan Bio-Resource" in 8th Student Seminar Series-2024. September 05.

Kumar R (2024) Awarded best poster in the 8th Student Seminar Series at CSIR-IHBT, Palampur. September 05.

Kumari A (PI: Dr Rohit Joshi) got SERB travel grant and DBT travel grant to present her poster in 2024 World Congress on in vitro Biology, USA. July 07.

Kumari K (PI: Dr Rohit Joshi) selected as finalist in Bob V. Conger Plant Biotechnology Student Oral Competition in 2025 In Vitro Biology Meeting. February 22.

Mamta, Pandey SS, Kaachra A, Vashisath S, Kumar D, Kumar S (2024) Poster entitled "Enhancing photosynthesis, biomass, and yield by coexpressing phosphoenolpyruvate carboxylase, aspartate aminotransferase, and glutamine synthetase for improved carbon and nitrogen utilization in *Brassica juncea*" authored by awarded best poster presentation award in the Second National Genetics Congress "Genetics and Genomics for a Better Future: Microbes to Man" held at ICAR-IARI, New Delhi. December 11-13.

Misra A, Rana S, Birsanta G, Verma K, Chandel A, Bodh R, Singh RK and Bhargava B (2025) Awarded the best paper award in the Tulip Festival and National Symposium on Ornamental Bulbous flowers" organized by Indian Society of Ornamental Horticulture on Evaluating tulip growth, flowering and bulb development in different agroclimatic conditions of western Himalaya held at CSIR- IHBT Palampur. February 18-19.

Nandini and Acharya A (2025) Harnessing Himalayan Bioresource for Carbon Nanomaterial to Target Amyloid Protein Aggregation" in 3rd International Conference on Emerging Trends in Biosciences and Chemical Technology Cum Workshop on Skills in Biosciences at Shri Mata Vaishno Devi University (SMVDU), Jammu & Kashmir. Jammu & Kashmir. February 14-15.

Nisha A and Acharya A (2024) Bio-inspired Carbon Dots as Potential Nanozymes for Combating Glioblastoma Hypoxia" International Conference on Composite Materials for Environmental Protection & Remediation (ICCMEPR - 2024), Gram Bharti College, Ramgarh, Kaimur, Bihar, India under the Flagship of Chemical Research Society of India. July 02-03.

Patial V (2024) Received the IAVP-Dr B.L. Purohit Memorial Best Toxico-Pathologist Award-2024 by the Indian Association of Veterinary Pathologists (IAVP) in Veterinary Pathology Congress-2024 held at SKAUST, Jammu. November 28-30.

Randhawa S and Acharya A (2024) Beta-Amyloid Oligomer Targeted Dopamine-conjugated Gold Nanoparticles to Attenuate Toxicity in Alzheimer's Disease via Dopadelic Boost of Synaptic Function" in International Conference on "Engineered Materials for Sustainable Development" EMSD 2024, Jointly organized by Physics Department, Punjab Engineering College, Chandigarh and National Agri-Food Biotechnology Institute, Mohali Punjab. July 24-26.

Ravi Raj (2025) Awarded PhD Industrial Exposure Fellowship (PIEF) by the Indo-German Science and Technology Centre (IGSTC) at Lionex Diagnostics and Therapeutics GmbH in Braunschweig, Germany. October 2024- March 2025.

Rawat M (Dr Rohit Joshi) got first prize in "हिन्दी लोकप्रिय विज्ञान लेखन", during "हिन्दी पखवाड़ा समारोह-2024". September 19.

Roy A and Hallan V (2024) Kappaphycus alvarezii-derived formulation enhances anti-viral resistance in Solanum lycopersicum. Oral presentation at the Student Seminar Series 2024, CSIR-IHBT, Palampur, India. Awarded Best Oral Presentation. September 05.

Roy A and Hallan V (2024) Red seaweed derived formulation enhances anti-viral resistance in Solanum lycopersicum. Poster presentation at IPS North Zone and National Symposium of Himalayan Phytopathological Society on "New Vistas in Plant Pathological Research," Palampur, India. Awarded Best Poster Presentation. November 07–08.

Saini TC and Acharya A (2025) Mitigation of Bacterial Biofilm Protein Induced Cross-Seeding of Aβ (1-42) and Synaptic Disfunction via Bio-Inspired Quantum dots" in 3rd International Conference on Emerging Trends in Biosciences and Chemical Technology Cum Workshop on Skills in Biosciences at Shri Mata Vaishno Devi University (SMVDU), Jammu & Kashmir. February 14-15

Sharma T, Sharma M and Sharma U (2024) Co(III)-Catalyzed Functionalization of Isoquinolones with Naphthoquinones, Conference on Advances in Chemistry for Energy and Environment (CACEE -2024) TIFR, Mumbai, India (Poster Presentation) Ms. Tamanna Sharma got best poster award for this poster presentation. December 16-20.

Singh D (2024) Won 1st Prize for the poster presentation by Mr. Rajneesh Kumar (Ph.D. student) for work entitled "A Native Weed Extract as an Intervention for the Management of Aluminium-induced Neurotoxicity" authored by Rajneesh Kumar, Poonam Dhiman, Shiv Kumar Saini, Damanpreet Singh* at the International

Conference on "Advancing Pharmaceutical and Health Sciences: Merging Innovation, Research, and Academia" (APHS: MIRA) organized by Career Point University, Hamirpur in association with APTI. November 21.

Singh S (2024) Awarded 3rd prize in the poster presentation at 2nd National Conference on Natural Products/ AYUSH System of Medicine at PGIMER chandigarh (April 19-21).

Singh S (2024) Awarded Ist prize in the poster presentation at 8th student Seminar Series at CSIR-IHBT, Palampur.

Subasini T (PI: Dr Rohit Joshi) Summer Research Fellowship-2024 offered by three Science Academies. April 12.

Thakur D, Verma V and Bhargava B (2025) Awarded the best paper award in the "Tulip Festival and National Symposium on Ornamental Bulbous flowers" organized by Indian Society of Ornamental Horticulture on in vitro propagation protocol for the domestication of Tulipa clusiana (Lady Tulip): a foundation for sustainable cultivation held at CSIR-IHBT Palampur. February 18-19.

Vashishta N, Katoch M and Bhargava B (2024) Awarded the best poster award in "National Conference on Smart Farming Solutions for Ornamental Horticulture" organized by Indian Society of Ornamental Horticulture on Impact of Indole Acetic Acid on Salt Stress Mitigation in Limonium bicolor and Limonium sinuatum at MHU, Karnal Haryana. November 08-09.

Verma V (2024) Received Prof. SK Sopory Young Scientist Award 2024 presented by the Indian Society of Plant Physiology (ISPP) on Engineering herbicide and disease resistance in agriculture and floriculture crops.

सिंह सतबीर (2024) The work on "कैमोमाइल (*मैट्रिकेरिया कैमोमिला*) जीन–प्ररूपों की आनुवंशिक विविधता का लक्षणप्ररूपी मूल्यांकन" was recognized as one of the three Best-Oral presentations at "राष्ट्रीय हिंदी विज्ञान सम्मेलन-2024" Bhopal (MP). July 30-31.

CERTIFICATE OF APPRECIATION

Joshi R (2025) Received Reviewer certificate from Annals of Applied Biology 2023 and 2024 and Feb 07.

MEMBERSHIP OF PROFESSIONAL BODIES/ ORGANIZATIONS

Dr. Vipasha Verma nominated as a Life member of ISOH (Indian Society of Ornamental Horticulture).

Dr Vipasha Verma nominated as a Life time membership of ISPP (Indian Society for Plant Biologists).

Vikas Soni nominated as a Life member of ISOH (Indian Society of Ornamental Horticulture).

Dr Jeremy Dakar Life member of Indian Society of Plant Genetic Resources (ISPGR) and Indian Society for Plant Physiology (ISPP) (LM 1213).

Dr. Yogendra Padwad nominated as life member Academy of Indian Academy of Biomedical Sciences and Indian Society of Translational Research.

Dr Arun Kumar became a Life member of (1) Society of Biological Chemists, IISc Banglore, India (Membership No. 4895)

Dr Arun Kumar became member of Indian Society of Chemists and Biologists, Lucknow, India (Membership No. LF 1334/2024).

Dr Vipin Hallan became life member of Indian Virological Society.

Dr Vipin Hallan became member of Indian Pytopathological Society.

Dr Vipin Hallan became member of American Society for Virology.

Dr Vipin Hallan became member of American Phytopathological Society. Feb 2026.

Dr Vidyashankar Srivatsan nominated as Life member of Nutritional Society of India, Hyderabad, (NSI Membership No.: LM 2024-0268)

Dr Vidyashankar Srivatsan Life member of Association of Food Scientists and technologists of India AFST(I), Mysuru (AFST(I) membership No.: AFSTI/ LM/2025/822)

POSTER PRESENTED

Aggarwal G, Anmol, Singh D, Chawla A, Sharma M and Sharma U (2025) Influence of Geographical Variations on Essential Oil Yield, Chemical Diversity, and Bioactivities of the High-Elevation Aromatic Herb Elwendia persica (Kala jeera) from Indian Western Himalaya, Conference on High Elevation Plant Adaptation in Changing Environment (EMBO-HEPACC 2025). CSIR-IHBT, Palampur, India. February 25-28.

Aroor M S and Gupta M (2024) Effect of post-harvest drying techniques on metabolomic variation Myrica esculenta fruits. 30th ICFOST held at DY Patil University in Navi Mumbai. December 19-21.

Bhardwaj A, Pal P and Sharma U (2025) Phytochemical exploration of High altitude Himalayan medicinal plant Trillium govanianum Wall ex D.Don for certified reference material (CRM) development, Conference on High Elevation Plant Adaptation in Changing Environment (EMBO-HEPACC-2025) CSIR-IHBT, Palampur. February 25-28.

Bhardwaj R and Singh A (2025) Identification of natural habitats for conservation of Arnebia euchroma (Royle ex Benth.) I.M. Johnst. with application of Ecological Niche Modeling Technique. In: International conference Ecosystem Functioning and Sustainability in Changing Environment, Banaras Hindu University (BHU). February 06-08.

Bora PS and Sharma U (2025) Biochemometric-Driven Isolation of Novel Isosteroidal Alkaloids from Fritillaria cirrhosa D.Don as Potential Acetylcholinesterase Inhibitors Conference on Current Trends in Drug Discovery Research (CTDDR-2025), , CSIR-CDRI, Lucknow, India. February 19-22.

Chaudhary S, Awasthi P, Tamang A, Kumar S, Sharma K and Hallan V (2025)). Elucidating the role of host phloem protein (PP2) binding with apple scar skin viroid. Poster presentation at the National Symposium on Molecular Intricacies of Plant Associated Microorganisms (MIPAM – 2025), Mandi. March 07–08.

Chauhan P, Dev R and Gupta M (2025) Study the nutritional, functional and sensory properties of millet – based extruded noodles. International conference on "The future of food science and technology: innovation, sustainability and health". March 27-28.

Chauhan R (2025) Effect of agronomic factors on yield and essential oil of Pushkarmool, a critically endangered medicinal plant of western Himalaya. Sustainable Science and Technology for Viksit Bharat (SSTV-2025). March 06-07.

Dev R, Chauhan P, Shambhvi and Gupta M (2024) Standardization of fermented millet soup rich in anthocyanins. 30th ICFOST held at DY Patil University in Navi Mumbai. December 19-21.

G Aggarwal and Sharma U (2025) NADES-Assisted Extraction of Ageratina adenophora Flowers: Enhanced Essential Oil Yield and Discovery of a New Compound, 5,11-Epoxycadin-3,4-en-8-one, Conference on Advances in Medicinal & Aromatic Plant Research in Context to Indian Ocean Region (IORA-AMAR 2025), CSIR-CIMAP, Lucknow. February 04-06

Gupta S, Hegde AS and Srivatsan V (2025) Phytochemical investigations in Urtica dioica L.: A plant of ethnomedicinal importance from the high-altitude Himalayas. High Elevation Plant Adaptation in a Changing Climate (HEPACC) organized by European Molecular Biology Organization, CSIR-IHBT. February 25-28.

Gusain S and Joshi R (2025) Exploring Elicitor Mitigated Changes in Cellular Dynamics during *In Vivo* and *In Vitro* Propagation of Saffron (*Crocus sativus* L.) under drought stress. 46th Annual Meeting of Plant Tissue Culture Association (India) and Symposium on Current Trends and Challenges in Plant Biotechnologyorganized by BITS Pilani K.K. Goa Campus and Plant Tissue Culture Association (India). Feburary 24-26.

Joshi R, Kumari A, Nath J, Patial M, Kumari K, and Devi K (2025) Creeping with Changing Climate: Micro-propagate to Invade in High Altitudes. EMBO workshop "High Elevation Plant Adaptation in a Changing Climate" organized by CSIR-IHBT, Palampur. February 25-28.

Joshi S and Joshi R (2024) *Nardostachys jatamansi* (D. Don) DC.: An untapped critically endangered Himalayan Bio-resource. 8th student seminar series, CSIR-IHBT, Palampur, H.P., India., organized by CSIR-IHBT, Palampur. September 05,

Joshi S and Joshi R (2025) Breaking barriers for transient and stable gene transformation in recalcitrant critically endangered Himalayan medicinal plant *Nardostachys jatamansi*. EMBO workshop "High Elevation Plant Adaptation in a Changing Climate" organized by CSIR-IHBT, Palampur. February 25-28.

Kumar M and Das P (2024) Conference on Advances in Chemistry for Energy and Environment (CACEE) held at Tata Institute of Fundamental Research, Mumbai, India. December 16 to 20.

Kumar R and Kumar V (2025) Taxonomic and geospatial characterization of genus Cremanthodium Benth. in Indian Himalaya: A Himalayan sunflower. In: International conference on ecosystem functioning and sustainability in changing environment (Dept. of Botany, Institute of Science, Banaras Hindu University, Varanasi. February 06-08.

Kumari A and Joshi R (2024) Revolutionizing Cultivation of Economic Bamboo Species: Macro-Propagation, Micro-Propagation and Nano-Elicitation Approaches. SIVB World Congress on In-Vitro Biology 2024 St. Louis at the Arch, St. Louis, MO, USA. organized by Society for In Vitro Biology, USA. June 8-12

Kumari A, Bhati U, Sharma P, Devi K, Shankar R, Sharma RK and Joshi R (2025) Characterizing Glyoxalase Family: Expanding Functions of Fundamental Metabolic Profiling in Phyllostachys pubescens (Mazel ex. J. Houz.). 46th Annual Meeting of Plant Tissue Culture Association (India) and Symposium on Current Trends and Challenges in Plant Biotechnology. Organized by BITS Pilani K.K. Goa Campus and Plant Tissue Culture Association (India). Feburary 24-26.

Kumari A, Bhati U, Sharma P, Devi K, Shankar R, Sharma RK and Joshi R (2025) Molecular Adaptation Mechanisms of *Phyllostachys pubescens* in High-Elevation Environments: Exploring Molecular Mechanisms and Propagation Strategies Under Changing Climate. EMBO workshop "High Elevation Plant Adaptation in a Changing Climate" organized by CSIR-IHBT, Palampur. February 25-28.

Kumari K, Kachra A and Joshi R (2024) Exploring the molecular dynamics of *in vitro* dedifferentiation and redifferentiation in *Ferula assa-foetida* L. 5th Edition of the Genomics Analysis & Technology Conference ICGEB, New-Delhi. April 12-14. P-68.

Kumari K, Kachra A and Joshi R (2024) Transcriptomics Integrated with metabolomics reveals the Dynamics of In vitro organogenesis in *Ferula assa-foetida* L. 10th International Conference on Recent Advances in Agriculture, Engineering, Applied & Life Sciences for Environmental Sustainability Uttaranchal University, Dehradun, Uttarakhand. Organized by Agro Environmental Development Society. October 23-25.

Kumari K, Mittal S, Kachra A, Kadyan V, Upadhyay J and Joshi R (2025) Artificial Neural Network Based Modeling to Optimize Somatic Embryogenesis and Metabolomics Analysis to Highlight Cellular Crosstalk During Organogenesis in *Ferula assa-foetida* L. 46th Annual Meeting of Plant Tissue Culture Association (India) and Symposium on Current Trends and Challenges in Plant Biotechnology, organized by BITS Pilani K.K. Goa Campus and Plant Tissue Culture Association (India). Feburary 24-26. P- 65.

Kumari M, Tamang A, Swarnkar M, Kumar P, Kumar D, Warghat AR, Hallan V and Pandey SS (2024) Unraveling the endomicrobiome of *Podophyllum hexandrum*: endophytic bacterial associations in *in-planta* Podophyllotoxin biosynthesis. International Conference on Innovations in Biotechnology for Sustainability (IBS-2024) at Jawaharlal Nehru University, New Delhi and the Biotech Research Society, India at New Delhi. November 23-25.

Nath J and Joshi R (2025) Exploring the Adaptive Strategies of *Picrorhiza kurrooa* in High-Elevation Habitats Amid Climatic Changes: Insights from Phytochemical Analysis, Gene Expression, and Metabolite Profiling. EMBO workshop "High Elevation Plant Adaptation in a Changing Climate" organized by CSIR-IHBT, Palampur. February 25-28.

Nath J and Joshi R (2024) WUSCHEL-related homeobox genes uncovers their differential regulation

during abiotic stress and organogenesis in endangered plant *Picrorhiza kurrooa*. 10th International Conference on Recent Advances in Agriculture, Engineering, Applied & Life Sciences for Environmental SustainabilityUttaranchal University, Dehradun, Uttarakhand. Organized by Agro Environmental Development Society. October 23-25.

Neha Y, Kumar R, Dhiman and Srivatsan V (2024) Nutritional characterization of Microalgae from Tetradesms genus towards dietary applications. 30th ICFoST "Indian convention of Food scientists and Technologists FoodSSSS – "Food Safety, Standards, Security and Sustainability at DY Patil University, Mumbai organized by Association of Food Science and technologists, India [AFST(I)]. December 19-21.

Puri S and Sharma U (2025) New Oleanane-type Triterpenoid Saponins as Defence Metabolites: A Chemometric Driven Phytochemical Investigation of Achyranthes bidentata Blume Seeds from Himalayan Region, Conference on High Elevation Plant Adaptation in Changing Environment (EMBO-HEPACC-2025) CSIR-IHBT, Palampur, India. February 25-28.

Raj Y, Kumar R and Kumar R (2024) Re-integration of *Hypericum perforatum* L. with its root-associated and non-associated beneficial bacteria distinctively sculpts rhizosphere bacterial community structure and produces differential amounts of secondary metabolites. 8th International Conference of Indian Network for Soil Contamination Research (INSCR-2024) on 'Exploring the Microbial World from Human Health to Environmental Sustainability' and 4th International Symposium on Ciliate Biology (ISCB-2024), organised by INSCR and Acharya Narendra Dev College, University of Delhi (UoD) at Conference Centre, UoD, Delhi, India. April 03-05. Pp-354.

Ranout AS, Kaur R, Kumar R and Nadda G (2024) Acaricidal potential of two native entomopathogenic fungi associated with *Ophiocordyceps indica* against *Tetranychus urticae*. CSIR-IHBT, Palampur. Sept 05.

Roy A and Hallan V (2025) Seaweed-based formulation enhances resistance in tomato against Tomato Leaf Curl Begomovirus. Oral presentation at the National Symposium on Molecular Intricacies of Plant Associated Microorganisms (MIPAM – 2025), IIT Mandi, March 07–08.

Sarthi (2025) Conference on High Elevation Plant Adaptation in Changing Environment (EMBO-HEPACC-2025) CSIR-IHBT, Palampur, India. February 25-28.

Shambhvi and Gupta M (2025) Development and characterization of sorghum based probiotic enriched flakes. International conference of millets: cultivating sustainability and nourishing nations, millet fusion at amity university, Noida. January 22-24.

Sharma A, Kumar R, Kaur R, Kumari P and Nadda G (2024) Exploring *Beauveria bassiana* associated with *Ophiocordyceps indica* for Biocontrol: Effects on *Plutella xylostella*, *Aphis craccivora*, and *Tetranychus urticae*. CSIR-IHBT, Palampur. Sept 05.

Sharma M and Sharma U (2025) Natural Deep Eutectic Solvents (NADES) as a cosolvent to enhance the essential oil yield of commercially important Himalayan medicinal plant Nardostachys jatamansi (EMBO-HEPACC-2025) CSIR-IHBT, Palampur, India. February 25-28.

Sharma P and Das P (2024) International Conference on Green Catalysis and Drug Discovery (ICRAGCDD-2024) held at Akal University, Talwandi Sabo, Bathinda, Punjab, India. September 04 to 06.

Sharma P, Sharma K and Srivatsan V (2024) Valorization of cauliflower greens for development of functional foods. 30th ICFoST "Indian convention of Food scientists and Technologists FoodSSSS – "Food Safety, Standards, Security and Sustainability at DY Patil University, Mumbai organized by Association of Food Science and technologists, India [AFST(I)]. December 19-21.

Sharma P, Sharma K and Srivatsan V (2025) Enhancing nutritional benefits: replacing wheat with millets in traditional panjeeri preparation to combat anemia and malnutrition. International conference on "MilletFusion:Cultivating Sustainability, Nourishing Nations, Amity University. January 22-24.

Sharma R and Agnihotri VK (2025) In-vitro Antidiabetic Studies of VOCs from the Roots of Rosa damascena Mill. Cultivated at High Altitudes in the North-Western Himalaya. EMBO Workshop High Elevation Plant Adaptation in a Changing Climate (HEPACC) in Palampur, India. February 25-28.

Sharma R, Anmol and Sharma U (2025) Phytochemical investigation of Himalayan medicinal plant Aconitum heterophyllum for certified reference material (CRM) development, Conference on High Elevation Plant Adaptation in Changing Environment (EMBO-HEPACC-2025), CSIR-IHBT, Palampur, India February 25-28.

Sharma R. and Agnihotri, V.K. (2024). Investigations of the antidiabetic properties of volatile organic compounds (VOCs) derived from the roots of Rosa damascena Mill. in the North-West Himalaya. Eighth Student Seminar Series at CSIR-IHBT on September 08.

Sharma T, Sharma M and Sharma U (2024) Co(III)-Catalyzed Functionalization of Isoquinolones with Naphthoquinones, Conference on Advances in Chemistry for Energy and Environment (CACEE -2024) TIFR, Mumbai, India. December 16-20.

Sharma, A, Devi, K and Kumari, A (2025). Green chemistry approach for aromatic wax extraction from floral waste: Waste to Wealth generation. National Symposium on Ornamental Bulbous Crops at CSIR-IHBT, Palampur. February 18-19.

Shivani and Sharma U (2025) Phytochemical exploration of the Indian Medicinal Plant Cocculus hirsutus (L.) W. Theob, Conference on High Elevation Plant Adaptation in a Changing Climate (HEPACC), 2025, CSIR-IHBT, Palampur, India. February 25-28.

Shivani and Sharma U (2025) Phytochemical investigation of Cocculus hirsutus (L.) W.Theob for characterization of new bioactive alkaloids, Conference on Current Trends in Drug Discovery Research (CTDDR-2025) CSIR-CDRI, Lucknow, India. February 19-22.

Shrivastav A, Awasthi S, Anmol and Sharma U (2025) Scalable Isolation of Vitexin and Isovitexin from Zanthoxylum armatum Leaves for Quality Assessment and Multilocation sample analysis, Conference on High Elevation Plant Adaptation in Changing Environment

(EMBO-HEPACC-2025) CSIR-IHBT, Palampur, India. February 25-28.

Singh A, Devi Phoola, and Bhardwaj Rajat (2025) Conservation of Important Species Polygonatum cirrhifolium (Wall.) Royle and Eremurus himalaicus Baker: Connecting the Gap between Wild Populations and Sustainability in the High Altitude areas of Himachal Pradesh. In: National conference on Sustainable Science & Technology for Viksit Bharat-2025, CSIR IIMT, Bhubaneshwar. March 06-07.

Singh Pal P, Shivprasad P Suresh and Sharma U (2024) Trillium govanianum: A Medicinal Boon, International Conference on Advances in Chemical and Applied Sciences for Sustainable Development (ACASSD-2024) JECRC University, Jaipur. March 29-30.

Singh R, Gupta H, Anmol, Aggarwal G, Bhattacharyya K, Reddy SGE, Sharma U (2025) Enhancing Essential Oil Yield from Cyperus rotundus L. Roots Using Natural Deep Eutectic Solvents (NADES) and Evaluating Its Efficacy Against Aphis craccivora Koch and Planococcus lilacinus (Cockerell), Conference on Current Trends in Drug Discovery Research (CTDDR-2025) CSIR-CDRI, Lucknow, India. February 19-22.

Singh S, Bhatt S, Gupta M and Bhandari P (2024) Characterization, stabilization and in-vitro gastrointestinal behavior of red cabbage anthocyanins on 2nd National Conference on Natural Products/ AYUSH System of Medicine at PGIMER chandigarh. April 19-21.

Tamang A, Kumar A, Kumar P, Kumar D, Pandey SS and Hallan V (2025) Microbial partners: The role of endomicrobiome in growth and secondary metabolites biosynthesis in Picrorhiza kurrooa. Oral presentation at the National Symposium on Molecular Intricacies of Plant Associated Microorganisms (MIPAM - 2025), Mandi, India. March 07–08.

Thakur A, Thakur K, Kumar A, Warghat AR, Kumar D and Pandey SS (2025) Unraveling plant-endophyte communication: fungal elicitors as key drivers of metabolite biosynthesis in *Valeriana jatamansi*. National Symposium on Molecular Intricacies of Plant Associated Microorganisms (MIPAM - 2025) at IIT Mandi, Himachal Pradesh. March 07-08.

PARTICIPATION IN EXHIBITION

Dr Poonam Kumari (2024) Participated as judge for the Science-cum-Art Exhibition at DAV Public School, Dehra, Gopipur. November 23.

Dr Poonam Kumari (2024) Organized an exhibition on Waste to wealth at Neugal Sr. Sec. Public School, Bindraban (Palampur) district Kangra during Swachhta Pakhwada. May 03.

Dr. Ramesh Chauhan (2024) Exhibited the R&D activities and products of CSIR-IHBT during OWOT program at NIEST, Jorhat. Many farmers, industrialists and businessmen visited and interacted with IHBT team. November 09.

Dr. Vidyashankar Srivatsan (2024) Exhibited the R&D activities of CSIR-IHBT at 5th Anniversary Program of Science and Heritage Research Initiative organized by Department of Science and Technology at Prithwi bhavan, New Delhi. Dr. Jitendra Singh, Hon. Minister of Science and Technology and Earth Sciences vistied the IHBT stall and interacted with the team headed by Director, CSIR-IHBT. December 16.

Dr. Vidyashankar Srivatsan and Vikrant Awasthi (2024) Exhibited the R&D activities of CSIR-IHBT organized by Career Point University, Hamirpur at Hamirpur. December 27.

INSTITUTE PUBLICATIONS

Dr Bhavya Bhargava (2024) CSIR Floriculture Mission Success stories Part-I" shedding lights on the remarkable achievements of 50 farmers under CSIR Floriculture mission was released on May 13, 2024.

Dr Bhavya Bhargava (2024) Booklet on floriculture entitled "Impact of CSIR Floriculture Mission in Himachal Pradesh" was released on July 02, 2024.

Dr Bhavya Bhargava (2025) CSIR Floriculture Mission Success stories Part-II" shedding lights on the remarkable achievements of 50 farmers under CSIR Floriculture mission was released by Dr Jitendra Singh, Hon'ble minister of State (Independent Charge) Ministry of Science & Technology and Ministry of Earth Sciences, and Vice-President CSIR. February 26.

Dr Bhavya Bhargava (2025) Booklet on floriculture entitled "Impact of CSIR Floriculture Mission" was released on 26th February, 2025 by Dr Jitendra Singh, Hon'ble minister of State (Independent Charge) Ministry of Science & Technology and Ministry of Earth Sciences, and Vice-President CSIR.

SOFTWARE DEVELOPED

Dr Ravi Shanker (2024) Developed a software PTFSpot: A Deep-learning based software to detect plant TF binding regions across genome.

TECHNOLOGY DEVELOPED

Er Amit Kumari (2024) Developed technology Technology on Floral Wax (Aromatic/Non-Aromatic) at TRL>6.

Er Amit Kumari (2024) Developed technology on Aromatic Floral Wax Candle at TRL>6.

Er Amit Kumari (2024) Developed technology on Natural Travel/Pocket Perfumes at TRL>6.

VISITED ABROAD

Dr Rakesh Kumar (2024) Visited Taiwan to attend as panel speaker in Double Tenth joint conference of International Association for the Study of Traditional Asian Medicines (IASTAM) and Asian Society for the History of Medicine (ASHM) held in Taipei, Taiwan. June 20-24.

Ravi Raj (2025) Visited Germany for PhD Industrial Exposure Fellowship (PIEF) by the Indo-German Science and Technology Centre (IGSTC) at Lionex Diagnostics and Therapeutics GmbH in Braunschweig, Germany. October 2024- March 2025.

Dr Vidyashankar Srivatsan (2024) Visited Portugal to attend the 8th International Congress of International Society for Applied Phycology, in Porto, Portugal, June 16-21.

LINKAGES

Established Linkages with various International/ Domestic stakeholders/ organizations/ departments for different activities and programmers as follows

International Linkage

1. International MoU with Empowering Farmers Foundation (EFF), Tanzania to collaborate for developing the Industry in Africa through introduction of modern methods of Tissue Culture, Hydroponic, and Aeroponic methods of growing plants and high value floriculture and aromatic crops.

Some of the of the Indian/ Domestic Linkages with Industries/Academic Institutions

1. National Research Development Corporation (NRDC), New Delhi for transfer of CSIR-IHBT's technologies.
2. CSIR-NIScPR for promotion and transfer of CSIR-IHBT technologies.
3. Gurugram University during International conference on Communication and Dissemination of Traditional Knowledge (CDTK-2024)
4. Deputy Commissioner/District Rural Development Agency, Chamba, (H.P.)
5. National Institute of Technology (NIT), Delhi, GT Karnal Rd, Delhi
6. ICAR- Indian Veterinary Research Institute, Izatnagar, Bareilly (U.P.)
7. D.D.U. Gorakhpur University, Gorakhpur, India
8. Axis Institute Of Pharmacy, Milestone-478, NH-2, Chakeri Ward, Kanpur (U.P.)
9. Govt. Arya Degree College, Nurpur, Kangra-176202 (H.P.)
10. University of Petroleum and Energy Studies, Dehradun, Uttarakhand for collaboration in academic activities
11. Rural Technology and Development Centre, V.P.O Kamlehar, Tehsil Palampur, Distt Kangra (H.P)
12. 1Institute of Natural Resources (INR), Meghalaya, Lachumiere, Shillong for sustainable livelihoods by joint research and extension project for benefit the state of Meghalaya
13. M/s Parwaaz Organics, Jalandhar
14. EWOK Mid-Himalayan Farmer Producer Company Limited, Village Salgi, P.O. Kamand, Tehsil Sadar, District Mandi
15. M/s Good Food Boutique Pvt. Ltd. Carlton Woods, South City, Ludhiana for Technology transfer of CSIR-IHBT's three technologies
16. Tashvika India Food Pvt. Ltd, Dwarka, New Delhi
17. Mahalaxmi Malt Products Pvt Ltd., Mansarover Garden, New Delhi for Technology transfer of CSIR-IHBT's two technologies.
18. M/s Biomimicry Technologies Pvt. Ltd., Address at 120, Mayur Vihar, DLF Galleria, MV Extension, Delhi

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

Senior Principal Scientist:
Dr. Sanatsujat Singh
Dr. Shashi Bhushan
Dr. Pralay Das
Dr. Vijai Kant Agnihotri
Dr. Ravi Shankar
Dr. Probir Kumar Pal
Dr. Dharam Singh
Dr. Mahesh Gupta
Dr. Rituraj Purohit

Principal Scientist:
Dr. Gireesh Nadda
Er. Mohit Sharma
Dr. Amit Chawla
Dr. Y.S. Padwad
Dr. Dinesh Kumar
Dr. Damanpreet Singh
Dr. Upendra Sharma
Dr. Pamita Bhandari
Dr. Amitabha Acharya
Dr. Vikram Patial
Dr. Vishal Acharya
Dr. Ashok Singh
Dr. Bhavya Bhargava
Dr. Kunal Singh
Dr. Sukhjinder Singh
Dr. Jeremy Dkhar
Dr. Rohit Joshi
Dr. Shiv Shankar Pandey
Dr. Ashish Rambhau Warghat
Dr. Rajiv Kumar
Dr. Narender Vijay Tirpude
Dr. Arun Kumar

Senior Scientist:
Dr. Vivek Dogra
Dr. Gaurav Zinta
Dr. Rajesh Kumar Singh
Dr. Vidyashankar Srivatsan
Dr. Ankit Saneja
Dr. Poonam Kumari
Dr. Vandana Jaiswal
Dr. Satbeer Singh
Dr. Ramesh
Dr. Vikas Kumar
Dr. Sarita Devi

Scientist:
Er. Amit Kumari
Dr. Ashok Kumar Pathera
Dr. Vishal Sharma
Dr. Amit Kumar
Dr. Sandopu Sravan Kumar
Dr. Prashant Kumar

Senior Technical Officer (3):
Dr. Kiran Devi
Sh. Vikrant Gautam
Dr. Avnesh Kumari
Sh. J. S. Bisht
Dr. Kiran Singh Saini

Senior Technical Officer (2):
Sh. Shiv Kumar
Dr. Rajneesh
Sh. Rakesh Verma
Dr. Anish Kaachra
Sh. Anil Kumar
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)

Senior Technical Officer (1):
Sh. Mohit Kumar Swarankar
Mrs. Vijaylata Pathania
Sh. Pabitra Gain
Sh. Aman Kumar
Mrs. Meenakshi
Dr. Arvind Kumar Verma
Sh. Anil Chaudhary

Technical Officer:
Sh. Pawan Kumar
Dr. Rimpy Diman
Sh. Virat Abhishek
Sh. Saurabh Sharma

Technical Assistant:
Sh. Rajeev Kumar Koundal
Sh. Vikas Soni

Senior Technician (2):
Sh. Ramesh Kumar (Retired on 31.08.2024)

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 (1):
Sh. Sanjeev
Sh. Sanjeet Kumar
Sh. Monu Kumar
Sh. Ishwar Dass

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 (joined on 01.01.2025)

Administration Officer:
Sh. Virender Lamba (transferred on 22.01.2025)

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

Section Officer (F&A):
Sh. Mahabir Singh

Section Officer (S&P):
Sh. Ravinder Singh
Sh. Sohan Singh (joined on 09.09.2024)

Assistant Section Officer (G.):
Mrs. Santosh Kumari
Sh. Baldev
Sh. Kiran Kumar
Mrs. Pooja Awasthi
Sh. Ankit Rohilla (Joined on 10.03.2025)
Mrs. Jyoti (Joined on 17.03.2025)

Assistant Section Officer (F&A):
Mrs. Aruna Kumari
Sh. Mukul Sharma (joined as ASO (F&A) on 24.07.2024)
Sh. Saurabh Sharma (joined on 17.03.2025)

Assistant Section Officer (S&P):
Sh. Rajeev Sood
Ms. Deepika (Joined on 17.03.2025)

Sr. Stenographer:
Sh. Boni Kumar

Senior Secretariat Assistant (G.):
Sh. Praveen Kumar
Sh. Sandeep Kumar (transferred on 09.08.2024)
Sh. Mukul Sharma (transferred to Finance & Accounts Section)
Sh. Ajay Singh Kaundal (transferred on 26.07.2024)

Senior Secretariat Assistant (S&P):
Sh. Rajinder Singh

Coupon Clerk (Canteen):
Sh. Anand Sharma

Cook:
Sh. Karan Singh

Driver:
Sh. Partap Chand
Sh. Braham Dass
Sh. Lakhwinder Singh
Sh. Nitesh Bhardwaj

Bearer (Canteen):
Sh. Bipan Kumar

Tea & Coffee Maker:
Sh. Bipan Gurung

MTS:
Sh. Thaman Bahadur
Mrs. Rujala Devi

Joined CSIR-IHBT between 01.04.2024-31.03.2025

S.N.	Name	Designation	Date of Joining
1.	Sh. S.D. Rishi	Controller of Administration	01.01.2025
2.	Sh. Mukul Sharma	ASO (F&A)	24.07.2024
3.	Dr. Ashok Kumar Pathera	Scientist	26.09.2024
4.	Dr. Vishal Sharma	Scientist	30.09.2024
5.	Dr. Amit Kumar	Scientist	30.09.2024
6.	Dr. Sandopu Sravan Kumar	Scientist	12.11.2024
7.	Dr. Prashant Kumar	Scientist	28.11.2024
8.	Sh. Ankit Rohilla	ASO (G)	10.03.2025
9.	Mrs. Jyoti	ASO (G)	17.03.2025
10.	Ms. Deepika	ASO (S&P)	17.03.2025
11.	Sh. Saurabh Sharma	ASO (F&A)	17.03.2025

Staff Superannuated

Sh. Ramesh Kumar
Sr. Technician (2): 31.08.2024

Transferred to other CSIR Labs/Institutes:

1 Sh. Sandeep Kumar, CSIR-IHBT to CSIR-CSIO, Chandigarh: 09.08.2024

2 Sh. Ajay Singh Koundal, CSIR-IHBT to CSIR HEAD QUARTER: 26.07.2024

3 Sh. Virender Lamba, CSIR-IHBT to CSIR-CSIO, Chandigarh: 22.01.2025

INSPIRE Faculty
Dr. Nishma Dahal
Dr. Poonam Jyoti

RAMANUJAN Fellow
Dr. Satish Singh

Young Scientist
Ms. Tanvi Sharma

Senior Research Associate (Pool Scheme)
Dr. Vipasha Verma

Women Scientist
Ms. Ujala
Ms. Mamta
Dr. Vidya Rajendran
Ms. Nitisha Sendri
Ms. Neha Kumari

NPDF & PDF
Dr. Asha Kiran
Dr. Narender Kumar

ISWP
Ms. Abhisha Roy
Mr. Sourav Kanungo
Mr. Mathewos Geneto Abiche

Research Associate
Dr. Ashish Gupta
Dr. Shagun Bali
Dr. Girija Kaushal
Dr. Mohammed Saba Rahim
Mr. Shinde Bhagatsing Devidas
Dr. Avriti Ranjan

Project Research Scientist (PRS-I)
Mr. Navneet Thakur
Mr. Paramdeep Kumar

Principal Project Associate
Dr. Megha Katoch

Senior Project Associate
Dr. Sandhya Yadav
Dr. Aparna Misra
Mr. Deekshith H. N.
Dr. Payal Kapoor
Ms. Babita Thakur
Dr. Amit Rana
Mr. Himanshu Shekhar
Mr. Sukhchain Singh
Mr. Devesh Chandra
Dr. Anuj Choudhary
Ms. Sheetal Rana
Mr. Ajay Kumar Sharma
Mr. Manish Kumar
Mr. Prateek Singh Bora
Dr. Mahinder Partap
Dr. Arif Khan
Mr. Sachin Ashok Thorat
Dr. Sapna Thakur
Ms. Neha Kumari
Dr. Rajveer Singh
Ms. Sheetal
Mr. Hrishikesh Mahato

Senior-PAT
Ms. Upasana Choudhury
Dr. Sumeet Parkash Kaundal
Mr. Nitesh Kaushal
Dr. Kavita Rana
Mr. Anmol
Mr. Karthik R

SRF
Mr. Rohit Bains
Ms. Nymphaea Arora
Ms. Tsering Dolma
Ms. Ritu
Ms. Ankita Thakur
Ms. Poonam Dhiman
Ms. Priya Kumari
Mr. Rajneesh Kumar
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CSIR - IHBT IN PRINT AND ELECTRONIC MEDIA

ट्यूलिप के बाद हिमाचल की वादियों को महकाएगी पियोनी पुष्प की महक

वाह ! प्रदेश में 'ऑफ सीजन' के दौरान लहलहा रहा ट्यूलिप

सीएसआईआर आईएचबीटी पालमपुर में मनाया राष्ट्रीय प्रौद्योगिकी दिवस

पालमपुर विज्ञान केंद्र में हुआ 3 डी विज्ञान फिल्म प्रदर्शनी का उद्घाटन

हींग के पौधों से लहलहाने लगे खेत, दो साल में तैयार होगी फसल

राष्ट्रीय प्रौद्योगिकी दिवस पर आइएचबीटी में चार प्रौद्योगिकी हस्तांतरित

प्रौद्योगिकी से जीवन व ज्ञान के प्रसार में वृद्धि : डा. सुरेश

गीले कचरे से खाद बनाने की विधि बताई

ट्रायल रहा सफल, शीघ्र ही रसोई में हिमाचली हींग की महक खिलेगी

आईएचबीटी, ताइवानी संस्थानों के बीच सहयोग की संभावना

जड़ी-बूटी से निर्मित दवाएं व फूलों की खेती से होगा लाभ : डा. सुदेश

CSIR-IHBT advances collaboration in Traditional asian Medicines

विश्व की अपेक्षाएं पूरी करने में रहें प्रयासरत : डा. कलैसेल्वी

सीएसआईआर के निदेशक ने ताइवान में संयुक्त सम्मेलन में लिया भाग

सीएसआईआर आईएचबीटी ने मनाया 42वां स्थापना दिवस

कांगड़ा केसरी

विज्ञान एवं प्रौद्योगिकी से देश को बहुत आशा: डॉ. कलैसेल्वी

सीएसआईआर-आईएचबीटी पालमपुर ने मेघालय के शिलांग में सगंध फसलों की खेती पर किया जागरूक

CSIR-IHBT's two-day program enhances aromatic Crop knowledge

पहल : लाभकारी विकल्प बन रहा प्राकृतिक खेती करना

Farmers explore aromatic crops at CSIR-IHBT event

राजकीय आर्य महाविद्यालय नूरपुर में बीएससी नॉन-मेडिकल छात्रों ने किया सीएसआईआर आईएचबीटी पालमपुर का शैक्षणिक दौरा

जागरण सिटी कांगड़ा

प्रत्येक पौधे में होते हैं कई गुण, औषधियों और उत्पाद के लिए करें उपयोग : परोदा

सीएसआईआर-आईएचबीटी पालमपुर में सीएसआईआर का स्थापना दिवस समारोह आयोजित

सीएसआईआर-आईएचबीटी पालमपुर में सीएसआईआर का 83वां स्थापना दिवस समारोह

हिमालय क्षेत्र की चुनौतियों और समाधानों पर की चर्चा

विज्ञान ने बनाया कृषि क्षेत्र में आत्मनिर्भर

पालमपुर में वैज्ञानिक तथा औद्योगिक परिषद् अनुसंधान ने मनाया स्थापना दिवस

उत्तरी हिमालय की कृषि जैव विविधता का प्रबंध आवश्यक

सी.एस.आई.आर. के स्थापना दिवस पर कार्यक्रम आयोजित

आय बढ़ाने के लिए जलवायु परिवर्तन से निपटना आवश्यक

सीएसआईआर-आईएचबीटी में जलवायु परिवर्तन एवं बाग उत्पादन में स्थिरता शीर्षक पर दो दिवसीय कार्यशाला सम्प

आयुर्वेद एक मजबूत चिकित्सा प्रणाली : डा. विजय

पालमपुर में आयोजित नौवें आयुर्वेद दिवस के दौरान सभी • जागरण

संवाद सहयोगी, जागरण • पालमपुर : राजकीय आयुर्वेदिक महाविद्यालय सोएसआइआर-हिमालय जैवसंपदा पपरोला के प्रधानाचार्य डा. विजय प्रौद्योगिकी संस्थान पालमपुर में चौधरी ने दैनिक जीवन में आयुर्वेद,

CSIR-IHBT hosts workshop on tackling climate change impact on horticulture in the Himalayas

CSIR-Institute of Himalayan Bioresource Technology (CSIR-IHBT) recently org two-day workshop titled "Sustaining Horticultural Production under the Climate Scenario in the Himalayas" at Palampur, Himachal Pradesh. The event foc identifying and addressing the challenges faced by farmers due to climate Distinguished guests included Dr. Rajendra S. Paroda (Padma Bhushan), Cha TAAS and former Secretary, DARE & DG, ICAR, Dr. P.L. Gautam, former DD Science) and former Vice-Chancellor of G.B. Pant University, and Dr. Sudesl Yadav, Director of CSIR-IHBT. The experts emphasized the importance of ad climate change to boost crop productivity and farmers' income through high-vak, Dr. Yadav stressed the need for a multipronged approach involving diverse stak to combat the effects of climate change on agriculture.

The workshop, attended by scientists, farmers, and industry partners, explored challenges and solutions for fruit and vegetable product Himalayan region, covering Northeast India, Uttarakhand, J&K, and Himachal Pradesh. Key issues highlighted were declining soil fertil irrigation, imbalanced cost-production ratios, outdated farming practices, and inadequate pest and disease management, all contributir farmers seeking alternative livelihoods. Experts proposed solutions including the use of certified planting materials, crop diversification

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सीएसआईआर-हिमालय जैवसंपदा प्रौद्योगिकी संस्थान पालमपुर में 9वां आयुर्वेद दिवस

सबेरा न्यूज/जसवंत कठियाल

पालमपुर, 29 अक्तूबर : सीएसआईआर-हिमालय जैवसंपदा प्रौद्योगिकी संस्थान पालमपुर में 29 अक्तूबर मंगलवार को 9वें आयुर्वेद दिवस का आयोजन किया गया। भारत सरकार आयुर्वेदिक सिद्धांतों जड़ी-बूटियों और जीवनशैली के बारे में जागरूकता बढ़ाने के लिए 2016

कार्यक्रम में प्रतिभागी स्कूली के छात्र व स्टाफ।

में राजकीय आयुर्वेदिक महाविद्यालय पोलो के प्रधानाचार्य डा. विजय पुरी ने उपस्थित विषय पर अपने के महत्व पर प्रकाश डाला। उन्होंने कहा कि आयुर्वेद एक मजबूत चिकित्सा प्रणाली और वैश्विक स्म पर लगातार साथ केंद्रीय विद्यालय पालमपुर के अपने स्वागत संबोधन में आयुर्वेद दिवस की शुभकामनाएं दी। उन्होंने आयुर्वेद दिवस 2024 की थीम को रेखांकित करते हुए संस्थान द्वारा इस दिशा में किए जा रहे कार्यों जैसे कि जड़ी बूटियों का दस्तावेजीकरण, सत्यापन और प्रामाणिकता पर विस्तार पूर्वक व्याख्या प्रस्तुत किया। संस्थान के कार्मिक एवं छात्रों; आयुर्वेदिक कॉलेज, पपरोला के सदस्यों के साथ

आयुर्वेद चिकित्सा प्रणाली वैश्विक स्तर पर बढ़ा रही पग

सी.एस.आई.आर. पालमपुर में 9वां आयुर्वेद दिवस आयोजित

पालमपुर, 29 अक्तूबर(भृगु): सी.एस.आई.आर.-हिमालय जैवसंपदा प्रौद्योगिकी संस्थान पालमपुर में 9वें आयुर्वेद दिवस का आयोजन किया। भारत सरकार धनवंतरी जयंती के अवसर पर आयुर्वेद दिवस मनाती आ रही है। इस वर्ष का विषय वैश्विक स्वास्थ्य के लिए आयुर्वेद जचाचार है।

समारोह में राजकीय आयुर्वेदिक महाविद्यालय, पपरोला के प्रधानाचार्य डा. विजय चौधरी ने उपस्थित विषय पर दैनिक जीवन में आयुर्वेद, विशेष तौर पर आहार एवं जीवनशैली के महत्व पर प्रकाश डाला। उन्होंने संस्थान के निदेशक डा. सुदेश कुमार यादव ने आयुर्वेद दिवस 2024 की थीम को रेखांकित करते हुए संस्थान द्वारा इस दिशा में किए जा रहे कार्यों जैसे कि जड़ी-बूटियों का दस्तावेजीकरण, सत्यापन और प्रामाणिकता पर ध्यान प्रस्तुत किया। साथ ही उन्होंने पादप संरक्षण एवं उनके प्रसार हेतु संस्थान द्वारा किए गए कार्यों की जानकारी उपस्थित

पालमपुर : आई.एच.बी.टी. में आयोजित एवं आयुर्वेद दिवस समारोह में मुख्यातिथि के साथ प्रतिभागी। (भृगु)

वैज्ञानिक, उद्यमी व अकादमिक के मेल-जोल से भारत विश्व गुरु बनने की राह में अग्रसर

हिमालय जैवसंपदा प्रौद्योगिकी संस्थान में कृषि पोषण जैव प्रौद्योगिकी थीम पर कार्यक्रम का आयोजन

पालमपुर, 5 पपरथा (भृगु): सीएसआईआर-हिमालय जैवसंपदा प्रौद्योगिकी संस्थान में एक सप्ताह एक विषय कार्यक्रम के तहत कृषि पोषण जैव प्रौद्योगिकी थीम पर एक दिवसीय कार्यक्रम का आयोजन किया गया। इस दौरान वैज्ञानिकों, उद्यमियों और अकादमिक विशेषज्ञों ने भाग लिया। कार्यक्रम का उद्देश्य कृषि, पोषण और जैव प्रौद्योगिकी के बीच तालमेल को बढ़ावा देना था। इस अवसर पर संस्थान के निदेशक डा. सुदेश कुमार यादव ने मुख्य अतिथि के रूप में शिरकत की। उन्होंने अपने संबोधन में कहा कि भारत विज्ञान को आगे ले जाने में अपनी भूमिका निभा रहा है। उन्होंने कहा कि

सीएसआईआर आईएचबीटी पालमपुर में कृषि पोषण जैव प्रौद्योगिकी थीम पर एक सप्ताह एक विषय कार्यक्रम

सीएसआईआर आईएचबीटी में कृषि पोषण जैव प्रौद्योगिकी थीम पर द्वारा सप्ताह एक विषय कार्यक्रम के आयोजन पर उपस्थित गणम

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पर्वतीय सीएसआईआर-हिमालय जैवसंपदा प्रौद्योगिकी संस्थान पालमपुर में सजी कार्यशाला

किसान-महिला सशक्तिकरण पर फोकस

जयदीप सिंह-पालमपुर

सीएसआईआर - हिमालय जैवसंपदा प्रौद्योगिकी संस्थान, पालमपुर में 'कृषि पोषण जैवप्रौद्योगिकी' थीम पर 'एक सप्ताह एक विषय' कार्यक्रम का आयोजन किया गया। यह देश पर केंद्रित एक विषय कार्यक्रम है। कार्यक्रम के मुख्य अतिथि डा. शशी कुमार धीमान, कुलपति, हिमाचल प्रदेश तकनीकी विश्वविद्यालय, हमीरपुर ने अपने संबोधन में कहा कि सी.एस.आई.आर भारत में विज्ञान को आगे ले जाने में अपनी भूमिका निभा रहा है। उन्होंने कहा पेडागैरिक, सी.एस.आई.आर-आईएचबीटी के प्रयास से किसानों को आजीविका के अवसर मिलेंगे। डा. सुदेश कुमार यादव ने अपने संबोधन में कृषि पोषण जैवप्रौद्योगिकी मिशन के निदेशक एवं निदेशक, सी.एस.आई.आर-आईएचबीटी डा. जबीर अहमद, अतिथि, डा. जबीर अहमद, की सराहना की। अपने अध्यक्षीय से जुड़े सीएसआईआर के संस्थानों संबोधन में कृषि पोषण के कार्यों की भी चर्चा और जैवप्रौद्योगिकी मिशन के निदेशक सराहना की। कार्यक्रम में विशिष्ट

CSIR-IHBT to host 'One Week, One Theme' program focused on AgriNutribiotech

The CSIR-Institute of Himalayan Bioresource Technology (IHBT), Palampur, kickstarted its "One Week, One Theme" (OWOT) event, focusing on the AgriNutribiotech (ANB) theme. This event brings together experts from the agricultural, nutritional, and biotechnological sectors, aiming to foster collaboration, promote innovative technologies, and support the development of aromatic and floriculture crops.

Inaugural Ceremony and Guest of Honor: The inauguration began with a tree plantation, followed by a formal welcome. Key dignitaries attending included Prof. Shashi Kumar Dhiman, Vice-Chancellor of Himachal Pradesh Technical University (HPTU), as the Chief Guest, alongside Dr. Zabeer Ahmed, Director of IIIM Jammu, and Madam Netra Meti, IAS, SDM Palampur, as Guests of Honor.
Addressing the audience, Prof. Dhiman stressed the importance of innovation in agricultural biotechnology to uplift rural communities, particularly through value-added crops like chamomile and lavender. Dr. Ahmed and Madam Meti highlighted the role of institutions like CSIR-IHBT in driving research that directly benefits farmers and entrepreneurs in the region.
Aromatic Plants and Floriculture Crops Released: A key highlight was the release of new

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देश की वैज्ञानिक विरासत को गति देने की आवश्यकता

हिमालय जैवसंपदा प्रौद्योगिकी संस्थान में इंटरनैशनल साइंस फैस्टीवल के कर्टेन रेजर कार्यक्रम में बोले मुख्यातिथि कैप्टन एस. शास्त्री

पालमपुर, 4 नवम्बर (भृगु): सी.एस.आई.आर.-हिमालय जैवसंपदा प्रौद्योगिकी संस्थान, पालमपुर में इंटरनैशनल साइंस फैस्टीवल (आईआईएसएफ) 2024 के कर्टेन रेजर कार्यक्रम का आयोजन किया गया। यह देश पर केंद्रित एक विषय कार्यक्रम है। कार्यक्रम के मुख्य अतिथि डा. शशी कुमार धीमान, कुलपति, हिमाचल प्रदेश तकनीकी विश्वविद्यालय, हमीरपुर ने अपने संबोधन में कहा कि सी.एस.आई.आर भारत में विज्ञान को आगे ले जाने में अपनी भूमिका निभा रहा है। उन्होंने कहा पेडागैरिक, सी.एस.आई.आर-आईएचबीटी के प्रयास से किसानों को आजीविका के अवसर मिलेंगे। डा. सुदेश कुमार यादव ने अपने संबोधन में कृषि पोषण जैवप्रौद्योगिकी मिशन के निदेशक एवं निदेशक, सी.एस.आई.आर-आईएचबीटी डा. जबीर अहमद, अतिथि, डा. जबीर अहमद, की सराहना की। अपने अध्यक्षीय से जुड़े सीएसआईआर के संस्थानों संबोधन में कृषि पोषण के कार्यों की भी चर्चा और जैवप्रौद्योगिकी मिशन के निदेशक सराहना की। कार्यक्रम में विशिष्ट एवं निदेशक, सी.एस.आई.आर-आईएचबीटी डा. जबीर अहमद, अतिथि, डा. जबीर अहमद,

सफलता की ओर सीएसआईआर-आईएचबीटी में इंडिया इंटरनेशनल साइंस फेस्टिवल कर्टेन रेजर में चुनाई को किया प्रेरित

समृद्ध वैज्ञानिक विरासत -दृष्टिकोण से बढ़ेंगे आगे

कार्यालय संवाददाता-पालमपुर

सी.एस.आई.आर -हिमालय जैवसंपदा प्रौद्योगिकी संस्थान, पालमपुर ने इंडिया इंटरनेशनल साइंस फेस्टिवल (आईआईएसएफ) के कर्टेन रेजर कार्यक्रम का आयोजन किया। कार्यक्रम के मुख्य अतिथि कौम्पेलेा एस शास्त्री, राष्ट्रीय सचिव, विज्ञान भारती ने आईआईएसएफ के महत्व और एसआईटी हमीरपुर ने विकास में फ्लोरीकल्चर और फाइटो फार्मास्यूटिकल के माध्यम से सके। डॉ. अमित कुमार, वरिष्ठ प्रधान वैज्ञानिक ने आईआईएसएफ 2024 के विजुल प्रोग्राम की जानकारी साझा की। इस अवसर पर विज्ञान कार्यक्रम के अंतर्गत राजकीय वरिष्ठ माध्यमिक कन्या विद्यालय, पालमपुर की 50 छात्राओं और पीएम श्री केंद्रीय विद्यालय, पालमपुर के 50 छात्र उपस्थित रहे। संस्थान की गतिविधियों को जाना। आईआईएसएफ एक वार्षिक

सीएसआईआर पालमपुर में साइंस फेस्टिवल का कर्टेन रेज़र सम्पन्न

पालमपुर,(आपका फैसला)।

सीएसआईआर-हिमालय जैवसंपदा प्रौद्योगिकी संस्थान, पालमपुर ने इंडिया इंटरनेशनल साइंस फेस्टिवल (आईआईएसएफ) के कर्टेन रेजर कार्यक्रम का आयोजन किया। आईआईएसएफ एक वार्षिक

चुनियादी ढांचे और प्रकृति के साथ सामंजस्य में एक समृद्ध भारत की परिकल्पना करता है, जो सभी क्षेत्रों और सभी नागरिकों को विज्ञान और प्रौद्योगिकी के माध्यम से अपनी क्षमता तक पहुंचने के अवसर प्रदान करता है। सीएसआईआर-

पर विस्तार से चर्चा की। कार्यक्रम के विशिष्ट अतिथि, डॉ. अश्विनी राणा, अध्यक्ष,विज्ञान भारती एच.पी. चैप्टर और एसोसिएट प्रोफेसर, एन.आई.टी. हमीरपुर ने विकास में विज्ञान की भूमिका और इसे जनसाधारण के

डा. एस. सुदेश कुमार यादव ने गणमान्य व्यक्तियों और अतिथियों का स्वागत किया। उन्होंने संस्थान में किए जा रहे कार्यों के बारे में विस्तार से बताया। उन्होंने बताया कि कैसे संस्थान, सीएसआईआर मिशनों जैसे आरोमा, फ्लोरीकल्चर और फाइटोफार्मास्युटिकल के माध्यम से विकसित भारत 2047 के सपने को पूरा करने की ओर अग्रसर है। उन्होंने जनसाधारण के बीच जागरूकता सृजन और विज्ञान को लोकप्रियकरण की आवश्यकता को भी रेखांकित किया ताकि इसके पूर्ण लाभ प्राप्त किए जा सकें और युवा

हिंदी साहित्य में चित्रित समाज विषय पर शोध पत्र पर की चर्चा

सी.एस.आई.आर. में हुआ कार्यक्रम

पालमपुर, 10 दिसम्बर(भृगु): सी.एस.आई.आर. सभागार पालमपुर में हिमाचल प्रदेश में हिंदी साहित्य में चित्रित समाज विषय पर भाषा और संस्कृति विभाग हिमाचल प्रदेश और रचना साहित्य एवं कला मंच के सौजन्य से शोध पत्र पर चर्चा की।

कार्यक्रम में मुख्यातिथि सी.एस.आई.आर. के निदेशक डा. सुदेश कुमार यादव और अध्यक्ष डा. सुशील कुमार फुल्ल रहे। निदेशक डा. यादव ने हिमाचल प्रदेश की समृद्ध संस्कृति की सराहना करते हुए साहित्यिक कार्यक्रमों के लिए भविष्य में भी सहयोग भाटिया, पंकज दर्शी, भूपेन्द्र जम्वाल भूपी, राजीव त्रिगर्ती, गंगाराम राजी, प्रभात शर्मा, चिरानंद आनन्द, कुशल कटोच, विक्रम गथानिया, कृष्ण चन्द्र महादेविया व संजय मेहरा आदि विद्वानों ने अपने-अपने विचार प्रकट किए। सहायक निदेशक भाषा एवं संस्कृति विभाग हिमाचल प्रदेश सुरेश राणा और जिला भाषा अधिकारी कांगड़ा अमित गुलेरी भी इस अवसर पर उपस्थित रहे। द्वितीय सत्र में कवि सम्मेलन का आयोजन किया गया जिसमें रूपेश्वरी शर्मा ने पांचाली का अंतर्द्वंद्व कविता का वाचन किया।

कमलेश सूद, सुमन शेखर, सुदर्शना भटेड़िया, सोनिया शर्मा, सुमन बाला, हरिप्रिया, डा. शिल्पी व

शोध प्रदेश के अन्य हिस्सों की तुलना में देरी से होने वाली फलावरिंग पर शोध में जुटा सीएसआईआर

लाहौल में भी अब समय पर तैयार होगी फूलों की खेती

विनोद राणा

पालमपुर (कांगड़ा)। लाहौल के किसानों को अब तक देरी से अपने खेतों में फूलों की खेती समय पर आ सकेगी।

लाहौल ने अन्य जगहों से लेने में चार माह देरी से फूल खिलते हैं। फूलों की खेती में फूल अने पर होने पर चार माह का समय लगता है, जिसके कारण से उन्हें फसल समय पर नहीं मिल पाती।

खास खबर

सीएसआईआर-हिमालय जैवसंपदा प्रौद्योगिकी संस्थान (सीएसआईआर-आईएचबीटी) पालमपुर में जलवायु परिवर्तन एवं बागवानी उत्पादन में स्थिरता शीर्षक पर दो दिवसीय कार्यशाला का आयोजन किया गया। कार्यशाला का उद्घाटन जलवायु परिवर्तन के प्रभाव से निपटने के लिए आवश्यक उन्नत, जलवायु-सहनशील बागवानी प्रथाओं पर केंद्रित था। कार्यशाला में हिमाचल प्रदेश, उत्तराखंड, जम्मू-कश्मीर और पूर्वोत्तर राज्यों के 100 से अधिक वैज्ञानिकों, किसानों और उद्योग भागीदारों ने भी प्रतिभागिता की और फसलों जलवायु परिवर्तन के प्रभाव से निपटने के उपायों पर चर्चा की। विशेषज्ञों ने उन्नत बागवानी तकनीकों, जैसे उच्च घनत्व वृक्षारोपण, संरक्षित खेती और सटीक सिंचाई, के महत्व पर जोर दिया। इसके अलावा, उन्होंने जलवायु-लचीली किस्मों के विकास और किसानों के लिए क्षमता निर्माण कार्यक्रमों की आवश्यकता पर भी प्रकाश डाला।

पोलम सीएसआईआर-आईएचबीटी में 14 से 15 फरवरी तक आयोजित होगा ट्यूलिप फेस्टिवल

पालमपुर तैयार, राष्ट्रीय संगोष्ठी के साथ ट्यूलिप फेस्ट करेगा होस्ट

युवाओं के लिए प्रेरणा बनीं फरीदाबाद की क्रिस्टीना

मार्केटिंग प्रोफेशनल्स को हिमाचल में सुगंधित पौधों की खेती में नजर आया भविष्य

...0 एकड़ में शुरू की खेती, महिलाओं को दिया रोजगार

मार्केटिंग प्रोफेशनल क्रिस्टीना ने सीएसआईआर की तकनीकों से पाया स्वरोजगार

मिजोरम में 20 एकड़ भूमि को लो चिलिंग सेब क... खेती के लिए किया चिन्हित, पायलट पौधारोपण पू...

मिजोरम को सेब राज्य के रूप में देश में पहचान दिलवाए जाने की पहल

जमीन की बात | सगंधित फसलों और सेब की लो चिलिंग किस्मों की खेती को दिया जा रहा बढ़ावा

मिजोरम के किसानों की आर्थिकी सुधारने में जुटा आईएचबी...

जयदीप रिहान - पालमपुर

हिमालय जैवसंपदा प्रौद्योगिकी संस्थान (सीएसआईआर-आईएचबीटी), पालमपुर, मिजोरम विज्ञान, प्रौद्योगिकी और नवाचार परिषद (मिस्टिक), एवं बागवानी महाविद्यालय, थेनजोल, मणिपुर, मिलकर मिजोरम में कई परियोजनाएं चला रहे हैं। इन परियोजनाओं का उद्देश्य किसानों को स्थिर और बेहतर आजीविका प्रदान करना है। इन योजनाओं में खासतौर पर सगंधित फसलों...

देने के लिए प्रारंभ की गई है। ये मिजोरम के जैव संसाधनों का सतत उपयोग करने के एक...

अधिकारी भी उनके सा... टीम ने बागवानी महावि... थेनजोल में वैज्ञानिकों और... और मिजोरम के ... सिहफिर, मुअलफेंग, ... और तविजो जैसे विभिन्न ग... किसानों के लिए प्रशिक्षण... आयोजित किए। डा. राकेश... पहलों की महत्वपूर्ण क्षमत... उजागर करते हुए कहा, ... पौधे और सेब की लो चिलिंग...

...व प्रौद्योगिकी विभाग के इंटर-इंस्टीट्यूशनल प्रोग्राम में तीन परियोजनाओं को मिली मंजूरी : डा. यादव

...सुगंधित फसलों की खेती करने से किसानों की आय में होगी बढ़ोतरी

...चल दस्तक | पालमपुर

...सआईआर हिमालय जैव संपदा ...ोगिकी संस्थान पालमपुर, ...ोरम विज्ञान, प्रौद्योगिकी और ...चार परिषद (मिस्टिक) एवं ...वानी महाविद्यालय थेनजोल ...एयू, मणिपुर) मिलकर मिजोरम ...ई परियोजनाएं चला रहे हैं। इन... जिससे मिजोरम के लिए नए आर्थिक अवसर बनेंगे। डॉ. सुदेश कुमार यादव निदेशक सीएसआईआर-आईएचबीटी ने बताया कि फरवरी 2022 में जैव प्रौद्योगिकी विभाग के इंटर-इंस्टिट्यूशनल प्रोग्राम के अंतर्गत तीन परियोजनाओं को मंजूरी दी गई।

ये परियोजनाएं शिटाके और... हिस्सा हैं ताकि किसानों की आय में सुधार हो सके। सीएसआईआर-आईएचबीटी के वरिष्ठ प्रधान वैज्ञानिक डॉ. राकेश कुमार के नेतृत्व में विशेषज्ञों की टीम ने जनवरी 16 से 18 जनवरी को मिजोरम का दौरा किया, ताकि परियोजना की प्रगति का मूल्यांकन किया जा सके। डॉ. राकेश कुमार ने इन पहलों की महत्वपूर्ण...

WED,05 FEBRUARY 2025
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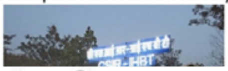
Cricket and Volleyball Competitions to be Held at CSIR-IHBT, Palampur from 7th to 10th February

52nd Shanti Swarup Bhatnagar Memorial Tournament: A Confluence of Sports and the Scientific Community



The CSIR-Institute of Himalayan Bioresource Technology (IHBT), Palampur, will enthusiastically host the 52nd Shanti Swarup Bhatnagar Memorial Tournament (SSBMT) from 7th to 10th February 2025. This tournament is a prestigious and significant event of the CSIR Sports Promotion Board, regularly organized in various CSIR laboratories at specific inte... volleyball and cricket will be organized during this SSBMT (outdoo... sixteen CSIR laboratories across India who have qualified the zon... in the tournament. These are CSIR-CCMB, Hyderabad; CSIR-CDRI, ... CSIR-CEERI, Pilani; CSIR-CGCRI, Kolkata; CSIR-IICT, Hyderaba... Dehradun; CSIR-IMTECH, Chandigarh; CSIR-NAL, Bengaluru; CSIR-... CSIR-NGRI, Hyderabad; CSIR-NIO, Goa; CSIR-NIScPR, New Delhi; ... cricket match would be hosted. Dr. Sudesh Kumar

पालमपुर में शांति स्वरूप भटनागर मेमोरियल टूर्नामेंट का हुआ शुभारंभ

52वां शांति स्वरूप भटनागर मेमोरियल टूर्नामेंट 7 से

हिमाचल दस्तक | पालमपुर

वैज्ञानिक एवं औद्योगिक अनुसंधान परिषद (सीएसआईआर) के स्पोर्ट्स प्रमोशन बोर्ड के तत्वावधान में सीएसआईआर-हिमालय जैवसंपदा प्रौद्योगिकी संस्थान, पालमपुर 7 से 10 फरवरी तक 52वें शांति स्वरूप भटनागर मेमोरियल टूर्नामेंट (एसएसबीएमटी) का उत्साहपूर्वक आयोजन कर रहा है। एसएसबीएमटी (आउटडोर) फाइनल का उद्घाटन कार्यक्रम 6 फरवरी को सीएसआईआर-आईएचबीटी के परिसर में आयोजित किया जाएगा। यह टूर्नामेंट सीएसआईआर का एक प्रतिष्ठित और महत्वपूर्ण आयोजन है, जो नियमित अंतराल पर विभिन्न सीएसआईआर प्रयोगशालाओं में आयोजित किया जाता है। इस एसएसबीएमटी (आउटडोर) फाइनल के दौरान वॉलीबाल और क्रिकेट की प्रतियोगिताएं आयोजित की जाएंगी, जिसमें सोलह सीएसआईआर प्रयोगशालाओं की टीमें जिन्होंने जोनल स्पर्धाओं को क्वालीफाई किया है, इस एसएसबीएमटी (आउटडोर) फाइनल प्रतियोगिता में भाग लेंगी। साथ ही एक महिला क्रिकेट मैच का आयोजन भी किया जाएगा। गौरतलब है कि शांति स्वरूप भटनागर (1894-1955) भारत के सबसे प्रतिभाशाली वैज्ञानिकों में से एक और सीएसआईआर के पहले निदेशक (अब महानिदेशक) थे। उनकी स्मृति एवं सम्मान में सीएसआईआर ने शांति स्वरूप भटनागर मेमोरियल टूर्नामेंट (एसएसबीएमटी) का आयोजन शुरू किया। सीएसआईआर-आईएचबीटी के निदेशक डॉ. सुदेश कुमार यादव ने कहा कि सभी तैयारियां पूरी हो चुकी हैं और मैं प्रतिभागियों का स्वागत करने के लिए उत्सुक हूं।

हैदराबाद, लखनऊ, कराईकुडी, पिलानी, कोलकाता, हैदराबाद, जम्मू, देहरादून, चंडीगढ़, बेंगलूरु, लखनऊ, पुणे, तेलंगाना, गोवा, नई दिल्ली, एनपीएल नई दिल्ली भाग ले रही हैं। इस टूर्नामेंट में कुल 20 क्रिकेट और 20 वॉलीबॉल के लीग मैच खेले जाएंगे तथा इसके बाद सेमी फ़ाइनल और फ़ाइनल मैच 9 ए... 10 फ़रवरी को खेले जाएँगे। इस दौरान, एक महिला क्रिकेट मैच का आयोजन भी किया जाएगा।

चार दिवसीय एसएसबीएमटी टूर्नामेंट के दौरान सांस्कृतिक संध्याओं का आयोजन किया जाएगा, जिसमें प्रदेश के प्रतिष्ठित कलाकारों के अतिरिक्त संस्थान के शोधार्थी...

खोसला ने बोर्ड की गतिविधियों ...ी देते हुए सभी टीमों ...वना के साथ खेलने ... किया। निदेशक डॉ. यादव ने बताया कि ...ं सीएसआईआर की ...ोलह प्रयोगशालाओं...

...ांति स्वरूप भटनागर टूर्नामेंट आई.एच.बी.टी. पालमपुर में होगा आयोजित, देश...

क्या कहते हैं खिलाड़ी

जागरण सिटी कांगड़ा

...देश की 16 प्रयोगशालाओं के प्रतिभागी दिखाएंगे प्रतिभा

...पालमपुर में शांति स्वरूप भटनागर मेमोरियल टूर्नामेंट आरंभ

20 — 20 लीग मैच क्रिकेट और वालीबाल के खेले जाएंगे

9 — व 10 फरवरी को सेमीफाइनल और फाइनल मैच होगा

1 — महिला क्रिकेट मैच का आयोजन भी किया जाएगा

हिमाचल फर्स्ट

RNI NO-HPHIN/2020/80865 www.himachalfirst.org

पालमपुर में 52वें शांति स्वरूप भटनागर मेमोरियल टूर्नामेंट का शुभारंभ

सीएसआईआर–आईएचबीटी पालम... में दो दिवसीय ट्यूलिप महोत्सव आज

अनंत ज्ञान, पालमपुर

सीएसआईआर–हिमालय जैवसंपदा प्रौद्योगिकी संस्थान (सीएसआईआर–आईएचबीटी), पालमपुर एवं इंडियन सोसायटी ऑफ ओर्नामेंटल हॉर्टिकल्चर (आईएसओएच) मिलकर 18–19 फरवरी को ट्यूलिप महोत्सव और राष्ट्रीय संगोष्ठी का आयोजन कर रहे हैं। इस संगोष्ठी का उद्देश्य सजावटी कंदीय फूलों की खेती, शोध और व्यावसायीकरण को बढ़ावा देना है। इसके साथ एक किसान मेले का भी...

वक्ताओं के व्याख्यान शामिल होंगे जो... के विभिन्न राज्यों से सम्मिलित होंगे। ... से रेड मिर्ची एसोसिएट्स, लद्दाख से ... फ्लोरल्स और सर्चन फ्लावर्स, पंज... आरटीएस फ्लावर्स, उत्तराखंड से शिव... फ्लोरिस्ट, हिमाचल प्रदेश से व... फ्लोरीकल्चर सोसायटी एवं टियन फ्लावर... क्लस्टर, केएफ बायोप्लांट्स, राइज एन ... प्रिसिजन एग्रो टेक, फ्लोरेंस फ्लोरा, रिस... एनएचबी, सबजीरो फार्म्स सहित पंद्रह ... प्रतिभागिता करेंगे। इसके इलवा बिलासपुर, ... शिमला, चैल, फतेहगढ़ साहिब, कालाडुंगी, ... कारगिल से लगभग पचास किसान इसमें ... लेंगे। संगोष्ठी के चार तकनीकी सत्रों में जे... सुधार, उत्पादन संवर्द्धन, पौध संरक्षण, प्र... फाइटोसैनिटरी प्रोटोकॉल और कंदीय ...

सीएसआईआर- आईएचबीटी पालमपुर एवं इंडियन सोसाइटी ऑफ ओर्नामेंटल हॉर्टिकल्चर 18-19 फरवरी को ट्यूलिप महोत्सव व राष्ट्रीय संगोष्ठी करेगा आयोजित

सवेरा न्यूज/जसवंत कठियाल

पालमपुर, 17 फरवरी : सीएसआईआर-आईएचबीटी पालमपुर, एवं इंडियन सोसाइटी ऑफ ओर्नामेंटल हॉर्टिकल्चर (आईएसओएच) मिलकर 18-19 फरवरी, 2025 को ट्यूलिप महोत्सव और राष्ट्रीय संगोष्ठी का आयोजन संस्थान में कर रहे हैं। इस संगोष्ठी का उद्देश्य सजावटी कंदीय फूलों की खेती, शोध और व्यवसायीकरण को बढ़ावा देना है। इसके साथ एक किसान मेले का भी आयोजन किया जाएगा। संगोष्ठी में शोधकर्ता, बागवानी विशेषज्ञ, नीति निर्माता, किसान, उद्यमी और उद्योग हितधारक भाग लेंगे और कंदीय फूलों की खेती में प्रगति पर चर्चा करेंगे। इस... फ्लावर्स, उत्तराखंड से शिवालिक फ्लोरिस्ट, हिमाचल प्रदेश से वाटिका फ्लोरीकल्चर सोसायटी एवं टियन फ्लावर स्फूर्ति क्लस्टर, केएफ बायोप्लांट्स, राइज एन शाइन, प्रिसिजन एग्रो टेक, फ्लोरेंस फ्लोरा, रिसर्च एड, एनएचबी, सबजीरो फार्म्स सहित पंद्रह उद्योग प्रतिभागिता करेंगे। इसके इलवा बिलासपुर, मंडी, शिमला, चैल, फतेहगढ़ साहिब, कालाढूंगी, लेह, कारगिल से लगभग पचास किसान इसमें भाग लेंगे। संगोष्ठी के चार तकनीकी सत्रों में जेनेटिक सुधार, उत्पादन संवर्द्धन, पौध संरक्षण, प्रबंधन, फाइटोसैनिटरी प्रोटोकॉल और कंदीय फसलों का मूल्य संवर्द्धन विषय शामिल होंगे। प्रत्येक सत्र में विशेषज्ञ... हिमालयी जैव संसाधनों के सतत उपयोग पर ध्यान केंद्रित करता है। संस्थान संरक्षण, जेनेटिक सुधार, फसल उत्पादन, संरक्षण, प्रबंधन और वाणिज्यिक रूप से महत्वपूर्ण फसलों के मूल्य संवर्द्धन में अग्रणी है। इसका एग्रो टेक्नोलॉजी प्रभाग फूल और बागवानी शोध में विशेषज्ञता रखता है। इंडियन सोसाइटी ऑफ ओर्नामेंटल हॉर्टिकल्चर (आई.एस.ओ.एच), 1990 में स्थापित, एक राष्ट्रीय गैर-लाभकारी संगठन है जो भारत में सजावटी बागवानी को आगे बढ़ाने के लिए समर्पित है। यह प्रशिक्षण, परामर्श और उत्कृष्टता को सम्मानित करता है। यह संगोष्ठी, संस्कृति और प्रकृति का एक जीवंत मिश्रण है, जो हितधारकों को सजावटी...

सीएसआईआर पालमपुर सजावटी फूलों को देगा बढ़ावा

आईएसओएच करेगा सहयोग, संस्थान में दो दिवसीय ट्यूलिप फेस्टिवल और कंद फूलों पर राष्ट्रीय संगोष्ठी शुरू

फूलों की बिजाई में देरी, अगले हफ्ते खुलेगा ट्यूलिप गार्डन

अब चंबा में न्यूट्रीशन को लेकर करेंगे काम

3 HIMACHAL Tribune

Two-day tulip festival & national symposium opens in Palampur

हाई एलिवेशन प्लांट अडेप्टेशन पर चार दिवसीय अंतरराष्ट्रीय कार्यशाला शुरू

धर्मशाला | सीएसआईआर हिमालय जैवसंपदा प्रौद्योगिकी संस्थान पालमपुर में मंगलवार को हाई एलिवेशन प्लांट अडेप्टेशन इन अ चेंजिंग एंविरमेंट पर चार दिवसीय अंतर्राष्ट्रीय कार्यशाला का शुभारंभ हुआ।

यह कार्यशाला यूरोपियन मोलिकुलर बायोलोजी असोसिएशन (ईएमबीओ) के तत्वाधान में आयोजित की जा रही है और 25 से 28 फरवरी 2025 तक चलेगी। सीएसआईआर-आईएचबीटी के ... जानकारी दी। उन्होंने विशेष रूप से लाहौल में संस्थान के सेंटर फॉर हाई आल्टीट्यूड बायोलॉजी के कार्यों को उजागर किया। मुख्य संभाषण डॉ. क्रिश्चियन कोर्नर, बासेल विश्वविद्यालय, स्विट्जरलैंड ने दिया। उन्होंने उच्च पर्वतीय पारिस्थितिक तंत्र और पौधों पर चर्चा की और जलवायु परिवर्तन अध्ययन के लिए हिमालय के महत्व पर जोर दिया।

कार्यशाला वैश्विक विशेषज्ञों और युवा शोधकर्ताओं का एक...

Kangra News...
epaper.jagran.com

हिमालय क्षेत्रों में जलवायु परिवर्तन पर कार्यशाला शुरू

संवाद सहयोगी, जागरण • पालमपुर : हिमालयी क्षेत्रों में जलवायु परिवर्तन को लेकर हिमालय जैवसंपदा प्रौद्योगिकी संस्थान पालमपुर में चार दिवसीय कार्यशाला मंगलवार को शुरू हुई। सीएसआईआर आईएचबीटी के...

Palampur hosts tulip festi... on ornamental horticultur...

The Savera Times Network

Palampur: A two-day Tulip Festival & National Symposium on Ornamental Bulbous Flowers commenced on Tuesday at the CSIR-Institute of Himalayan Bioresource Technology (CSIR-IHBT) in Palampur. Organised in collaboration with the Indian Society of Ornamental Horticulture (ISOH), the festival aims to promote the cultivation, research, and commercialisation of ornamental bulbous flowers, attracting stakeholders from across India.

A Kisan Mela will also be held to engage farmers and showcase innovative agricultural practices. Researchers, horticulturists, policymakers, farmers, entrepreneurs, and industry stakeholders from across the country will participate in the symposium to discuss advancements in bulbous flower cultivation.

The event will explore how these flowers can enhance rural livelihoods, promote agro-tourism, and contribute to the ornamental horticulture market.

The symposium will feature 109 abstract presentations and expert talks from 26 eminent speakers representing various states across India.

A representative pict...

Fifteen industries, incl... Red Mirchi Asso... (Haryana), Blumen F... (Ladakh), Serchen Fl... (Ladakh), RTS Flo... (Punjab), Shivalik F... (Uttarakhand), V... Floriculture Soc... (Himachal Pradesh), Tian Flower Surti C... (Himachal Pradesh) ... Bioplants, Rise N S... Precision Agrotech, Flo... Flora, Research Aid, ... and Subziro Farms, participate alongsid... farmers from Bila... (Himachal Pradesh), ... (Himachal Pradesh), S... (Himachal Pradesh), ... (Himachal Prad... Fatehgarh Sahib (Pu... Kaladungi (Uttarakh... and Leh-Kargil (Lad... fostering a rich exchan... knowledge and experie... Four technical ses... over two days will cov... topics, including ge... improvement, produ... enhancements, ... protection, post-ha... management, phytosa... protocols, and value ad... of bulbous crops.

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

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वार्षिक प्रतिवेदन 2024-25 Annual Report