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वार्षिक प्रतिवेदन

Annual Report

2016-17

CSIR-IHBT

सीएसआईआर-हिमालय जैवसंपदा प्रौद्योगिकी संस्थान
CSIR-Institute of Himalayan Bioresource Technology
पालमपुर-हिमाचल प्रदेश
Palampur-Himachal Pradesh

संस्थान गान

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

प्रौद्योगिकी से हम तेरी, वैभवता को बढ़ाएंगे।
अनुसन्धान से जग में, अर्थ विकास करायेंगे।।

हिमांचल में तेरे, प्रगति कर दिखलायेंगे।
ज्ञान से अज्ञान तिमिर, हम मिटाते जाएंगे।।

हो समर्पित हम सभी, जन उत्थान करायेंगे।
हे हिमालय हम तुझे, भव्य बनाते जाएंगे।।

भव्य बनाते जाएंगे
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With Best Compliments from

Dr. Sanjay Kumar

Director

CSIR- Institute of Himalayan Bioresource Technology
Palampur (HP)-176061

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CONTENTS

OVERVIEW OF CSIR-IHBT

Vision

Develop technologies to boost bioeconomy through sustainable utilization of Himalayan bioresources for societal, industrial and environment benefits

Mission

To discover, develop and commercialize processes and products from Himalayan bioresources using cutting edge science and technology

CSIR-lnstitute 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 CSIR proposed to set up a National Biological Research Institute at Palampur. The state government at that time made available 1225 acres of land for this establishment. The Noble laureate, Sir Har Gobind Khurana was offered the position of Director for the proposed Institute. This could not materialize and the matter remained undecided for 18 years. In the mean time, major portion of the allocated land paved way for the establishment of Himachal Pradesh Agricultural University (now CSK HPKV) and other organisations. Meanwhile, Regional Research Laboratory (RRL), Jammu also opened a Regional Research Centre at Palampur in a rented building to make a base for setting up of the proposed CSIR institute. The then Director of RRL, Jammu played a vital role in this matter and took possession of the remaining 226.1 acres of land in 1978. Subsequently, the then Chief Minister of Himachal Pradesh formally requested Prof. Nurul Hasan, the Vice President of CSIR during that period to initiate the process and give a final shape to the proposal of setting up a CSIR institute. Finally, the foundation stone of CSIR Complex Palampur was laid on July 2, 1983 and the first Coordinating Director was appointed in February, 1984. Since then, the institute has been relentlessly working towards the development of technologies for sustainable utilization of Himalayan bioresources and societal upliftment. Based on the mandate of the institute and the milestones achieved, CSIR Complex Palampur was rechristened as the Institute of Himalayan Bioresource Technology in 1997. 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 on October 1, 2012.

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.

ORGANIZATIONAL STRUCTURE

CSIR- Institute of Himalayan Bioresource Technology

Prime Minister of India
President, CSIR

Minister for Science & Technology
Vice President, CSIR

Director General, CSIR

Research Council — **Director** — **Management Council**

R & D Areas

- Agrotechnology of Medicinal, Aromatic & Commercially Important Plants
- Biotechnology
- Food and Nutraceuticals
- High Altitude Biology
- Natural Product Chemistry & Process Development

Support Services

- Business Development & Marketing Unit
- Planning, Project Monitoring & Evaluation
- Engineering Service Unit
- Library
- Intellectual Property Cell
- Computer Cell
- Instrumentation
- Press & Media Unit

House Keeping

- Administration
- Finance & Accounts
- Store & Purchase
- Security
- Hindi Cell
- Guest House & Hostel
- Experimental Farm

RESEARCH COUNCIL

Prof. Samir Bhattacharya, Chairman
Former Director,
CSIR-IICB, Kolkata
Emeritus Professor NASI and Sr. Scientist,
School of Life Sciences, Visva Bharati (A Central University)
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Director
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Palampur- H.P.

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Sh. Alok Sharma
Member Secretary
Administrative Officer
CSIR-Institute of Himalayan Bioresource Technology,
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CSIR-Institute of Himalayan Bioresource Technology,
Palampur- H.P.

Sh. Darshan Singh, SO(F)
Finance & Accounts Office,
CSIR-Institute of Himalayan Bioresource Technology,
Palampur- H.P.

IMPRESSIONS

Dr. Harsh Vardhan, Minister of Science & Technology & Earth Sciences, Govt. of India: It was indeed a treat to spend a day at CSIR-IHBT, Palampur with the scientists and young researchers today. The accomplishments of the institute till now are worth placing on record. The young people appear very enthusiastic and energetic. We need to connect, move and move with the people. There is a huge potential & capability to help the people and particularly, the farmers of the country for this prestigious institutions. All my good wishes and prayers to all of you are here" - October 18, 2016.

Sh. Ambuj Sharma, IAS, Additional Chief Secretary: I am very impressed with the facilities and technical expertise at CSIR-IHBT, Palampur, especially the initiatives to preserve and augment the many dwindling plant species in upper reaches of HP. My best wishes to Dr. Sanjay Kumar, Director and his Team IHBT"- May 13, 2016.

Dr. Gurdev S. Khush, University of California (USA): "I am delighted to have the opportunity to visit CSIR-IHBT. I had the opportunity to see many labs which are very well kept and have latest equipments. Staff is young and very enthusiastic and research programs are well focused. Institute is not only studying the native plants but are preparing very useful products. These are useful for our people. The research results are being reported in outstanding scientific journals. I have great satisfaction with my visit"- March 28, 2017.

FROM THE DIRECTOR'S DESK

It is with great pleasure that I am presenting the annual report of our institute on the 76th Foundation Day of CSIR. While the year witnessed sprawling activities on diverse fronts, the institute channelized its efforts towards transfer of technology to the industry and for upliftment of the society. The institute is relentlessly moving to fulfill its mission of boosting bio-based economy and national competitiveness. Our group aligned with the Mission Mode projects of CSIR on "Mission Aroma" and "Skill Development Programme" to empower, particularly the youth of the nation. Scientists of the institute participated in the 'Fast Track Translation project' of CSIR with an aim to deliver products to the industry within a span of two years by "walking the last mile from lab to land".

Rural empowerment through promotion of floriculture was one of the major achievements of the year and two new cultivars, 'Him Sumukh' and 'Him Shweta' of calla lily (*Zantedeschia aethiopica*) and five new cultivars 'Him Saumya, Him Gaurav, Him Aabha, Him Apoorva and Him Keerti' of gerbera (*Gerbera jamesonii*) were developed. The cultivars were released by the Hon'ble Prime Minister of India and President of CSIR, Shri Narendra Damodardas Modi on the occasion of 75th Foundation Day of CSIR on 26th Sept, 2016 at New Delhi. These cultivars were also distributed to progressive farmers of H.P. in a Kisan Mela organized at CSIR-IHBT, Palampur. A material transfer agreement (MTA) was signed with M/s Sashanka Agrotech Pvt. Ltd, Ranchi, Jharkhand for mass multiplication of gerbera cultivars. The institute motivated farmers for cultivation of Asiatic lily in place of traditional crops like pea and potato. This generated 5- 7 times higher income for the farmers that resulted in improved livelihood as evaluated by National Productivity Council, New Delhi. Hydroponic and aeroponic facilities were setup for cultivation of quality plant material. Hydroponic cultivation reduced the flowering time by 55 days in asiatic lilium as compared to the flowering observed under open field conditions.

CSIR-IHBT played a pivotal role in introducing apple in Mizoram - a state where this crop has never been grown. Back at home, two new crops i.e., quinoa (*Chenopodium quinoa*) and chia (*Salvia hispanica*) were introduced for the first time in the mid hills of western Himalayas. Our scientists and staff successfully promoted the cultivation of floriculture crops as well as high value medicinal and aromatic plants in Lahaul valley. Importantly, Him Gold, a high yielding variety of wild marigold developed by CSIR-IHBT, was cultivated by farmers in their land, where other crops could not be grown due to wild animals menace. Scientists helped farmers to process the crop for extraction of essential oil through mobile distillation units of the institute. Similarly, the work on stevia led to attainment of higher yield and better quality materail to meet the ever increasing demand of a low calorie, safe, natural sweetener for diabetics and others. The technology was transferred to agro-based industries and several hectares of land was brought under stevia cultivation in Punjab and Uttar Pradesh. In a separate work, MTA was signed with M/s Madan Big nursery for multiplication and dissemination of virus tested apple rootstocks.

Since rising costs and scarcity of farm labourers demand mechanization of farm operations, one man and two men harvesting machines were introduced in the region for tea plucking. The harvester could also be used for selective plucking of tea leaves.

The institute also made major headway in the area of process and product development. A new process technology was developed for the preparation of natural and refreshing instant teas. An MoU was signed with SDZ Cha Sarl, Mozambique for commercial production of tea wine. The process of steviosides production was successfully deployed to process dry leaves of stevia for M/s Agri Naturals India, Ludhiana. MTAs were signed with M/s Himalaya Natural and Herbal Products, Palampur and M/s Svyam Agro, Indore for technologies associated with stevia.

A canning technology for the production of "ready-to-eat", preservatives and chemicals-free-foods having a shelf life of seven months, was standardized by CSIR-IHBT to meet the emerging demand for safe "ready-to-eat" foods. The canned products did not lose its taste or flavour even after seven months of preservation. As a first step, the technology was deployed for "Kangri Dham", a famous, local Himalayan cuisine and the technology was transferred to M/s Sai Foods at Baijnath, H.P. for commercial production. Another technology was developed to prepare 'Crispy Fruits' by withdrawing water from fresh fruits with minimal loss of nutrition. 'Crispy Fruits' retain original colour, texture, taste as well as aroma with added advantage of prolonged shelf-life. Being a healthy product, 'Crispy Fruits' can serve as a healthy substitute for unhealthy snacks, currently prevailing in the market.

Continuing the research on bioprospection, superoxide dismutase enzyme of *Caragana jubata* was found to possess high thermostability and a wide range of temperature functionality. Studies revealed that thermostability of the enzyme was governed by its amino acid composition rather than the evolutionary status of the plant species. With focus on antineoplastic enzymes, an asparaginase having a very low glutaminase activity was identified from a bacterial source. Asparginase with a low glutaminase activity is a desired trait in the global market. Also, a novel cellulase, functional across a wide range of pH, was bioprospected from bacterial source. A bioplastic synthesizing unique bacterium is also on the shelf. In addition, exploratory field surveys were carried out in the state of Uttarakhand and H.P. for bioprospection of *Ophiocordyceps sinensis* (cordyceps).

Intensive work was carried out in the field of nanotechnology, computational biology, chemistry, food and nutraceuticals and regulatory research for developing new products and diagnostics for human wellness. Some of these include development of silicone nanoparticles, role of crocin from *Crocus* sp. in suppressing kindling development and linked cognitive impairments, management of glioma using salvionolic acid F and new catalytic methods for the remote C-H activation cum functionalization of quinolines as a possible anti-malarial agent. A diversity-oriented synthesis of macrocycles exploiting carbohydrate-derived building blocks has potential to be employed for synthesis of various molecules having versatile therapeutic applications.

Tissue culture (TC) of valuable rare, endangered and threatened medicinal and aromatic plants was developed as a promising system for propagation and conservation. TC raised plants of *Picrorhiza kurroa*, *Sinopodophyllum hexandrum* and other important species were transferred to the field for the purpose of cultivation.

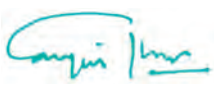
Molecular and bioinformatics based characterization of tea, bamboo, horsegram, and some high altitude plant species resulted in identification of stress tolerant genes, regulatory elements and markers, which can be used for transgenic development, markers assisted selections and breeding. Work in the field of crop protection resulted in identification of host factors responsible for viral as well as fungal diseases. Additionally, biopesticides were developed and native strains of entomopathogenic fungi were identified for effective control of insect pests.

Apart from strengthening traditional knowledge database from ethnic communities of Chamba region, scientists developed species-specific hyper spectral signatures of plant species to aid the identification remotely. Working on climate related changes, scientists observed a declining trend in Net Primary Productivity of Great Himalayan National Park, though statistically, the data was non-significant.

Major activities with respect to infrastructure development included laying of foundation stone for a sabbatical home, upgradation of the guest house, students hostel and laboratories. The state of art animal testing Regulatory Research unit was further strengthened with facility for rearing and breeding of zebrafish. This will facilitate the screening of a large number of compounds as per the guidelines of Committee for the Purpose of Control and Supervision of Experiments on Animals (CPCSEA), New Delhi and Institutional Animal Ethics Committee (IAEC).

Visit of Hon'ble Minister of Science and Technology, and Earth Sciences, Dr. Harsh Vardhan to our institute inspired and motivated the staff and research scholars to devote themselves for the cause of nation development through science and technology. The year also witnessed showcasing of our technologies and R&D activities at "India International Trade Fair" at Pragati maidan, New Delhi and at "India International Science Festival", New Delhi. A large number of school and college students visited the institute to learn multifarious scientific activities.

Needless to mention that the recognition and trust received from our business partners helped us in taking the technologies to the masses for the benefit of the society. CSIR-IHBT developed linkages with the state administration and various line departments to work on the issues of common interest for betterment of the Himalayan region. Directional guidance from Research Council, definitive recommendations of Management Council and Grant in Aid support from various funding agencies enabled us in taking R&D forward. All these achievements could not have been possible without the constant support from CSIR Headquarters. Dedicated and hard working team-CSIR-IHBT, with a culture of innovation are pledging relentless pursuance to meet national goals and missions for the benefit of society, industry and environment.



Sanjay Kumar

निदेशकीय प्रतिवेदन

सीएसआईआर के 76वें स्थापना दिवस के अवसर पर मुझे अपने संस्थान के वार्षिक प्रतिवेदन को प्रस्तुत करते हुए अत्यन्त आनंद की अनुभूति हो रही है। वर्ष के दौरान विविध क्षेत्रों में व्यापक गतिविधियाँ हुईं हैं, संस्थान ने उद्योगों को प्रौद्योगिकी हस्तांतरण और सामाजिक उत्थान के लिए अपने प्रयासों को दिशा दी। संस्थान जैव आर्थिकी को प्रोत्साहित करने और राष्ट्रीय प्रतिस्पर्धा के विकास के लक्ष्य को पूरा करने की ओर निरंतर अग्रसर है। संस्थान ने सीएसआईआर के 'एरोमा मिशन' तथा कौशल विकास कार्यक्रम द्वारा, विशेषकर राष्ट्र के युवाओं को सशक्त बनाने के लिए स्वयं को शामिल किया है। संस्थान के वैज्ञानिकों ने सीएसआईआर के फास्ट ट्रैक ट्रांसलेशन प्रोजेक्ट में प्रतिभागिता की, जिसका उद्देश्य प्रयोगशाला से प्रक्षेत्र की ओर तीव्र गति से आगे बढ़ते हुए दो वर्ष के भीतर उद्योगों को उत्पाद तैयार करके देना है।

इस वर्ष के दौरान ग्रामीण सशक्तिकरण हेतु पुष्पखेती को बढ़ावा देना संस्थान की एक मुख्य उपलब्धि रही है और कैला लिलि की 'हिम सुमुख' एवं 'हिम श्वेता' (*जेंटेडेजिया इथोपिका*) की दो तथा जरबेरा की हिमसौम्या, हिमगौरव, हिमआभा, हिमअपूर्वा, हिमकीर्ति नामक पांच किस्मों को विकसित किया गया। इन किस्मों को माननीय प्रधानमंत्री एवं सीएसआईआर अध्यक्ष श्री नरेन्द्र दामोदरदास मोदी ने 26 सितम्बर 2016 को नई दिल्ली में सीएसआईआर के 75वें स्थापना दिवस के अवसर पर विमोचित किया तथा सीएसआईआर–आईएचबीटी में एक किसान मेले का आयोजन करके इन किस्मों को हिमाचल प्रदेश के प्रगतिशील किसानों को वितरित किया गया। जरबेरा की किस्म का व्यापक पैमाने पर उत्पादन करने के लिए मै. सशंका एग्रोटेक प्रा. लि., रांची के साथ सामग्री हस्तांतरण करार (एमटीए) किया गया। संस्थान ने किसानों को मटर और आलू जैसे पारंपरिक फसलों के स्थान पर एशियाटिक लिलि की खेती के लिए प्रेरित किया। राष्ट्रीय उत्पादकता परिषद, नई दिल्ली के एक विश्लेषण से ज्ञात हुआ है कि इससे किसानों को 5 से 7 गुणा अधिक आय प्राप्त हुई और उनकी जीविका में सुधार हुआ। गुणवत्तायुक्त पौध सामग्री की खेती के लिए हाइड्रोपोनिक और एयरोपोनिक सुविधा स्थापित की गई। खुले क्षेत्र में लगाई गई फसल की अपेक्षा हाइड्रोपोनिक खेती से एशियाटिक लिलि के पुष्पण काल में 55 दिनों की कमी आई।

सीएसआईआर–आईएचबीटी ने मिजोरम जैसे राज्य, जहां पहले कभी सेब नहीं उगाया जाता था, में सेब की खेती को प्रारंभ करने में महत्वपूर्ण भूमिका निभाई है। स्थानीय स्तर पर दो नई फसलों क्यूनोआ (*चीनीपोडियम क्यूनोआ*) और चिया (*साल्विया हिस्पेनिका*) को पहली बार पश्चिमी हिमालय के मध्यम पहाड़ी क्षेत्रों में लगाया गया। हमारे वैज्ञानिकों और कर्मियों ने लाहौल घाटी में फूलों और मूल्यवान औषधीय एवं सगंध पौधों की खेती को सफलतापूर्वक प्रोत्साहित किया है। यह उल्लेखनीय है कि संस्थान द्वारा विकसित जंगली गेंदे की 'हिमगोल्ड' किस्म को किसान ऐसे स्थलों पर लगा रहे हैं जहां पर उन्होंने जंगली जानवरों के डर से अन्य फसलें उगाना बन्द कर दिया था। संस्थान ने अपनी चल आसवन इकाई के माध्यम से किसानों को उनकी फसल के आसवन के लिए सहायता की है। इसी प्रकार, स्टीविया पर किए जा रहे कार्य से अधिक उपज और बेहतर गुणवत्ता प्राप्त हुई है जो कि कम कैलोरीयुक्त प्राकृतिक स्वीटनर की बढ़ती मांग को पूरा करने में सहायक होगी, यह मधुमेह ग्रस्त एवं अन्य लोगों के लिए सुरक्षित है। कृषि आधारित उद्योगों को स्टीविया की प्रौद्योगिकी हस्तांतरण से पंजाब और उ.प्र. में कई हैक्टेयर भूमि में इसकी खेती की जा रही है। मै. मदन बिग नर्सरी के साथ विषाणु परीक्षित सेब के रूटस्टॉक के बहुगुणन और प्रदर्शन के लिए सामग्री हस्तांतरण करार (एमटीए) किया गया।

बढ़ती लागत और श्रमिकों की कमी के कारण चाय बागानों के कार्यों के लिए मशीनीकरण की आवश्कता अनुभव की गई। इस क्षेत्र में चाय की यांत्रिक तुड़ाई के लिए एक व्यक्ति और दो व्यक्तियों द्वारा चलित

चाय तुड़ाई हारवेस्टर का निर्माण किया गया। इस हारवेस्टर का प्रयोग चयनित फसल तुड़ाई के लिए भी किया जा सकता है।

संस्थान ने प्रक्रम और उत्पाद विकास में प्रमुखता के साथ आगे कदम बढ़ाया है। प्राकृतिक और स्फूर्तिदायक चाय पेय को तैयार करने के लिए एक नई प्रक्रम प्रौद्योगिकी को विकसित किया गया है। टी–वाइन उत्पादन प्रौद्योगिकी को हस्तांतरित करने के लिए एसडीजैड चा सर्ल, मोज़ाम्बिक के साथ समझौता ज्ञापन किया गया है। स्टीवियोसाइड के निष्कर्षण के लिए स्टीविया की सूखी पत्तियों से प्रक्रम की एक उन्नत प्रौद्योगिकी को मानकित कर इसे मै. एग्री नेचुरल इंडिया, लुधियाना को दिया गया। स्टीविया से संबन्धित प्रौद्योगिकी के लिए मै. हिमालय नेचुरल एण्ड हर्बल प्रॉडेक्ट, पालमपुर तथा मै. स्वयं एग्रो, इंदौर के साथ सामग्री हस्तांतरण करार (एमटीए) किया गया।

बदलती जीवन शैली में सुरक्षित 'रेडी टू ईट' खाद्यान्नों की मांग को देखते हुए सीएसआईआर–आईएचबीटी ने इसके व्यावसायिक उत्पादन के लिए केमिकल और प्रिज़रवेटिव रहित तथा सात माह तक उपभोग की जा सकने वाली केनिंग प्रौद्योगिकी को मानकित कर लिया है। इन केन्ड खाद्य पदार्थों में सात माह से भी अधिक समय तक रखने पर भी स्वाद और सुंगध में कोई कमी नहीं आती है। प्रारंभिक तौर पर इस प्रौद्योगिकी को हिमालय के इस स्थानीय क्षेत्र के लोकप्रिय व्यंजन 'कांगड़ी धाम' के लिए विकसित किया गया तथा इसकी प्रौद्योगिकी मै. साई फूड, बैजनाथ को हस्तांतरित किया गया।

एक अन्य प्रौद्यागिकी प्राकृतिक 'क्रिस्पी फ्रूट्स' को विकसित किया है, इस तकनीक से फलों के पानी को इस प्रकार सुखाया जाता है जिससे फल के पोषक तत्व कम से कम नष्ट होते हैं। लंबे समय तक तरोताजा रहने के अतिरिक्त इसकी मूल बनावट, स्वाद, सुगंध और रंग बना रहता है। क्रिस्पी फ्रूट को स्वास्थ्यवर्धक स्नैक्स के रूप में उपयोग किया जा सकता है और यह बाजार में उपलब्ध स्वास्थ्य के लिए हानिकारक स्नैक्स का अच्छा विकल्प हो सकते है।

बायोप्रोसपेक्शन पर शोध को जारी रखते हुए *केरागेना जुबाटा* से सुपर ऑक्साइड डिस्म्यूटेज एंजाइम के नवीन स्रोत को खोजा गया जिसमें उच्च थर्मोस्टेब्लिटी है और यह विविध तापमान में कार्य कर सकता है। शोध से पता चला कि एंजाइम की थर्मोस्टेब्लिटी पादप प्रजातियों के विकासमूलक स्तर की बजाय इसकी एमिनो एसिड संयोजन घटक द्वारा निर्धारित की जाती है। एंटीनियोप्लास्टिक एंजाइम पर ध्यान केंद्रित करते हुए, बैक्टीरियल स्रोत से एल–एस्परजिनेज़ की पहचान की गई जिसमें बहुत कम ग्लुटामिनेज़ गतिविधि पाई गई। कम ग्लुटामिनेज़युक्त गतिविधि वाली एस्परजिनेज़ विश्व भर में वांछित है। साथ ही बैक्टीरियल स्रोत से एक नवीन सेलुलोज़ को खोजा गया जिसमें व्यापक पीएच रेंज है। संस्थान ने बायोप्लास्टिक संशलेषित अनुठा जीवाणु खोजा है। वर्ष के दौरान ऑफियोकॉर्डिसेप्स (कॉर्डिसैप्स) के बायोप्रोसपेक्शन के लिए उत्तराखंड और हिमाचल प्रदेश राज्य में अन्वेषी प्रक्षेत्र सर्वेक्षण किए गए।

मानव स्वास्थ्य और नये उत्पादों के विकास के लिए नेनोप्रौद्योगिकी, जैवसूचना विज्ञान, रसायन, खाद्य एवं न्यूट्रास्यूटिकल के क्षेत्र में गहन कार्य प्रारंभ किया गया है। इनमें सिलिकॉन नेनोपार्टिक्ल का विकास, दाह शमन और संबन्धित संज्ञानात्मक विकारों में *क्रोकस* प्रजाति की भूमिका, सेल्वोनोलिक एसिड एफ का उपयोग, ग्लायोमा का प्रबन्धन और मलेरिया रोधी कारक के रुप में क्विनोलिन का रिमोट सी–एच सक्रियणता एवं कार्यात्मकता के लिए नवीन उत्प्रेरण उपाय आदि प्रमुख हैं। कार्बोहाइड्रेट–व्युत्पन्न निर्मित ब्लॉक्स को उपयोग करते हुए मैक्रोसाइकल के विविधता उन्मुख संश्लेषण की संभाव्यता का बहुमुखी चिकित्सीय अनुप्रयोगों युक्त विभिन्न अणुओं के संश्लेषण के लिए उपयोग किया जा सकता है।

मूल्यवान दुर्लभ, लुप्तप्राय एवं संकटापन्न, औषधीय एवं सगंध पौधों के उतक संवर्धन संरक्षण और व्यावसायिक उपयोग के लिए बेहतर उपाय के तौर पर विकसित किया गया। *पिक्रोराइजा कुरुआ, सिनोपोडोफाइलम हेक्जेंड्रम* और अन्य महत्वपूर्ण प्रजातियों को खेती के लिए प्रक्षेत्र में लगाया गया।

चाय, बांस, होर्सग्राम और कुछ उच्च तुंगता क्षेत्र के पौधो के आण्विक और जैवसूचना विज्ञान आधारित लक्षण ाचित्रण के परिणामस्वरुप दबाव सहनशील जीन, विनियामक तत्वों और मार्कर की पहचान की गई है जिसे ट्रांसजेनिक विकास, मार्कर सहित चयन और प्रजनन में उपयोग किया जा सकता है। फसल रक्षण के क्षेत्र में विषाणु एवं फफूंद रोगों के लिए उत्तरदायी होस्ट फैक्टर का पता चला है। इसके अतिरिक्त जैवकीटनाशक विकसित करने की दिशा में स्थानीय फफुंद को खोजा गया जो कि विभिन्न प्रकार के कीटो के नियंत्रण के प्रति प्रभावशाली पाया गया है।

चम्बा क्षेत्र के स्थानीय लोगों के परम्परागत ज्ञान के डेटाबेस को सुदृढ़ करने के अतिरिक्त वैज्ञानिकों ने पादप प्रजातियों के प्रजाति विशेष हाइपरस्पेक्ट्रल संकेतन विकसित किए। वैज्ञानिकों ने जलवायु परिवर्तन के अध्ययन में पिछले एक दशक में ग्रेटर हिमालयन नेशनल पार्क की कुल प्राथमिक उत्पादकता की गिरावट की प्रवृति देखी, जबकि सांख्यिकी दृष्टि से यह डेटा महत्वपूर्ण नहीं था।

सबैटिकल निलय का शिलान्यास, अतिथिगृह, होस्टल और प्रयोगशाला भवनों का उन्नयन इस वर्ष आधारभूत विकास की मुख्य गतिविधियाँ रहीं। अत्याधुनिक विनियामक अनुंसधान केन्द्र की प्रयोगशाला को सशक्त करने के लिए जैबराफिश प्रजनन तथा सीपीसीएसइए, नई दिल्ली एवं आईएईसी के दिशा निर्देशों के अनुरुप व्यापक संख्या में यौगिको की सक्रीनिंग के लिए परीक्षण सुविधा स्थापित की गई।

डॉ. हर्ष वर्धन, माननीय मंत्री, विज्ञान और प्रौद्योगिकी एवं पृथ्वीविज्ञान के संस्थान दौरे ने विज्ञान और प्रौद्योगिकी के माध्यम से देश के विकास के लिए शोधार्थियों और कर्मचारियों को प्रेरित और प्रोत्साहित किया। इस वर्ष प्रगति मैदान, नई दिल्ली में आयोजित भारतीय अन्तर्राष्ट्रीय व्यापार मेले और भारतीय अन्तर्राष्ट्रीय विज्ञान मेले में संस्थान की प्रौद्योगिकियों और शोध एवं विकास गतिविधियों को प्रदर्शित किया गया। बड़ी संख्या में विद्यालयों और कॉलेज के छात्रों ने बहुआयामी वैज्ञानिक गतिविधियों को जानने के लिए संस्थान का भ्रमण किया।

यह उल्लेखनीय है कि हमारे व्यावसायिक भागीदारों के विश्वास और स्वीकार्यता ने हमें प्रौद्योगिकियों को समाज की भलाई के लिए आम जन तक पंहुचाने में सहायता की है। सीएसआईआर–आईएचबीटी ने हिमालयी क्षेत्र में उन्नति के लिए राज्य प्रशासन और विभिन्न संबन्धित विभागों के साथ संपर्क बनाकर कार्य शुरु किया है। अनुसंधान परिषद के दिशा निर्देशों और प्रबन्ध परिषद की सार्थक संस्तुतियों एवं विभिन्न वित्त पोषित एंजेसियों से शोध एवं विकास गतिविधियों को आगे ले जाने के लिए सहायता प्राप्त हुई। सीएसआईआर मुख्यालय के निरंतर सहयोग के बिना यह सब उपलब्धियां संभव नहीं थी। नवोन्मेष की संस्कृति के साथ हमारी समर्पित और कर्मनिष्ठ टीम समाज, उद्योग और पर्यावरण के लाभ के लिए राष्ट्रीय लक्ष्यों और मिशन का लगातार अनुसरण कर रही है।

(संजय कुमार)

CSIR-FAST TRACK
TRANSLATIONAL AND MISSION MODE PROJECTS

1. Developing L-asparaginase with low glutaminase activity for therapeutic applications

L-Asparaginase is well known for its chemotherapeutic properties**.** In commercial applications, L-asparaginase is derived from bacteria such as *Escherichia coli* and *Erwinia*. However, the presence of glutaminase activity in the L-asparaginase limits its use as potential therapeutic. Therefore, it is desirable to search for robust/engineered L-asparaginase having novel properties with lesser adverse effects. The project aimed at screening the bacterial diversity of unexplored trans-Himalayan regions of H.P. for L-asparaginase having novel properties and lesser adverse side effects.

Unique parameters of technology development

- An efficient enzyme from Himalayan microbial source with minimal glutaminase activity.
- Enzyme with less toxicity and wide kinetic parameters.

Major application(s)

- Food and pharmaceutical industries.

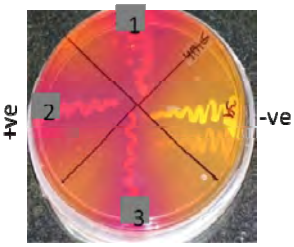
General and societal impact

Asparaginase industry is a multi-crore business, worldwide. Asparaginase therapy is an important component of acute lymphoblastic leukemia treatment. The commercially available asparaginase drug is currently, derived from *E. coli* and *Erwinia*. However, this drug works on a dose dependent manner and is always associated with hypersensitivity and other major side effects. Hence, new sources of this therapeutic protein are being explored because serologically different enzyme having efficient therapeutic effects with low glutaminase activity is desired.

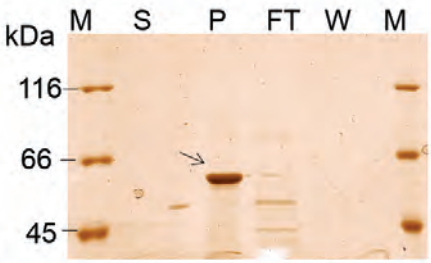
According to import data of Govt. of India, more than $43,41,344 of asparaginase has been imported in last 2 yrs and the improved asparaginase drug, Erwinaze of EUSA Co. costs about $150,000 to $175,000 for a full course of treatment. It has been estimated that world enzyme market will grow up to $6.2 billion by 2020 and 40% will account for therapeutic enzymes. Of this, asparaginase contributes towards 1/3rd of total sales. Therefore, even if at least 10% (~550 crores INR) of therapeutic enzymes market worldwide is targeted, the Himalayan version of asparaginase will generate a huge market potential. In this regard, the major aim of the present project is to align with the Govt. of India mission of 'Swasth Bharat' and provide affordable asparaginase accessible to common man and in turn generate revenue, while improving the quality of life.

Milestones achieved

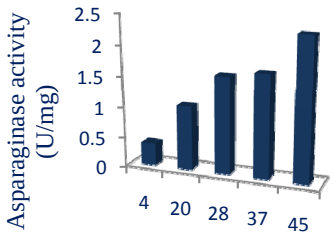
- More than 500 pure bacterial isolates from higher altitude were screened for L-asparaginase activity.
- Among 28 potentially active isolates, showed minimum or no glutaminase activity.
- Wide temperature (4°-60°C) active, stable and efficient asparaginase.
- Initial testing on cancerous cell lines showed significant cytotoxic effects (≥80% cell death).



Highly efficient bacterial positive (pink color) and negative (yellow color) for Asparaginase activity are shown.



Purified protein on SDS-PAGE



Asparaginase activity of purified enzyme at different temperature

2. Process for substituted cyclohexane-1-3-diones synthesis

Cyclohexane-1,3-dione compounds are used in the production of agrochemical, pharmaceutical and fine chemicals. There is a huge national and international demand for the compound. India exports different cyclohexane-1,3-dione compounds annually. Therefore, development of scalable and cost-effective processes for the production of new and known classes of cyclohexane-1,3-dione is required for meeting the global demands.

Important parameters unique to the development

- ✓ Development of a cost-effective process for the production of substituted cyclohexane-1,3-diones
- ✓ Synthesis of new molecules to meet the global demands for agrochemicals, pharmaceuticals and fine chemicals

Major application(s)

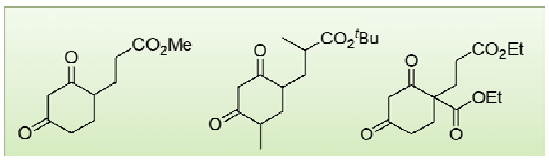
The compound will have major industrial applications as agrochemicals, pharmaceuticals and fine chemicals

Highlights of general impact

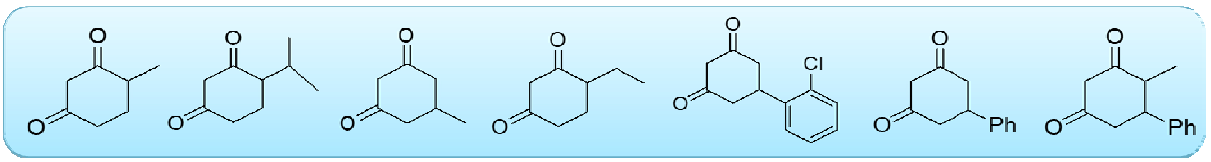
Cyclohexane-1,3-dione derivatives have a vast market demand globally and is growing at a rapid rate. Therefore, a number of methods have already been published/ patented in this regard. However, economically viable method(s) for the synthesis of cyclohexane-1,3-diones still remains to be developed.

First of all in the study, a long existing problem of synthesizing substituted cyclohexane-1,3-diones from un-reactive acetone was solved using consecutive Michael-Claisen process. The practical applicability of the process was then tested for a novel compound, 4-ethyl propionate-cyclohexane-1,3-dione up to 500 gm scale. Further, different acetone derivatives were investigated using similar and consecutive Michael-Claisen process for synthesizing substituted cyclohexane-1,3-diones and a high substrate selectivity was observed during the synthesis. The process is expected to meet the industrial demands for novel molecules while facilitating target based designing of natural and unnatural bioactive molecules.

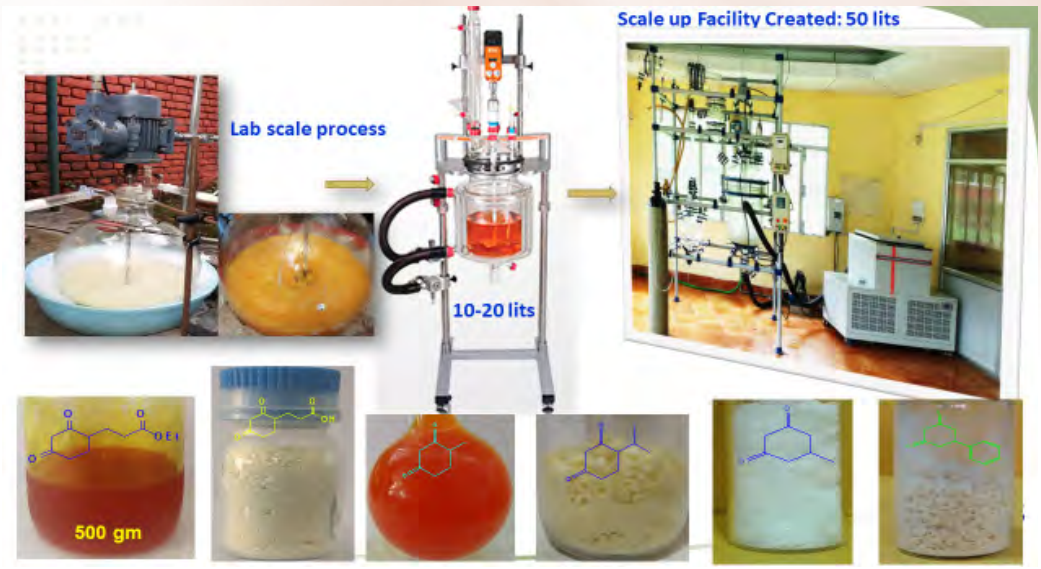
New compounds:



Commercially known compounds:



Some highlights of the research



Scaling-up of the process for cyclohexane-1, 3-diones synthesis

CSIR MISSION AROMA

Council of Scientific and Industrial Research (CSIR) and other institutes of CSIR have contributed significantly towards the transformation of the essential oil-based aroma industry in India over past several decades. The high-end scientific interventions and technologies developed by CSIR have not only facilitated job creation and income-enhancement but also promoted the essential oil industry, farmers and entrepreneurs of India. In order to continue with this legacy, a mission was conceptualized to further provide an end-to-end technology for catalyzing rural empowerment through cultivation, processing, value addition and marketing of aromatic plants. The effort is expected to bring about a decisive and transformative change in the rural economy, market dynamics and growth opportunity across the country.

The mission targets to achieve the following outcomes across the country through its five plant based laboratories located in different parts of the country *viz*., CSIR-CIMAP, Lucknow, CSIR-IIIM, Jammu, CSIR-IHBT, Palampur, CSIR-NEIST, Jorhat and CSIR- NBRI, Lucknow:

a) Bring about 5500 ha of additional area under captive cultivation of aromatic cash crops particularly, targeting the rain-fed /degraded lands across the country.

b) Provide technical and infrastructural support to farmers/growers all over the country.

c) Enable effective buy-back mechanisms and assure remunerative prices to the farmers/ growers.

d) Value-addition to essential oils and aroma ingredients for their integration in global trade and economy.

The major verticals of the missions are:

- Development of superior varieties and their agro-technologies.
- Assessment of the developed varieties for their suitability in specific agro-climatic regions.
- Promotion of cultivation and processing of aromatic crops.
- Enhancing area under selected aromatic crops and enabling interventions including setting up of distillation units and catalyzing cooperative formation for marketing of the produce.
- Value-addition of aromatic crops for developing high-end aroma chemicals and products.
- Skill development activities *viz*., awareness programs, up-gradation of skills on cultivation and processing the crops, advanced training on value addition of produce and quality assessment.
- Intellectual property generation, valuation and management.
- Entrepreneurship development/spin-offs.

Target Crops of CSIR-IHBT under Aroma Mission

In H.P., 85 % land holdings are small and marginal. Resources are also limited and dependency on agriculture is high. Traditional farming is becoming non remunerative mainly due to wild animal menace and unpredictable weather. Moreover, large chunks of hilly terrains remain uncultivated for the want of high input-farming technology and tillage requirements. Under such circumstances, aromatic crops hold promise for successful cultivation and higher revenue generation. *Tagetes minuta* (Wild marigold), *Valariana jatamansi* (Muskbala), *Rosa damascena* (Damask rose), *Dracocephalum heterophyllum* (Thimsingli), *Artemisia maritima* (Sea wormwood) and *Cymbopogon flexuosus* (Lemongrass) crops were shortlisted by CSIR-IHBT under the mission for cultivation in an area of 530 hectare during the project period for different agroclimatic regions in and around the state.

Activities undertaken

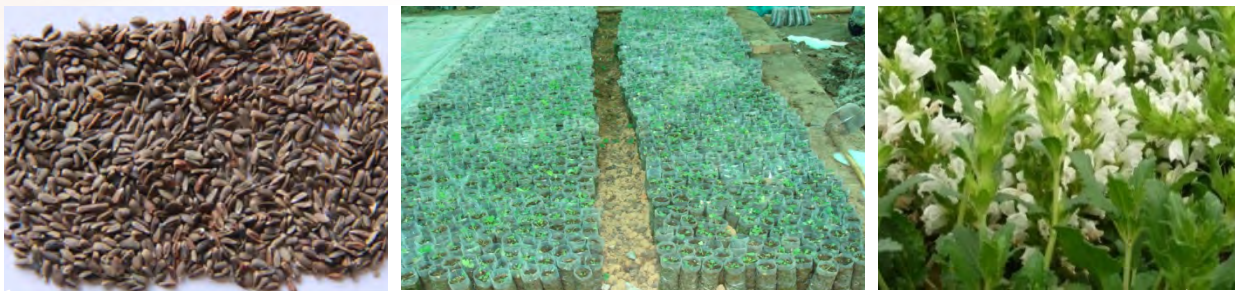
Multiplied seed of the improved variety of *Tagetes minuta* "Himgold" and extended its cultivation in 40.44 ha area belonging to 123 farmers of mid Himalayan region. Essential oil distillation facility was made available to the interested farmers for distillation of their oil.

Nursery plants of improved variety "Himbala" of *Valariana jatamansi*, developed by the Institute were raised. Plants were planted at CeHAB Ribling centre of the Institute for studying their performance. Plants were also supplied to HP State Council of Science, Technology and Environment for dissemination to the farmers.

Nursery raising and plants' supply of Valariana jatamansi

During this year 15,000 nursery plants of *Rosa damascena* were provided to the farmers in different regions to cover 1.5 ha area.

With a view to develop elite planting material, germplasm of *Dracocephalum heterophyllum* was collected from the high altitude region of Lahaul and Spiti. The nursery plants were being raised for further evaluation. The crop will be spread in high altitude regions for improving the livelihood of the farmers.



Dracocephalum heterophyllum: seeds, nursery and flowering plants

Different accessions of *Artemisia maritima* were also collected from high altitude regions for identifying the promising germplasm with high productivity and oil quality.

With Institute's efforts, lemongrass (*C. flexuosus*) has been popularized in warmer region of the state e.g. Una, Gagret etc. Distillation facility was provided by the Institute to the growers at their doorstep using mobile distillation van.

Rosa damascena

Artemisia maritima

Cymbopogon flexuosus

CSIR SKILL DEVELOPMENT PROGRAMS

The rural youth in India are marginalized and have low opportunities for skill building and sustainable livelihood. The youth are mostly unemployed because of lack of skill or non-matching skills required for the jobs available in blue-collared sectors. Non-availability of skilled manpower is also responsible for poor quality of workforce and consequent low productivity. Although the students completing their professional degrees in science are good in theoretical knowledge, they lack the requisite experimental skills to fare well or work as per the expectations of the industry and R&D organizations. Therefore, the institute has aligned with the Hon'ble PM's Skill Development Mission and developed skill development courses under the CSIR Integrated Skill Initiative. The major goals of this initiative are (i) enhancing the employability skills and (ii) promoting entrepreneurship for post-graduates as well as youths at grass-root levels.

The skill development programs fall under the agriculture skill sector, life sciences skill sector and healthcare skill sector. In this regard, programmes on gardener-ship, floriculture-protected cultivation, diploma in laboratory practices in animal house, and hands-on-training in laboratory experiments and analytical exposure have been initiated to enhance practical skills in these areas.

The salient features of the training programmes encompass 60 per cent practical laboratory and field trainings, exposure and handling of implements and equipment, record keeping and reporting for good laboratory practice (GLP), and trouble shooting. During the course, candidates will be given assignments/projects at individual level and team mode. These will be evaluated and only successful candidates will be awarded skill enhancement certificates.

More skill development programmes that are planned for the rural youth in the coming years include skill development in plant tissue culture, essential oil extraction, growing medicinal and aromatic plants and management of small laboratory animals for entrepreneurship development.

INCUBATION CENTRE OF CSIR-IHBT

The Common Research and Technology Development Hubs (CRTDHs) was established by the Department of Scientific and Industrial Research (DSIR) with an aim to foster industry-institution interaction and address problems faced by MSEs during translational research. A major aim was to provide an eco-system for research and innovation in the country. The incubation centre was set up in the area of 'Affordable Health' to carry out quality R&D in frontier areas of healthcare products and development of ingredients using under-utilized and food bioresources of the region. The centre has equipments and machineries for pilot scale food processing and product development for new and existing enterprises of the region. These include encapsulation unit, flaking mill, roaster, crispy fruit unit, centrifugal separator, hellicolidal juice extractor, pulverizer, sparkle filters, vacuum packaging facility etc.

Interaction with entrepreneurs and incubatees working in the CRTDH facility during the visit of the Honorable Minister

Incubatees working in the CRTDH facility at CSIR-IHBT

Recently, the Department of Industry, H.P. signed an MoU for implementation of the 'H.P. State Chief Minister Start-up Incubation Scheme' at CSIR-IHBT, Palampur. Following this, a number of incubatees applied for being trained at CSIR-IHBT, Palampur under this scheme and setting up new startups/enterprises in the state.

List of incubatees

- M/s Minocha Industries, Shimla for 'Development of Apple cider based functional beverages'
- M/s Roots and Flowers, Palampur for 'Development of seasonal fruit candy and crispy fruits'
- M/s Himalaya Natural and Herbals Products, Palampur for 'Development of ready to use stevia based tablets'

SURVEY, MAPPING, CHARACTERIZATION AND MANAGEMENT OF HIMALAYAN BIORESOURCES

One of the primary objectives of the institute is to generate information on the status and distribution of Himalayan bioresources for bioprospection, conservation and management.

SURVEYS

A total of 16 field surveys were conducted to different localities of Bilaspur, Kullu, Chamba, Mandi and Kangra district of H.P. to collect sample species for bio-indicator responses, analyze phenological patterns, document traditional conservation practices, record ethnobotanical information, collect target plant materials, soil samples and GPS coordinates of the areas. In addition, ecological studies to different forest landscapes were also carried out.

Epiphytes as indicators of environmental conditions

Epiphytes directly absorb nutrients from the environment and thus are amongst the best indicators of environmental conditions. Consequently, fronds of *Pyrrosia flocculosa* growing along a vehicular disturbance gradient were analyzed for heavy metal concentration. Concentration of the metals was in the order Fe (639.28±81.63) > Ni (56.03±4.97) >Mn (7.54±0.69) >Zn (6.51±0.36) >Cd (4.01±0.86) >Cu (1.93±0.74). Except for Mn, concentration of all the metals increased with disturbance and was positively correlated to it. However, except for Cd and Fe, none of the metals reported higher than threshold values (Fig. 1). An effective monitoring of the environment can thus be done using *P. flocculosa*.

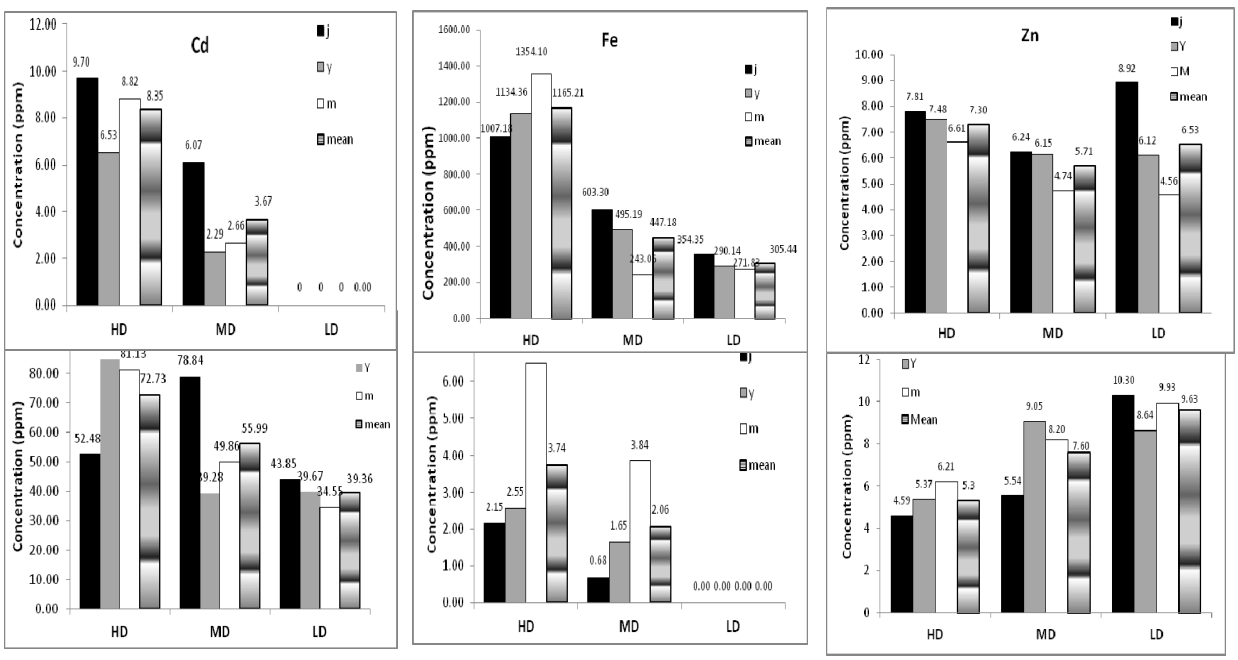


Fig. 1 Heavy metal concentration in different growth stages (j-juvenile, y-young, m-mature) of *P. flocculosa* growing in differently disturbed sites (HD-highly disturbed, MD-moderately disturbed, LD-least disturbed)

Indoor air pollution abatement through potted plants

Indoor air quality has become a serious concern due to increased urbanization (32% of Indians live in urban buildings). Reduction in fresh air intake can also result in the accumulation of gaseous contaminants like volatile organic compounds (VOCs) within the indoor environment leads to a variety of health concerns. Since urbanites spend 90% of their life in indoors (hospitals, offices, banks, shopping-malls, airports, seminar rooms, lecture halls, laboratories), the quality of the ambient indoor environment can have serious implications. Our aim is to investigate the capacity of the potted plants to reduce VOCs in indoor environment. In the intial stages of the project, real time readings of VOCs in three laboratories of IHBT were recorded using a Q-TRAK Indoor Air Quality Monitor.

Species phenological patterns

Recognizing that plant phenology is a key indicator of changing climatic conditions, identification of phenological stages in *Sapium sebiferum* using red, green and blue channel information of digital images was carried out. Across the three channels the Digital Number (DN) values ranged from a minimum of 71.42 in blue channel (B_{DN}) to 156.16 in green channel (G_{DN}). In general, the R_{DN}, G_{DN}, and B_{DN} values increased till 66 day of the year (DOY) after which there was a decline in DN values of R, G, and B channels till 224 DOY (Fig. 2). The value of Red Fraction (RF) ranged between 0.297348281 to 0.352612071. On the other hand, the value of Green Fraction (GF) ranged between 0.330045461 to 0.39841947.The values of Green Excess Index (2G-RBi) ranged between -0.009863618 to 0.19525841. It reported minimum value on 42 DOY and the maximum on 139 DOY. Green excess index was found

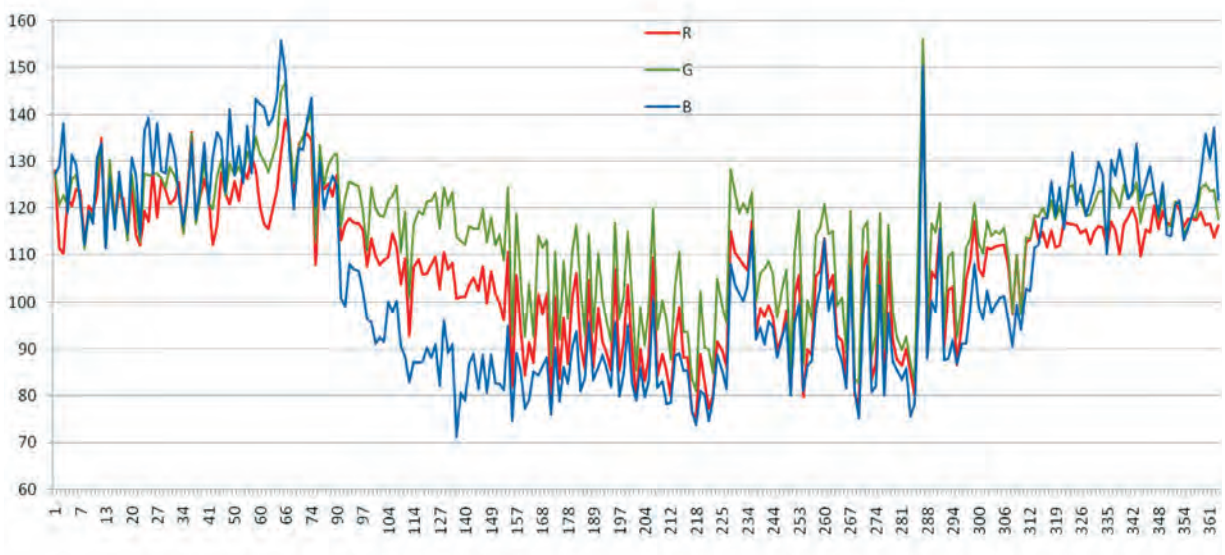


Fig. 2 Red, Green and Blue channel information across the year (X axis represent the day of the year)

to be reliable indicator of greening up in the species. Red Fraction was a good indicator of senescence.

Studies on Long Term Ecological Research (LTER) plots

The vegetation data from 30 permanently marked 1m x 1m quadrats in 3 summits at Chansal pass (distt. Shimla) were recorded following the GLORIA protocols (Fig. 3). These summits represent tree line (3600 m amsl), lower alpine (3770 m amsl) and upper alpine (3900 m amsl) ecosystems of the Himalaya. It was observed that species richness decreased from tree line to upper alpine zone, western aspect had higher number of species, and the lower alpine summit had higher species diversity than higher summit. Additionally, plant sampling and trait variations in species were recorded in the permanent plots marked in the Dhauladhar mountain range. Further, 60 soil samples were collected for analyses.

Tree line summit **Lower alpine summit** **Upper alpine summit**

Fig. 3 LTER permanent plots at Chansal Pass, H.P.

Tree carbon density of Dhauladhar Wildlife Sanctuary

Forests play an important role in the global and regional carbon (C) cycles as they exchange large quantities of C with atmosphere through photosynthesis and respiration. Forests store a significant quantity of C in vegetation and soil (approx. 60%). Therefore, quantification of different C pool is vital to understand C dynamics of the forests. The present study was designed to estimate tree C density of temperate forest in the Dhauladhar Wildlife Sanctuary (DWS), H.P. The study area is dominated by *Quercus semecarpifolia*, *Picea smithiana* and *Taxus baccata* tree species. For estimating C density of tree, above ground dry biomass (AGB) was calculated by using species-specific allometric volume equations for different tree species. These allometric equations required some parameters *viz.* diameter at breast height (DBH), tree height and wood density to calculate AGB. At each site, the DBH of different tree species was measured with the help of tree calipers at the height of 1.37 m above the ground. Tree height and wood density of all tree species were measured by Forestry Pro and increment borer, respectively. Below ground dry biomass was calculated by multiplying AGB with constant factor 0.26 (IPCC, 2006). The

total C-density of tree biomass was calculated by multiplying the individual tree total biomass with the conversion factor 0.5 (IPCC, 2006). The DBH and tree height of different species varied from 6.9 – 97 cm and 2.8 - 34.2 m, respectively among the sites. The mean value of above ground and below ground tree C density ranged between 63.7- 157.7 t-C ha^{-1} and 83.5 – 198.7 t-C ha^{-1}, respectively.

Documentation of ethnobotanical knowledge

Ethnobotanical studies were conducted amongst the *Gujjar* and *Gaddi* communities inhabiting Churah (Tisa) subdivision of Chamba district and *Bhangalis* of Chhota Bhangal in Kangra district. During the reporting period around 70 villages were surveyed and around 280 local knowledge holders were interviewed. Information on different aspects of traditional knowledge related to cultural, indigenous house architecture, traditional agriculture, conservation and utilization of local plant resources for food, health care, socio-religious beliefs and income generation were recorded. A total of 135 plants species belonging to 127 genera and 67 families were found to be used in health care for treating around 30 ailments. Amongst the important medicinal plants reported are *Aconitum heterophyllum*, *Berberis lycium, Rabdosia rugosa*, *Viola canescens*, *Cannabis sativa*, *Rheum australe*, *Dactylorhiza hatagirea*, *Verbascum thapsus*, *Urtica dioca*, *Sinopodophyllum hexandrum* etc. Besides livestock rearing and traditional agriculture, these communities also earn through sale of minor forest produce particularly medicinal herbs and selling of wool and woollen garments.

Bioprospecting insects for bioeconomy:

For prospecting insects for bioeconomy, field surveys were conducted in Pithoragarh district of Uttarakhand (U.K.) for habitat study and *Ophiocordyceps sinensis* and soil samples were collected for further studies. similarly, field surveys were also carried out in some districts of H.P. and fungus infected lepidopteron caterpillars were collected. Standardized method for simultaneous detection and identification of 10 marker compounds of *Ophiocordyceps* sp. has been initiated (Fig. 4).

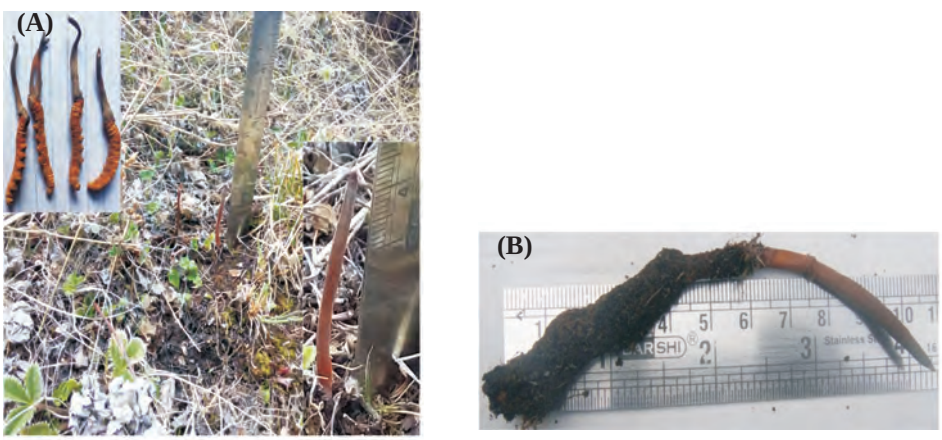


Fig. 4 *O. sinensis* collected from Uttarakhand (A) Stroma/Fruiting body (above ground part), (B) Insect Part (Below soil)

MAPPING

Land use land cover mapping

Land use land cover (LULC) map of Dharamshala region of H.P. (Fig. 4) was prepared using LANDSAT 8 image of 30 October, 2014 through following digital processing techniques of remote sensing. The region has 40.3% area under forest cover. Among all the forests, the sub-tropical pine forest had highest representation of 25.2%, scrub/grass lands (18.4%) and water bodies (11.7%) and agriculture (11.3%). The built-up land, temperate pasture, alpine pasture, open/barren/rocky area, sub-alpine forest, snow cover and tea garden were identified as 5.45%, 3.79%, 3.05%, 2.72%, 2.53%, 0.53% and 0.04% respectively.

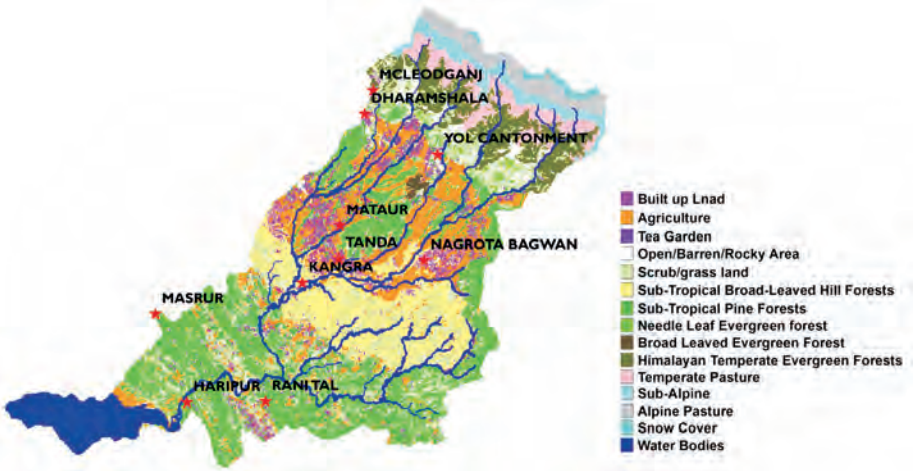


Fig. 5 LULC map of Dharamshala region of H.P.

Estimation of Net Primary Productivity of protected areas in Himachal Pradesh

Net Primary Productivity (NPP) of two National Parks, i.e., Great Himalayan National Park (GHNP) and Pin Valley National Park (PVNP), and one wildlife-sanctuary, i.e., Rupi-Bhabha Wildlife Sanctuary (RBWS) in H.P. was estimated using MODIS satellite data from 2000 to 2015. Highest NPP values were obtained for GHNP, ranging from 0.08 to 13.87 t C/ha/year. Though statistically non-significant, temporal changes in NPP showed decreasing trends in GHNP and an increasing trend in RBWLS (Fig. 6).

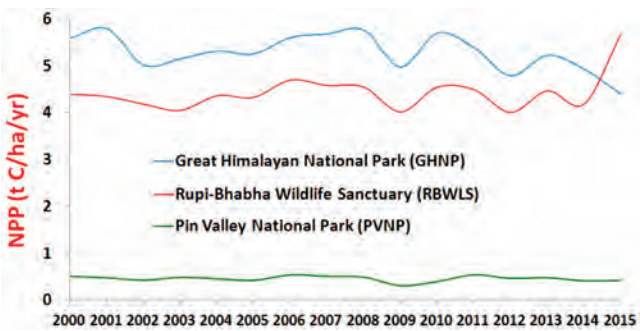


Fig. 6 Mean annual Net Primary Productivity of GHNP, RBWLS and PVNP during the years 2000 to 2015

Recording of hyperspectral signatures of Himalayan flora

The spectral signatures are key inputs for species discrimination and generation of narrow band spectral indices. Spectral reflectance of cut leaves of 14 Himalayan tree species that are representative of temperate and sub-alpine forests were recorded using ASD fieldspec Pro 2000 handheld spectroradiometer (325-1075 nm) from Chansal region of Shimla district of H.P. (Fig. 7).

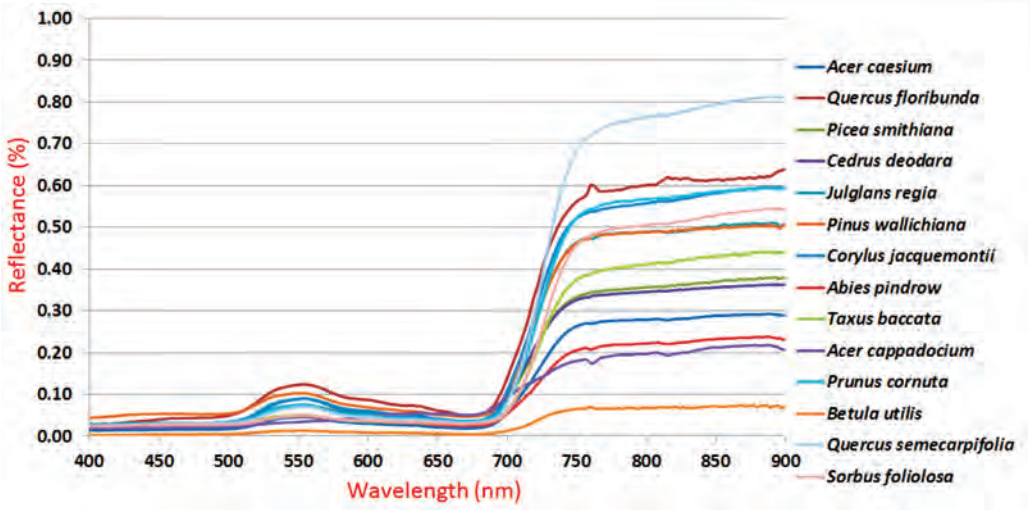


Fig. 7 Reflectance spectra of some important tree of Chansal region of Shimla, H.P.

Rainfall patterns of Himachal Pradesh using satellite data

The rainfall pattern of H.P. was analysed using the Tropical Rainfall Measuring Mission (TRMM) satellite data for 1998 to 2014 (Fig. 8). The derived data indicated a decreasing trend of rainfall in the state in the observed years.

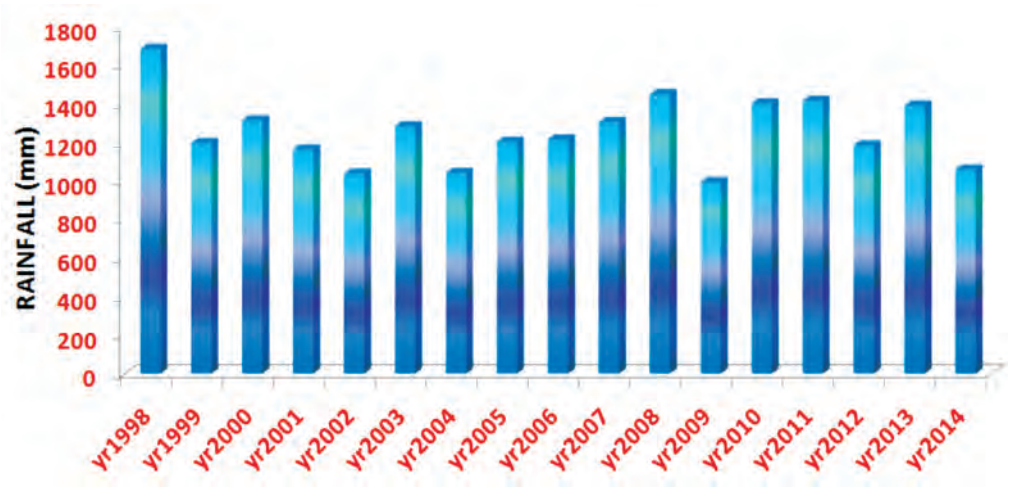


Fig. 8 Yearly rainfall pattern of H.P. derived from TRMM data

Modelling niche habitat of *Podophyllum hexandrum* in Himachal Pradesh

Suitable regions of occurrence of *Podophyllum hexandrum* in H.P. were mapped using Maxent probabilistic modelling. The modelling was run using its 42 GPS locations and 19 WorldClim environmental variables. The 18.76% geographical area in H.P. was mapped as being suitable for the occurrence of *P. hexandrum* (Fig. 9). Chamba district was identified as having the highest probability of *P. hexandrum* occurrence.

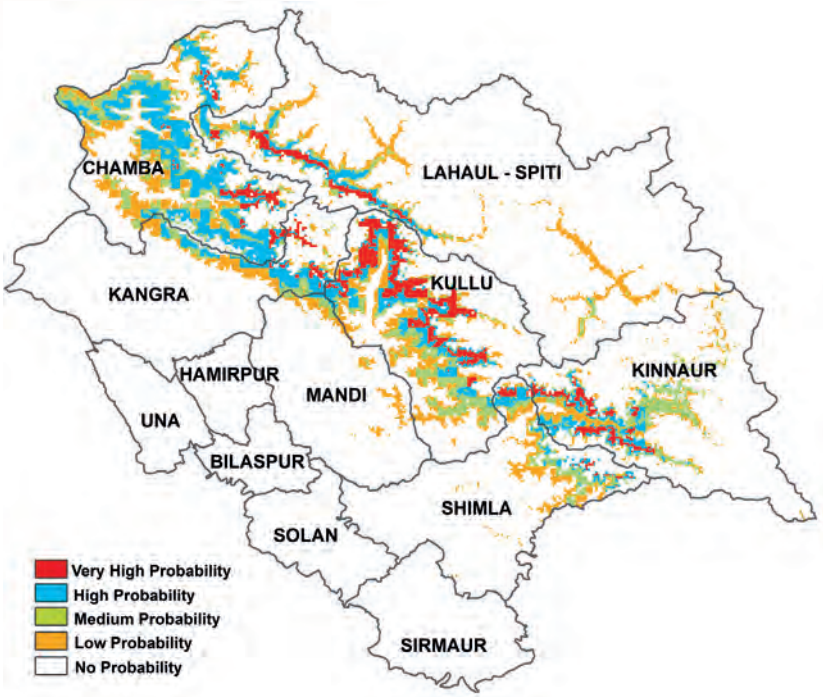


Fig. 9 Modelled niche area of *Podophyllum hexandrum* in H.P.

Generating indices to develop models for Himalayan plants

Picrorhiza kurroa, Sinopodophyllum hexandrum, Hypericum perforatum and *Valeriana jatamansi* are endangered medicinal plants of the Himalayan region. Documentation of their response towards climate change and future distribution is desired. This warrants comprehensive study on these plants for developing models to assess their performance under climate change. Various model input parameters were recorded for *P. kurroa* and *S. hexandrum* under glasshouse conditions. These include phenology, plant height, plant spread, number of leaves, leaf thickness, leaf area, specific leaf area, leaf area index, photosynthesis rate, stomatal conductance, intercellular CO_2 concentration, transpiration, vapour pressure deficit, and boundary layer conductance. Further, effect of environmental conditions on growth and yield of *H. perforatum* and *V. jatamansi* was studied under Free Air Carbon Enrichment (FACE), Free Air Temperature Increase (FATI) and FACE+FATI facility of the institute. Total dry biomass was significantly higher in FATI conditions in case of *H. perforatum*, and FACE+FATI conditions in *V. jatamansi*, respectively (Fig. 10).

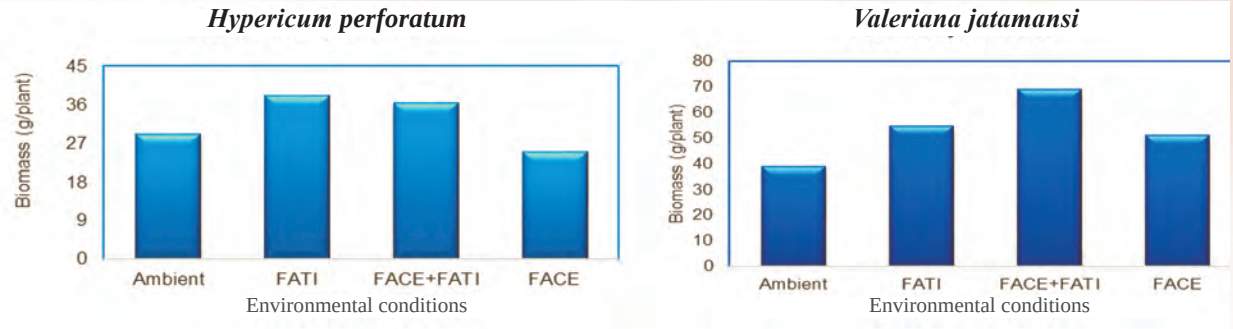


Fig. 10 Effect of environmental conditions on total dry biomass of *H. perforatum* and *V. jatamansi*

Strengthening of herbarium

As a result of extensive field surveys, around 1000 plant specimens belonging to around 300 species were collected from different localities of H.P. To avoid repetition, 140 voucher specimens mostly provided by outside educational and R&D organizations for authentication were processed and deposited in the herbarium (PLP) of the Institute. Among these are *Adhatoda vasica, Ajuga parviflora, Asparagus adscendens, Bryophyllum pinnatum, Centella asiatica, Cinnamomum tamala, Cirsium wallichii, Cissampelos pariera, Lepidagathis cuspidata, Murraya koenigii, Pogostemon benghalensis, Pyrus pashia, Spilanthes acmella, Vitex negundo, Zanthoxylum armatum*, etc.

E-inventory of CSIR-IHBT herbarium

The internationally recognized herbarium of CSIR-IHBT holds more than 15000 specimens of angiosperms, gymnosperms and pteridophytes. An *E-inventory* of these herbarium specimens was prepared using Visual Basic Programming and MS access as backend database. To access this database, the user has to login and then queries can be performed based on almirah, family, genus and species search options (Fig. 11).

Fig. 11 E-inventory of CSIR-IHBT Herbarium

CONSERVATION OF RARE, ENDANGERED AND THREATENED PLANT SPECIES

The western Himalayas are characterized by different altitudinal gradients ranging from the sub-tropical foot-hills to the sub-alpine and alpine regions and the starkly rain-starved cold deserts. The diverse array of plants and microbes that inhabit these regions are particularly unique in their growth behaviour and adaptive ability. Hence, most of the plants and microbes inhabiting these regions are endowed with diverse arrays of genes, enzymes and metabolic pathways for survival and adaptation in the harsh and changing climatic conditions. While many of these bioresources are being indiscriminately exploited by various pharmaceutical and nutraceutical industries, a large proportion is lying untapped and uncharacterized. Hence, conventional as well as emerging tools of biotechnology are being employed for bioprospection and characterization of these resources. Attempts are also being made to replenish and revert the rare, endangered and threatened status of selected bioresources for value addition and utilization by various industries. The outputs are envisaged to boost national efforts towards conservation and enhancing economy of the region. Plants produce a variety of natural compounds having immense importance in healthcare, food, cosmetics and pharmaceutical industries. Many plants are on the verge of extinction due to continuous over-exploitation from natural habitat. In this regard, plant cell culture technology is also being employed as a biotechnological tool for the production of secondary metabolites and preventing continuous extraction from wild. The technology has the potential to meet the growing consumer demands for natural ingredients and for sustainable utilization of valuable endangered medicinal plants of Himalaya.

Micropropagation of rare endangered and threatened medicinal plants for rehabilitation in nature

Natural populations of Himalayan medicinal plants have dwindled due to continuous extraction and indiscriminate exploitation. As a result, many plants have become endangered and require urgent rehabilitation in natural habitats. Therefore, work is being carried out to replenish the depleting resources of threatened plants like *Picrorhiza kurroa*, *Dactylorhiza hatagirea, Trillium govanianum, Fritillaria roylei*, *Rhodiola imbricata*, *Arnebia euchroma*, *A. benthamii, Malaxis acuminata* and endangered *Dendrobium* species in nature through micropropagation.

Fritillaria roylei (Jangli lahsan)

It is an important medicinal plant of Astavarga group, distributed in sub-alpine to alpine regions of the Himalayas. Its bulbs are an important constituent of many medicines and health tonics. Over exploitation of this medicinal herb has reduced the availability of *F. roylei* in natural habitats, putting it into endangered category in H.P. Therefore, aseptic cultures of the plant were initiated using small segments of bulbs as explants (Fig. 1). Regeneration of shoot buds from the surface of scales was observed after 6 weeks of incubation at 25±2°C and 16/8 h of light and dark period. Multiplication of the buds followed by shoot formation took place on MS medium supplemented with 3.0% sucrose, 1.0 mg/l Kn and 0.1 mg/l NAA.

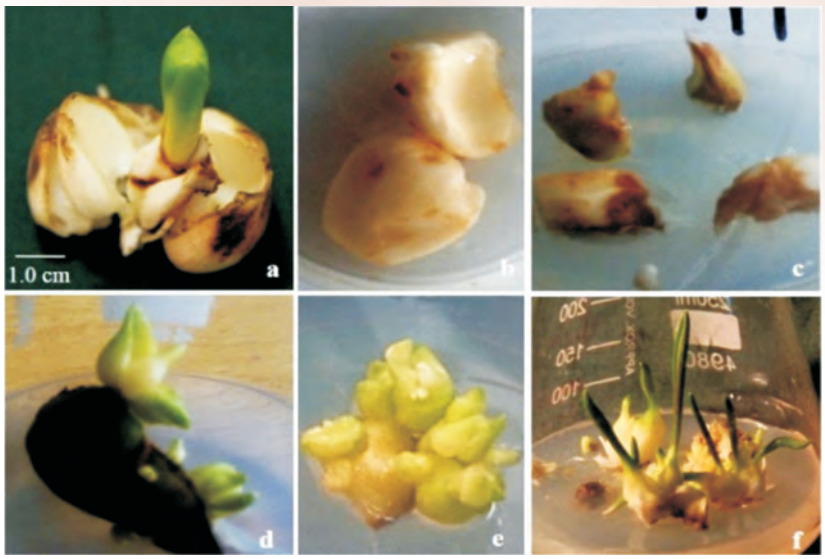


Fig. 1 Establishment of *in vitro* cultures of *Fritillaria roylei*, a) Bulb used as explant, b) Bulb scales ready to be inoculated, c) Scales inoculated on medium, d) Regeneration of shoot buds, e) Shoot bud multiplication, f) Multiple shoots

Trillium govanianum (nag chhattri)

It is commonly known as 'nag chhatri' or 'teen patra', and is a native of the Himalayas. The rhizomes are used to treat boils, wounds, dysentry, inflammation, menstrual and sexual disorders, and as an antiseptic. Its numbers are decreasing sharply in the natural habitats due to over-exploitation. In order to mass multiply the same through micropropagation, rhizome buds of plants growing in the field were cultured on ½ MS medium supplemented with various combinations of BAP and NAA. Sprouting of buds were observed at 5.0 mg/L BAP and 1.0 mg/L NAA (Fig. 2).

Fig. 2 Establishment of *in vitro* cultures of *T. govanianum* a) Rhizome used as explant, b) Sprouted buds

Arnebia euchroma (ratanjot)

Ratanjot is an economically important medicinal plant of the Himalayan region. Roots of this plant contain shikonin derivatives, which are used as medicines and also as natural dye for textiles, cosmetics, and food additives. *A. euchroma* is being over-harvested from the natural habitats and has become endangered. Therefore, aseptic shoot cultures of *A. euchroma* were established (Fig. 3) for mass multiplication and further initiation of different types of organ cultures and *in vitro* studies on secondary metabolite production.

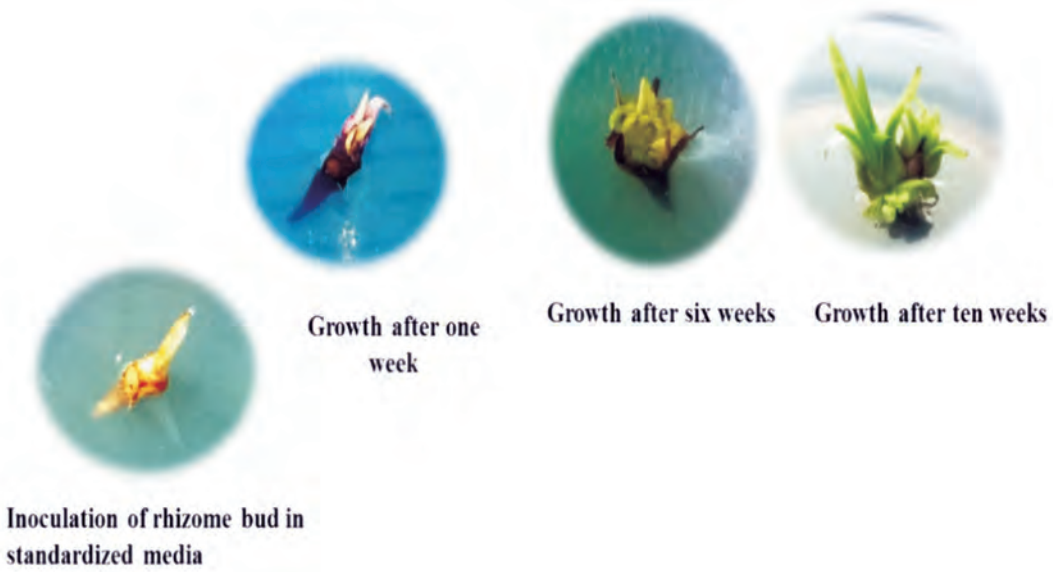


Fig. 3 Different stages of growth in *in vitro* shoot cultures of *A. euchroma* initiated from rhizome buds.

Production of shikonin in cell cultures of *Arnebia* species

In continuation to previous work on the production of shikonin in cell cultures of *Arnebia* spp., callus multiplication was carried out in 1000 ml conical flasks. These were also screened for high pigment producing cell lines (Fig. 4).

Fig. 4 Callus multiplication and screening of high pigment producing cell lines

Alternative systems (*in vitro*) for production of secondary metabolites

Adventitious root cultures

In the current year, adventitious root cultures were induced from leaf explants of *A. euchroma*. Profuse root formation in the cultures suggested its potential for stable production of shikonin (Fig. 5).

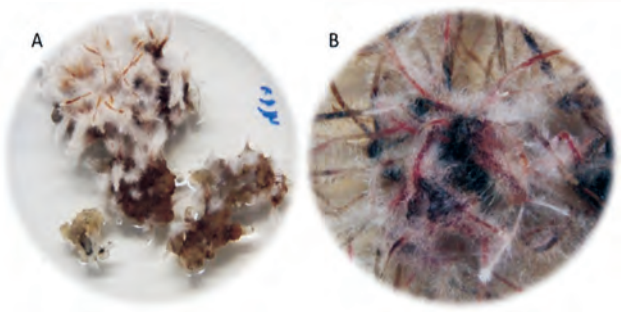


Fig. 5 Induction of adventitious root cultures from *A. euchroma* leaf explant: A) 15 days and B) 30 days old culture showing difference in pigment intensity.

Rhodiola imbricata (Rose root, arctic or golden root or shrolo)

This important medicinal plant of the high altitude region of Indian trans-Himalaya is used in the stimulation of the nervous system, enhancing work performance, eliminating fatigue, preventing high-altitude sickness and as anti-depressant. Most of these effects are attributed towards constituents such as salidrosides (rhodiolosides), rosavins, and ptyrosol, predominantly present in the roots. Since the roots are being heavily exploited from the wild, the natural resources are dwindling rapidly. In this regard, micropropagation of the plant was targeted in the current year and healthy shoot cultures were raised from shoot explants of germinated seedlings (Fig. 6).

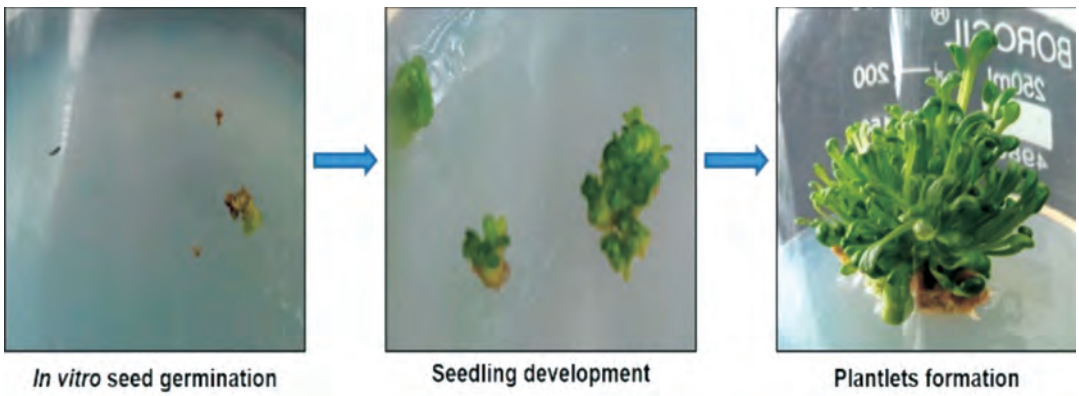


Fig. 6 Plantlets formation from shoot explants of *R. imbricata*

Callus cultures of *Rhodiola imbricata*

Callus cultures of *R. imbricata* were established from leaf explants of seedlings germinated *in vitro* (Fig. 7). The final aim is to produce commercially important metabolites in cell cultures of this less explored medicinal plant.

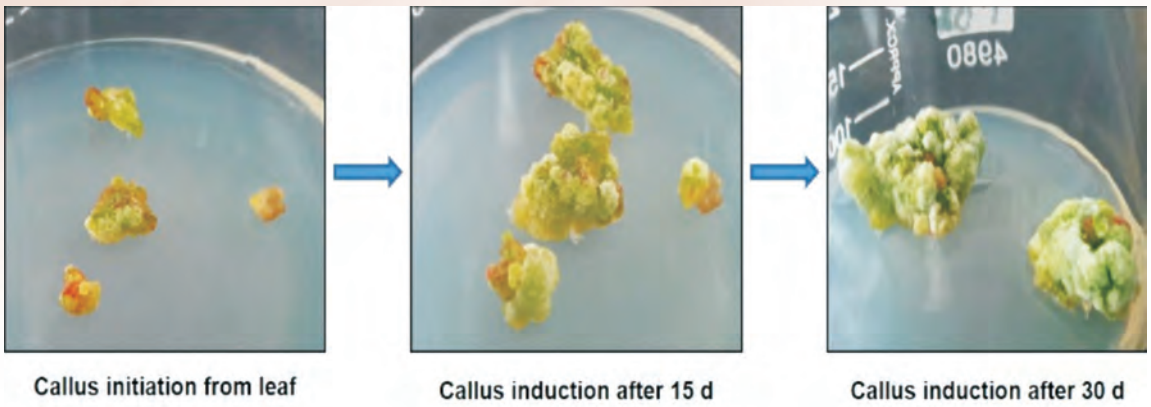


Fig. 7 Callus induction in *R. imbricata*

Picrorhiza kurroa

Picrosides I, II and kutkosides are predominantly present in the underground parts of *P. kurroa* and are used in the treatment of asthma, liver damage, wound healing and vitiligo. Since the underground parts are highly sought after by various herbal industries, *P. kurroa* has become endangered. Thus, in the previous years, micropropagation methods were standardized for large scale mass production of *P. kurroa* under the DBT sponsored project 'Preventing extinction and improving conservation status of threatened plants through application of biotechnological tools'. In the current year, the micropropagated plants of *P. kurroa* were handed over to growers for rehabilitation at Bharmour, district Chamba, H.P. (Fig. 8). The plants showed 100% survival at Bharmour.

Fig. 8 Micropropagation of *P. kurroa* plants from leaf explants and their rehabilitation at Bharmour, Distt Chamba, H.P.

Agrobacterium mediated genetic transformation of *Picrorhiza kurrooa* for stress tolerance

Transformation experiments were initiated to introduce *Ra*TLP and *Cj*SuccCoA genes into *P. kurroa* genome for resistance to fungal pathogens and abiotic stresses, and for lowering plant respiration. Probable transgenic plantlets for C95A and control construct (blank: LBA4404+pCAMBIA1302) have been obtained. However, their molecular confirmation is underway.

Hairy root cultures of *P. kurroa*

Hairy roots are produced through *Agrobacterium rhizogenes* mediated genetic transformation of explants. The genetically transformed root cultures have the ability to produce significant amounts of secondary metabolites equivalent to that of whole plants. The hairy roots can be also upscaled in pilot plants. In this regard, the *A. rhizogenes* strain A4 was used to initiate hairy root cultures from leaf explants of *P. kurroa*. Distinct hairy roots were reproducibly produced from transformed leaf segments but no hairy root formation was recorded in case of untransformed control.

Fig. 9 Hairy root formation in *P. kurroa* (A) transformed leaf segment with hairy roots (B) untransformed control.

Enhancing the biomass and metabolite production through Hi tech farming of RET plants

With an aim to enhance the root biomass as well as metabolite production in *P. kurroa*, the hydroponics/aeroponics cultivation of the plant versus control was studied. The pH and the electrical conductivity of nutrient solution were maintained at 5.6-6.5 and 2.0-2.1 mS cm^{-1}, respectively. Nutrient solution or water was added according to weekly mineral analysis. The level of supplied oxygen was maintained through a bubbler; and a chiller system was used to keep the water temperature at 10-12° C. The temperature was set at 22° C at day and night, and the relative humidity was maintained at 65%. A 16 hr photoperiod was maintained in the greenhouse by a controller. As compared to control, the leaf and root biomass were significantly higher in the aeroponically and hydroponically cultivated plants. The optimized parameters have the potential for higher biomass/metabolites production in a reduced period of time.

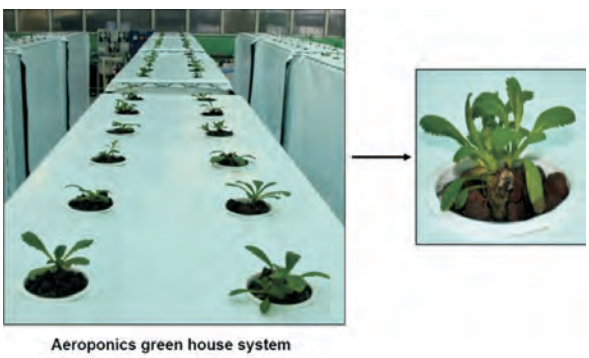


Fig. 10 Aeroponic cultivation of *P. kurroa*

Dactylorhiza hatagirea

It is a terrestrial medicinal orchid of Himalayan region. The tubers of *D. hatagirea* are rich in dactyloses A and B and dactylorhins A, B, C, D and E. The compounds are used in the treatment of pyorrhoea, chronic fever, cough, stomach ache, cuts, burns, fractures and intestinal disorders. The plant has become critically endangered because of indiscriminate up-rooting from wild. Therefore, *D. hatagirea* plants were successfully micropropagated through multiplication of protocorm like bodies (PLBs) under the DBT sponsored project 'Preventing extinction and improving conservation status of threatened plants through application of biotechnological tools'.

The plants are being hardened under greenhouse conditions for transfer to other natural habitats (Fig.11).

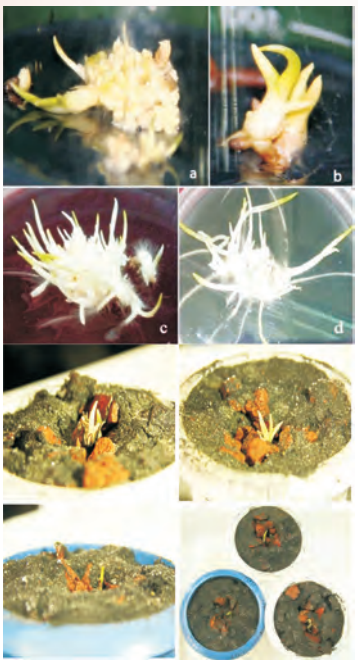


Fig. 11. Micropropagation of *D. hatagirea* plants through multiplication of protocorm like bodies and their establishment in soil under Palampur conditions

Orchids

Endangered orchids namely *Malaxis acuminata*, *M. muscifera*, *Coelogyne* sp. and some *Dendrobium nobile* were cultured aseptically. All these orchids have high commercial value because of their horticultural as well as medicinal properties. They are also the source of high value secondary metabolites like dietary fatty acids, α-hydroxy acids, phenolic acids, sterols, amino acids, sugars and glycosides. The novel aromatic cytokinin *meta*-topolin (mT), was used to establish pure line cultures for large scale propagation. Various concentrations of *m*-Tincombination with BAP and Kn were tested for the micropropagation of *M. acuminata* from nodal segments. The explants showed maximum shoot bud proliferation (10 shoot buds/explant) at 15 µM *m*T after 2 weeks of culturing (Fig. 12a, b). *m*T also supported high frequency regeneration in *D. nobile* after 2 weeks of culture at 20 µM. Regeneration of secondary PLBs along with shoot development were also observed (Fig. 12c, d). *Coelogyne* species were also micropropagated using germinated seed explants (Fig. 12e, f).

Fig. 12(A) Sampling and collection of *Malaxis* sp, from wild habitats along with inset photograph of *M. acuminata* (B, C) Initiation and proliferation of primary and secondary protocorm like bodies (PLB) of *M. acuminata*. (D) Proliferation of PLBs of *D. nobile* (E, F) Proliferation of multiple shoots of *D. nobile* (G) Proliferating *Coelogyne* sp.

Conservation of threatened taxa through establishment of a botanical garden

Introduction and conservation of rare, endangered and threatened plants through establishment of botanical gardens is one of the major thrust areas of the Institute. During the reporting period, 7 species namely *Ferula jaeschkeana, Hyoscyamus niger, Jasminum parkeri, Rauwolfia serpentina, Saussurea costus, Taxus baccata* and *Valeriana jatamansi* were collected and introduced in the botanical garden (Fig. 13). Other plants introduced and planted in different areas of the campus include species of *Araucaria, Buxus, Cedrus, Croton Cupressus, Cypress, Duranta, Ficus, Jasminum, Loropetalum, Ophiopogon, Schefflera,* palms, and ferns.

Fig. 13 *Jasminum parkeri* and *Erythrina blakei*

Consolidation of Hippophae genetic resources

A total of 660 accessions of sea buckthorn were consolidated at the Hippophae Germplasm Resource Centre, Ribling Farm, Centre for High Altitude Biology, Keylong, of which 95 accessions from Ladakh region and 41 accessions from H.P. have already been planted in field gene bank at the germplasm resource centre, while 102 accessions from Sikkim, 110 accessions from Uttarakhand, 82 accessions from H.P., 200 accessions from Ar.P. including two potential

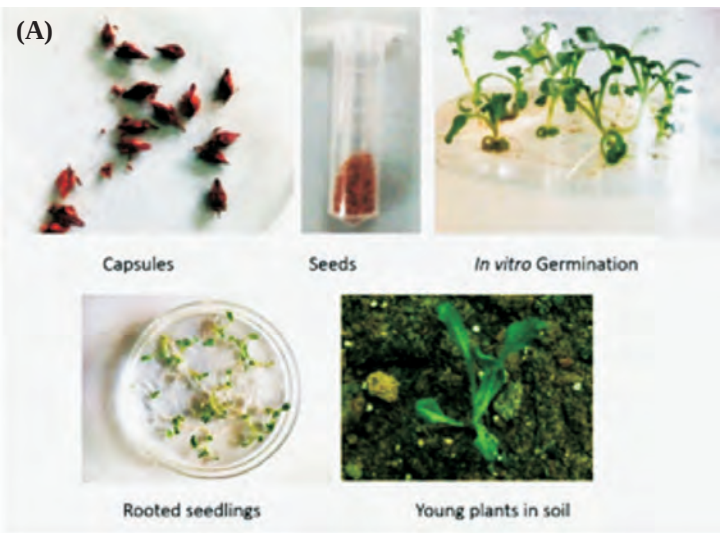


Fig. 14 Hippophae genetic resources (Plates Left to right)

Fig. 14 Germplasm Resource Centre; Field gene bank; Germplasm accessions consolidated in the nursery

selections and 176 accessions from Ladakh are being maintained under nursery conditions (Fig. 14A&B).

BIOPROSPECTION AND CHARACTERIZATION OF HIMALAYAN BIORESOURCES

ENZYME BIOPROSPECTION OF HIGH ALTITUDE HIMALAYAN PLANTS

In the past for several years, work on enzyme bioprospection and adaptation biology of plants of higher altitudes of western Himalayan region is being carried out. In this regard, a unique superoxide dismutase (SOD) enzyme was isolated from the western Himalayan plant, *Potentilla atrosangunia*, which grows under the snow. The enzyme can tolerate a temperature of 121°C and function across a wide range of temperatures. In continuation to this pursuit, studies on another plant, *Caragana jubata* (Pall.) Poir (*C. jubata*) growing at the high altitudes of the Himalayas was undertaken. The plant grows under extreme environmental conditions and is expected to experience oxidative stress. Therefore, a Cu, Zn SOD from *C. jubata* was cloned and its thermostable and kinetic properties were studied. The Cu, Zn SOD from *C. jubata* (Cj-Cu, Zn SOD) was found to be a thermostable enzyme with ability to function under a broad range of pH and temperature window. The enzyme was also resistant to denaturation by sodiumdodecyl sulfate (SDS) and urea. It exists in both monomeric and dimeric forms but the dimeric form is more active (Fig. 1).

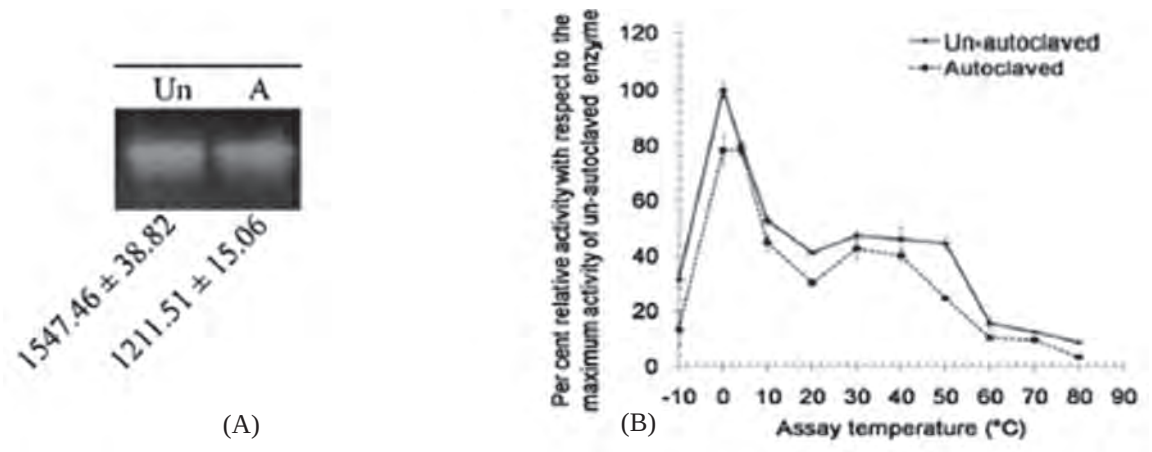


Fig. 1 Effect of autoclaving on Cj-Cu, Zn SOD activity. Panel "A" shows activity staining gel, in which equal quantity (300 ng) of each un-autoclaved (Un) and autoclaved (A) Cj-Cu, Zn SOD was loaded onto 10% native PAGE gel and stained for activity. Name of the protein samples is shown at the top of each panel, whereas, specific activities (unit/mg of protein) are given at the bottom of the panel. Values were mean ± SE of three separate replicates. Effect of assay temperature on SOD activity is given in panel (B) Percent relative activity with respect to the maximum activity across the temperature range is shown. Solid and dashed lines represent un-autoclaved and autoclaved enzymes, respectively. Values were mean ± SE of three separate replicates (adapted from article published in *Process Biochem* 51(10): 1434–1444, 2016).

Since, extreme thermostability is a unique feature of the identified SODs, a study was undertaken to investigate whether thermostability is a general feature of SOD across plant species or whether it was associated with some habitat/evolutionary attributes. A total of 94 plant species belonging to 37 families including herbs, shrubs and trees differing in their habitat preference were studied. It was found that among 94 phylogenetically diverse plant species across varied

habitat preferences, autoclavable SOD was present only in 15 species (Fig. 2). Our finding suggests that occurrence of thermolabile and autoclavable SOD did not show a distinct correlation within the family or order. For example, within the same genera such as *Cassia*, *Paspalum*, and *Solanum* species, thermolabile and autoclavable SOD was present. Among the 54 dicot plant species, only 10 species were found to produce autoclavable SOD. Conversely, of the four monocot orders, autoclavable SOD was encountered in five species, four in the family Poaceae of order Poales and one species in the family Zingiberaceae of order Zingiberales. The members of the families Fabaceae, Poaceae, Rosaceae, and Solanaceae contained both thermolabile and autoclavable SODs. No definitive relationship of autoclavable SOD was found in any of the 37 families in terms of their habitat specificity to plant type, light, temperature, or moisture affinities.

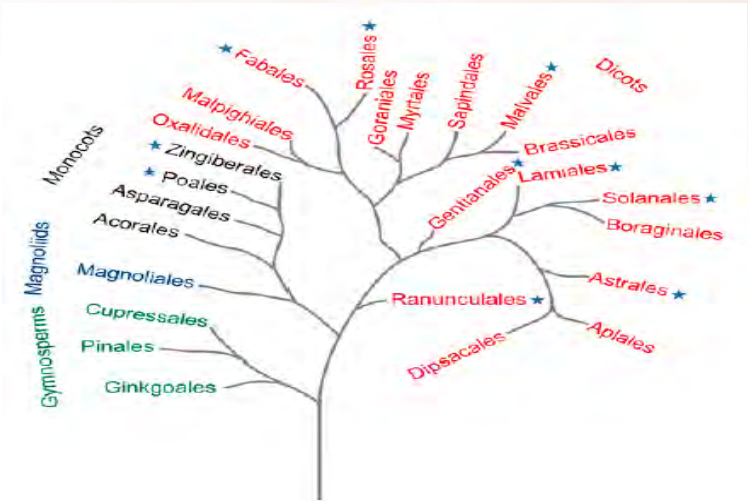
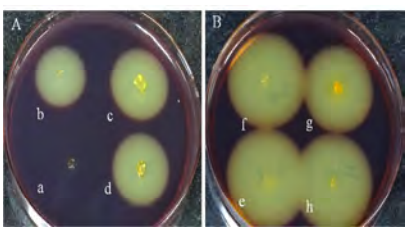


Fig. 2 Phylogenetic relationship among orders of seed plants and species studied for the presence or absence of autoclavable-SOD. Orders with plant species that produce autoclavable SOD are marked with "asterisk." The orders representing these families are arranged as per their progression on the evolutionary timescale, from primitive (Ginkgoales) to more evolved (Dipsacales) (adapted from our article published in *Process Biochem* 51(10): 1434–1444, 2016).

Bioprospection from microbial resources

1. Efficient and alkaline stable cellulase enzyme from high altitude bacteria

- Screened over 700 bacterial isolates from higher altitude niches for cellulase activities.
- More than 350 isolates were found positive for cellulase activity, out of which 90 were high cellulase producers.
- Among the potential isolates, a novel bacterial species with very high enzyme activity and functionality at broad pH and temperature range was identified.

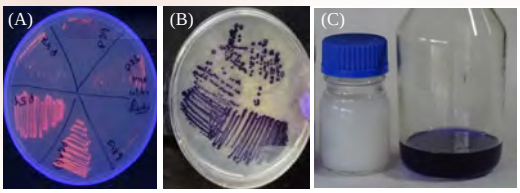


Qualitative plate assay for cellulolytic activity showed zone of clearance in CMC agar plates. Plate (A) showing negative control (a), and (b), (c), (d) are representative of potential bacterial isolates with moderate cellulase activity; and plate (B) showing isolate (e), (f) (g), (h) with high cellulase activity.

2. Biodegradable bioplastic from unique bacteria of high altitude region

- A total of 411 bacterial isolates were obtained from soil and water samples of high altitude regions in the trans-Himalaya and 70 polyhydroxyalkanoates (PHA) positive isolates were identified.

- GCMS quantification of 12 potential isolates showed PHA synthesis capability based on PHA contents with respect to dry cell weight ratio and PHA monomer.
- A unique bacterial isolates with capability to produce medium chain co-polymers, homo-polymers and anti-cancerous compounds were identified.



Qualitative screening for PHA synthesis is PHA specific medium in the presence of nile red visualized under UV. (A) Potential isolates were shown in the plate. (B) Unique bacteria producing violacein-like pigment and PHA. (C) Extraction for polyhroxybutryate (PHB) (left) and violacein pigment (right).

Study of bacteria from alpine region for understanding their survival strategies and bioprospection of potential enzymes

A total of 170 psycrotrophic bacteria, surviving at 10°C were isolated from the high altitude regions of Sikkim Himalaya and Western Himalaya. Based on ARDRA phylotyping, 70 unique patterns were obtained. Seventy four representative bacteria were identified by 16S rRNA gene sequence similarity and phylogenetic clustering. These were affiliated to Firmicutes, Gammaproteobacteria, Actinobacteria, Bacteroidetes and Betaproteobacteria. Qualitative screening revealed 89% lipase, 41% protease, 8% amylase & cellulase positive cold active strains at 10°C (Fig. 3).

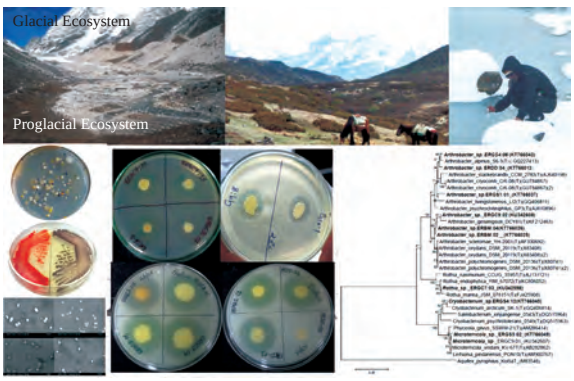


Fig.3 Sampling sites, bacterial isolation, Screening for enzymes and phylogenetic clustering for identification of pure bacteria

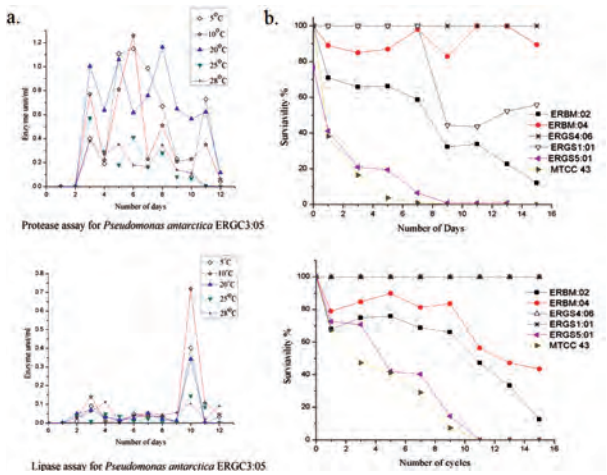
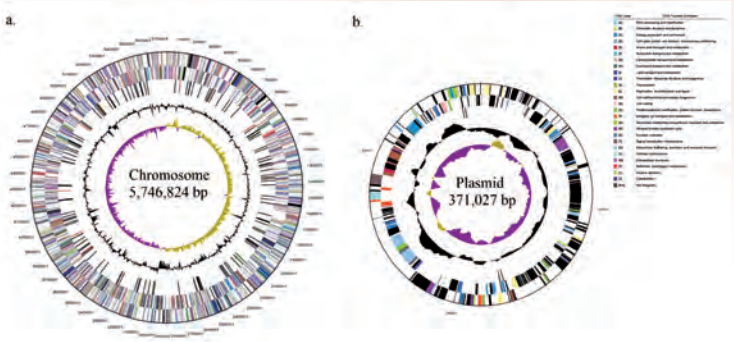


Fig. 4 Representative graphs of (a) quantitative enzyme assay for lipase and protease, (b) survivability at freezing and frequent freeze thaw cycles

Quantitative estimation of protease revealed extracellular enzyme activity at 0.1 to 1.16 µmoles/ ml/min (units/ml), whereas, lipase producing isolates showed extracellular activity at 0.1 to 0.7 units/ml (Fig. 4a). The bacteria were also tested for adaptational attributes like tolerance to UV radiation as well as freezing and frequent freeze-thawing. Among the identified bacteria, 15% were super-resistant to UV-B (test colony count > control), while 53 % were resistant (test colony count close to control) and 32% were susceptible (test colony count < control). Around 35% of strains survived freezing temperature (-20°C) for 30 hr without any ice crystal formation in culture broth (Fig. 4b).



The molecular basis of adaptation to cold and radiation were determined by whole genome sequencing of the model bacteria (Fig. 5). Genomic diversity and genome wide molecular adaptation to cold were characterized and various genes associated with cold and radiation resistance were identified using comparative genomics.

Fig. 5 Graphical circular map of the (a) chromosome and (b) plasmid of a representative bacterium (*Pseudomonas frederiksbergensis* ERDD5:01). From outside to the center: Genes on forward strand (color by COG categories), Genes on reverse strand (color by COG categories), RNA genes (tRNAs green, rRNAs red, other RNAs black), GC content, GC skew

Exploration of secondary metabolites from medicinal plants of Himalayas

In studies on regulation of secondary metabolites in the medicinal plants of Himalayas, the secondary metabolite pathway in *Picrorhiza kurroa* was deciphered. Therefore, a study was undertaken to gain insights into key regulatory molecules underlying the differential regulation of picrosides by temperature. miRNA libraries were prepared from leaf and rhizome tissues of *P. kurroa* plants exposed to different temperatures and a total of 286 identified miRNAs. Out of these, several of bioinformatically validated miRNAs were found to belong to different biological pathways including plant hormone signal transduction, plant pathogen interaction, phenylpropanoid, stilbenoid, cysteine and methionine metabolism and pentose and glucuronate pathways. The results suggest an important role of miRNAs at different temperatures in regulating expression of the targeted genes/transcripts. Furthermore, the genome of *P. kurroa* was sequenced for the complete understanding of genes involved in the picroside biosynthetic pathway. Since, the information on whole genome sequence of *P. kurroa* is also not available in public domain, whole genome sequencing of *P. kurroa* was also initiated. The genomic libraries were prepared from the leaf tissues and sequenced using two NGS platforms: Illumina GA IIx and Pacific Biosciences. The assembly of draft genome sequence of *P. kurroa* is under way. The outcome from such studies has far reaching implications in the metabolic engineering of plant secondary metabolism and synthetic biology.

Proteomic study of high altitude grasses

The grassland vegetation in the Indian Himalaya occupies nearly 35% of the geographical area. These grasslands support a large number of wild herbivores, domestic livestock, and several agro-pastoral cultures. Most of the grasslands in the lower temperate belt of western and central Himalaya consists of a variety of grasses. These are reported to serve as fodder for various domestic livestock throughout the year. The grasses have potent health promoting property with ability to increase milk production in animals that graze on them. Earlier reports suggested that milk and cheese fatty acid profiles changed when animals grazed on pastures

with a different botanical composition. This was attributed to the quality and quantity of bioactive peptides and secondary metabolites present in the grasses.

The performance of livestock was also directly related to the quantity and quality of offered grasses. Many quality characteristics influenced the intake of grasses by the livestock. The most useful were minerals and crude protein. The pasture herbages of the high hill are rich in crude protein (10.04%) in comparison to the mid hills (9.54%) and lower hills (4.36%). The high protein concentration at high altitude as compared to low altitude was attributed to the extreme environmental conditions *viz*., fluctuating temperatures, high UV radiations, salinity, low oxygen concentration and high wind velocity. Proteins were somehow directly or indirectly related to the adaptation and digestibility. Increase in crude protein resulted in enhanced livestock performance.

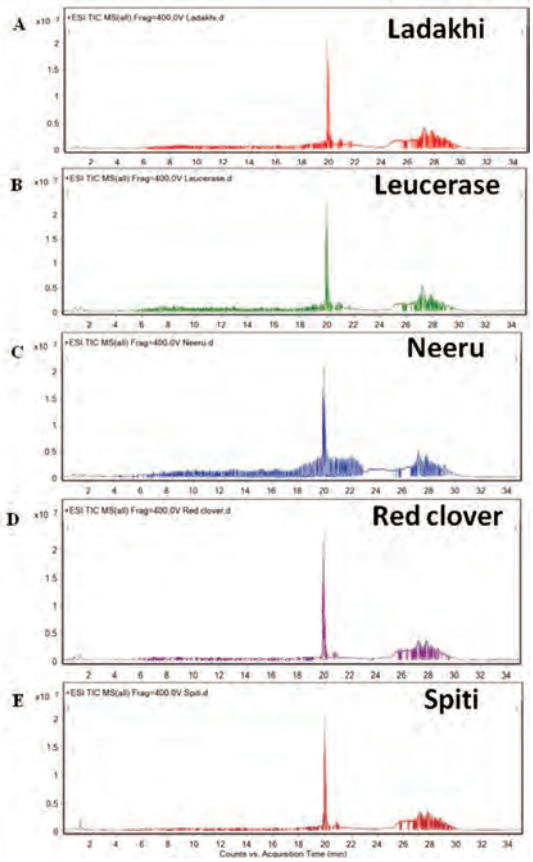


Fig. 6 TIC MS profile of five grasses

Proximate analysis of five high altitude grasses *viz., Festuca kashmiriana* (Neeru), *Medicago* sp. (Leucerase), Spiti, *Melilotus indicus* (Ladakhi) and *Trifolium pratense* (Red clover) revealed that total crude protein was highest in Ladakhi samples (3503.7 mg/ml), whereas moisture content (11.27 %) and minerals concentration of Ca (132 ppm), Mg (12.92 ppm) and Zn (2.17 ppm) were highest in Neeru grass with exception of Fe (6.22 ppm) (Table 1). In grass quality traits, dry matter was the most variable and the least controllable parameter. Furthermore, proteomic studies for identification of key intrinsic factors in response to abiotic stress was also conducted (Fig. 6). The study will be useful in developing high value grass based feeds directly related to improved performance of grazing animals.

Table 1 Proximity analysis and metal content of five selected high altitude grasses

Grasses	Total protein (mg/ml)	Total carbohydrates (mg/ml)	Moisture (%)	Total ash (%)	Essential elements (ppm)			
					Fe	Ca	Mg	Zn
Ladakh	3503.7	70.32	9.98	5.83	2.04	13.91	4.60	1.07
Leucerea	770.37	234.26	10.21	9.09	3.23	52.96	12.25	1.32
Spiti	1125.93	163.77	11.02	11.42	20.13	126.86	12.87	2.14
Red cloves	794.44	90.00	9.27	2.50	76.13	56.36	12.41	2.17
Neeru	1353.70	145.73	11.27	4.73	6.22	132.05	12.92	2.17

TEA (*Camellia sinensis* L. (O.) Kuntze)

Unravelling the molecular mechanism of defense against blister blight (BB)

Conventional breeding strategies in tea are often limited by out-breeding nature and long life cycle. Tea is a perennial plant that experiences a wide range of abiotic and biotic stresses during its life span. Among the biotic stresses, fungal pathogens are the most prevalent and are responsible for severe crop losses annually. Moreover, since young succulent leaves drive commercial tea production, leaf diseases are among the major bottlenecks. In this regard, it is important to have genomic resources in place for gaining insights into various pathways and also for dissection of complex traits. However, hardly any efforts have been directed towards the use of high-throughput NGS approach for genome-wide scanning, elucidation of key regulators and identification of functional variations. Blister Blight (BB) disease caused by the basidiomycetes obligate biotrophic pathogen, *Exobasidium vexans* Massee is amongst the most serious leaf diseases significantly affecting the commercial production of tea. Besides affecting the quality of tea significantly, it causes more than 40% total yield loss. Therefore, it is important to breed tea plants resistant to blister blight. Marker assisted breeding can be of particular importance in this regard. However, while candidate markers are required for implementation of markers assisted breeding tea suffers from the non-availability of such markers.

Therefore, a study was undertaken to unravel the molecular mechanism of defense against BB for combining traits in high yielding quality tea clones. In the study, key candidates were identified to analyze BB interactions with resistant and susceptible tea genotypes using genome-wide RNA-seq during ~20-day disease cycle (Fig. 7). From the study, approximately 69 million high quality reads were assembled *de novo* and 37,790 unique transcripts including 149 defense related transcripts were identified. Further, confirmation of abundant expression of well known RPM1, RPS2 and RPP13 in quantitative Real Time PCR indicated the possibility of salicylic acid and jasmonic acid mediated synthesis of antimicrobial compounds required to overcome the virulence of *E. vexans*. The findings can serve as important resource for unravelling the possible regulatory mechanism(s) of immunity against various biotic stresses in tea and other crops.

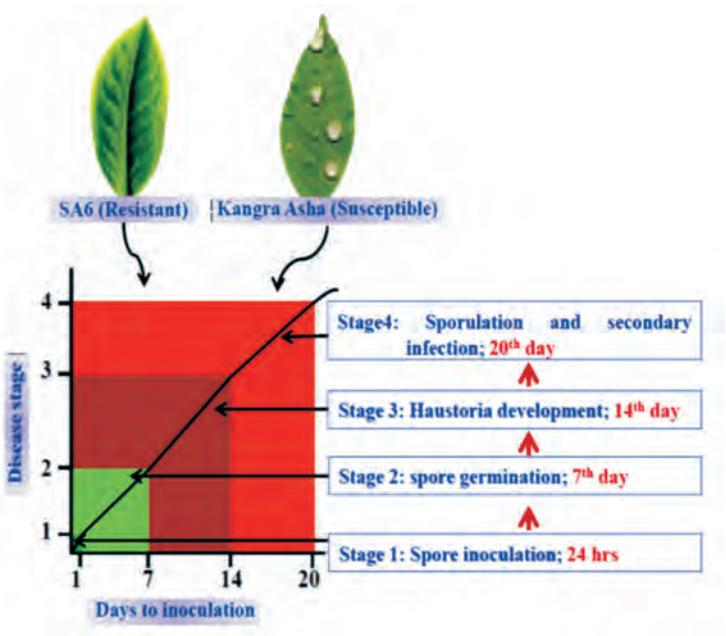


Fig. 7 Categorization of stages during BB progression

Characterization of disease resistant F_1 progenies for productivity

The resistant F_1 progenies of tea were characterized morphologically with respect to plant height, number of shoots, shoot length, leaf length, leaf width, internode length and plant spread diameter. Morphological characterisation of 13 promising genotypes resistant to diseases (Table 1) and under nursery conditions were studied.

Table 2 Morphological characters of promising disease resistant F_1 progenies of Cross SA-6 x Kangra Asha

Genotype	Morphological characters						
	Plant height (m)	No. of shoots	Shoot length (cm)	Length of internode (cm)	Leaf length (cm)	Leaf width (cm)	Plant spread diameter (m)
03-10	1.7	21	138	5.5	16	6.4	1.16
03-6	1.91	28	140	4.4	12.4	5.8	1.23
03-44	1.61	21	118	4.8	12.5	5	1.11
03-1	1.95	18	118	5.5	15.5	5.1	1.31
03-69	2.06	25	118	4.8	13.3	4.7	1.21
03-108	1.85	17	122	4.3	12.9	5.8	1.34
03-37	1.91	25	139	4.4	12.6	6.6	1.45
03-55	1.68	23	160	4.4	10.4	4.3	1.17
03-101	2.07	18	114	5.5	15.2	4.8	1
03-91	1.59	14	115	3.9	9.7	3.8	1.06
03-104	1.74	13	139	5.8	15	5	1.16
02-24	1.93	17	138	4.2	13.7	4.1	1
03-70	2.11	18	166	4.6	11	4.4	1.35

In the current year however, the genotypes were planted under field conditions in replicated trials for selection of disease resistant clones for higher productivity (Fig. 8).

Fig. 8 Planting of selections in the field for evaluation

Microsatellite marker development

Transcriptome data generated in tea was utilized for marker identification. A total of 37,790 NR contigs/ scaffolds were obtained. Survey of all of these using MISA (pgrc.ipk-gatersleben.de/misa) revealed 2519 (15.2%) potential contigs/ scaffolds containing one or more SSRs excluding monomers. Among the different repeat types, microsatellite containing di-repeats were found to be the most abundant (65.29%) followed by tri-repeats (30.71%). Additionally, few tetra (2.22%), penta (1.13%) and hexa (0.64%) repeats were also identified (Fig. 9).

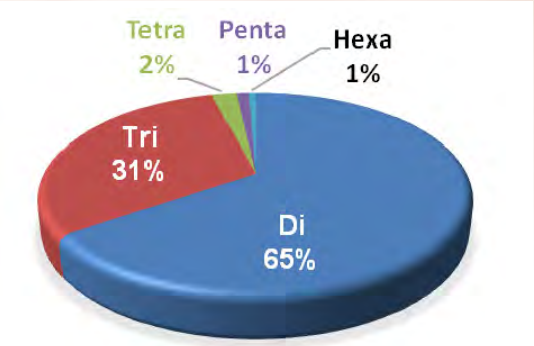


Fig. 9 Distribution of different repeat motifs in expressed NR dataset created in tea

Repeat motif categorization (di, tri, tetra, penta and hexa) based number repeat unit in each case was also analyzed to identify informative markers repeat motif with repeat number 5, 6, 7 and 8. These were maximum (72.07%) and present in higher numbers. Repeat unit of potential microsatellites was 6 and constituted 22.2% followed by 5 (20.0%), 7 (17.4%) and 8 (13.1%), respectively.

SSR primers/ marker resource development

Of the 2519 SSR containing sequences, 2021 (80.20%) sequences were used for designing flanking primer pairs. In total, 2186 primer pairs flanking the different repeat units were designed. Among these, primer pairs for di-repeats (58.40%) were found to be highly represented followed by tri (34.66%), tetra (2.7%), penta (2.37%) and hexa (1.8%) repeats (Fig. 10).

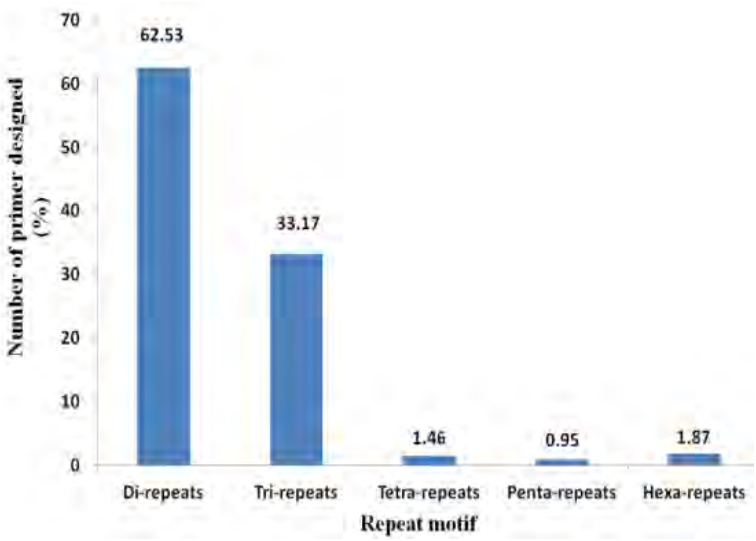


Fig. 10 Number of primers designed for different SSR repeats in tea genome

Amplifcation and Validation of SSR markers

A total of 1200 microsatellite markers having recorded functional relevance in sequence blast and in GO, EC and KEGG annotations were synthesized and validated in selected diverse tea accessions by PCR amplification. A total of 845 SSR markers showed successful amplification in a test array of 15 tea accessions. Amplification validation patterns of selected markers are represented in Fig. 11.

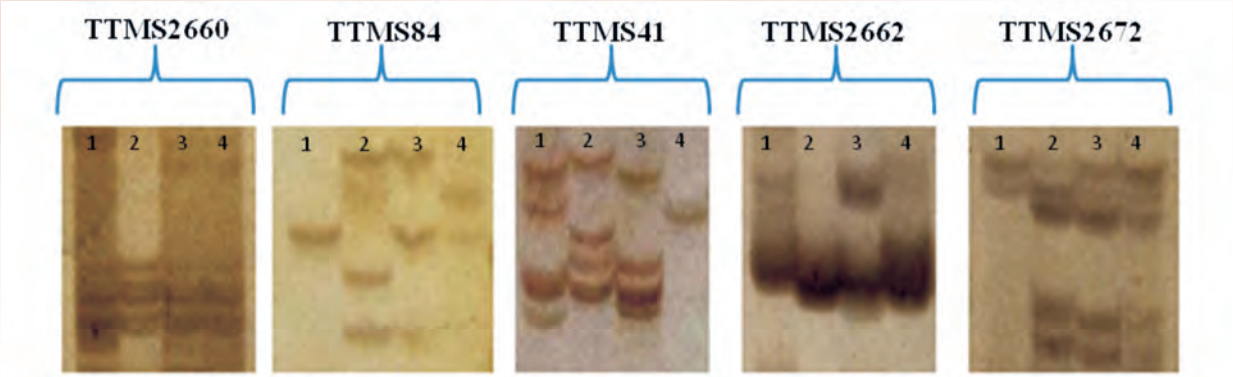


Fig. 11 Representative picture of PCR amplification validation of newly developed tea transcriptome derived microsatellite (TTMS) primers. Lane 1-4: Selected accessions of tea

Damask rose (*Rosa damascena* Mill.)

R. damascena is one of the most important essential oil-bearing industrial crops in the world. The flower yield and quality of essential oil are largely affected by seasonal variation and application of plant nutrients. Therefore, a field experiment was conducted using six levels (i.e., 0.25, 0.50, 0.75, 1.00 and 1.25%) of $Ca(NO_3)_2$ with water spray as control. Results showed significant ($P \leq 0.05$) effects of foliar application of $Ca(NO_3)_2$ on flower yield. Maximum yield was registered at 1% $Ca(NO_3)_2$ (Fig. 12). Variation in chemical profile of rose essential oil was also observed.

In a separate study, the pruning time of different varieties was standardized and correlated with agrometeorological indices. Pruning during December 30 to January 15 resulted in higher flower production, essential oil yield and desired composition. Effect of microclimate modification on growth, flower yield and chemical composition was also studied. Significantly higher flower yield was recorded in plants growing under sunny conditions without light stress and mulching with black polyethylene sheet. In the current year, 170.0 g rose oil with an average yield of 0.011 % (w/w) was produced after pilot scale processing of about 2439.4 kg fresh flowers. Besides rose oil, 800 litres of rose water was also produced.

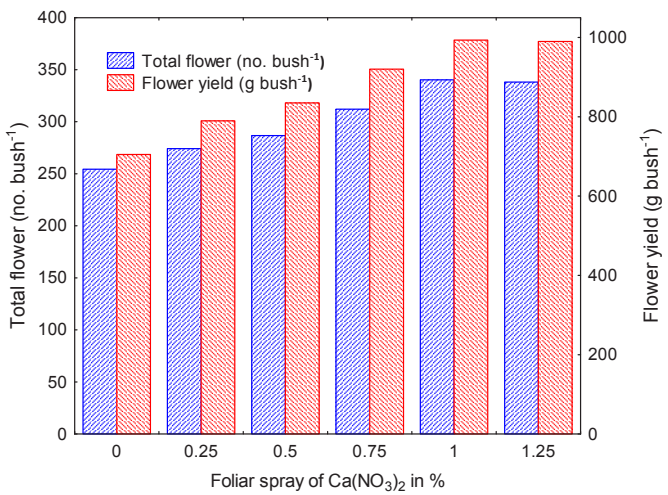


Fig 12 Effect of foliar application of $Ca(NO_3)_2$ on flower number (no. bush^{-1}) and yield (g bush^{-1}) of *R. damascena*

STEVIA (*Stevia rebaudiana*)

It is the source of the commercially important rebaudioside-A. Among the different sweeteners, rebaudioside-A is the most stable natural sweetener. It is about 450-fold sweeter than sucrose and 1.5-fold sweeter than stevioside. It has anti-diabetic and other medicinal properties. Therefore, the demand for rebaudioside-A is increasing in India. Globally also, the market demand for natural sweeteners is worth 68.1 billion USD and is expected to reach 95.9 billion USD by 2020, thereby, registering a CAGR of 5.7%. Therefore, different studies were undertaken in the current reporting period.

Effect of plant density and nitrogen on leaf yield

The effects of plant and levels of nitrogen were investigated in stevia crop under the western Himalayan conditions. Irrespective of level of nitrogen, there was higher dry leaf yield per plant (i. e., about 21.34%) when 50,000 plants were planted per ha as compared to denser population of 100, 000 plants per ha (Fig. 13). However, the overall dry leaf yield/unit area was higher in the latter. Among the levels of nitrogen, maximum dry leaf yield was recorded at 120 kg N per ha.

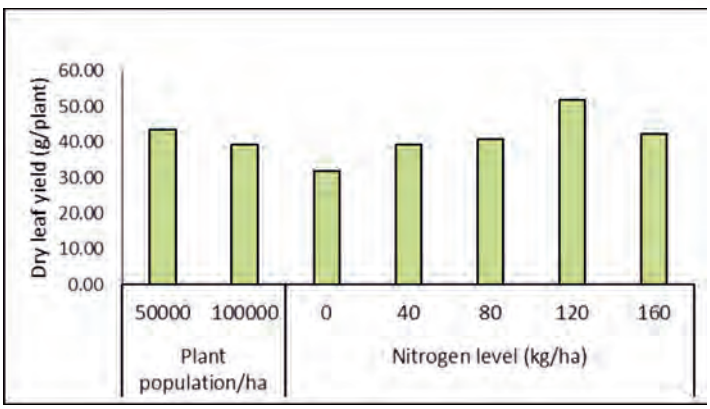


Fig. 13 Effect of plant density and nitrogen application on yield of dry leaves of *S. rebaudiana*

Quality improvement of *steviol glycosides* (SGs)

A process for scale-up of dry leaf processing up to 50 kg per batch was optimized at CSIR-IHBT. The process was improved with respect to total water recycled per each batch. The optimized process was also employed to process around 200 kg dry leaves for M/s Agri Natural India, Ludhiana (Fig. 14).

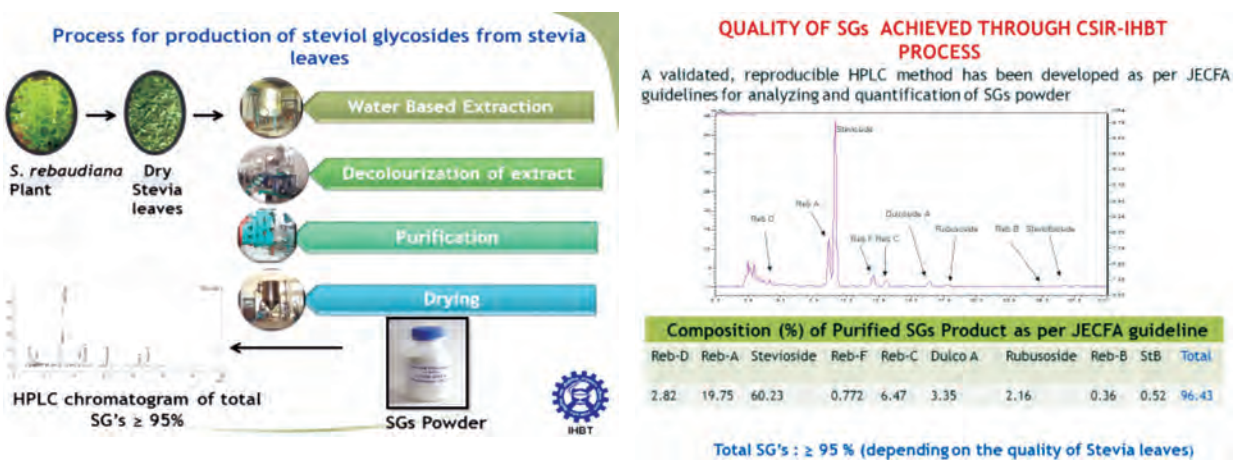


Fig. 14 Process for upscaling of *steviol glycosedes* up to 50 kg/batch

Production of rebaudiosides in cell cultures of Him stevia cultivar of *S. rebaudiana*

A plant cell culture system was targeted in the current year with an aim to develop an alternative system for increased production of rebaudioside A. Callus cultures were established from leaf explants of *in vitro* grown plants. The calli were then used for raising cell suspension cultures **(**Fig. 15**)**. In order to select explants with highest yield, *in vitro* leaves, stems and green calli were screened for stevioside and rebaudioside A contents and compared with that of leaves from plants growing in the field (Table 3).

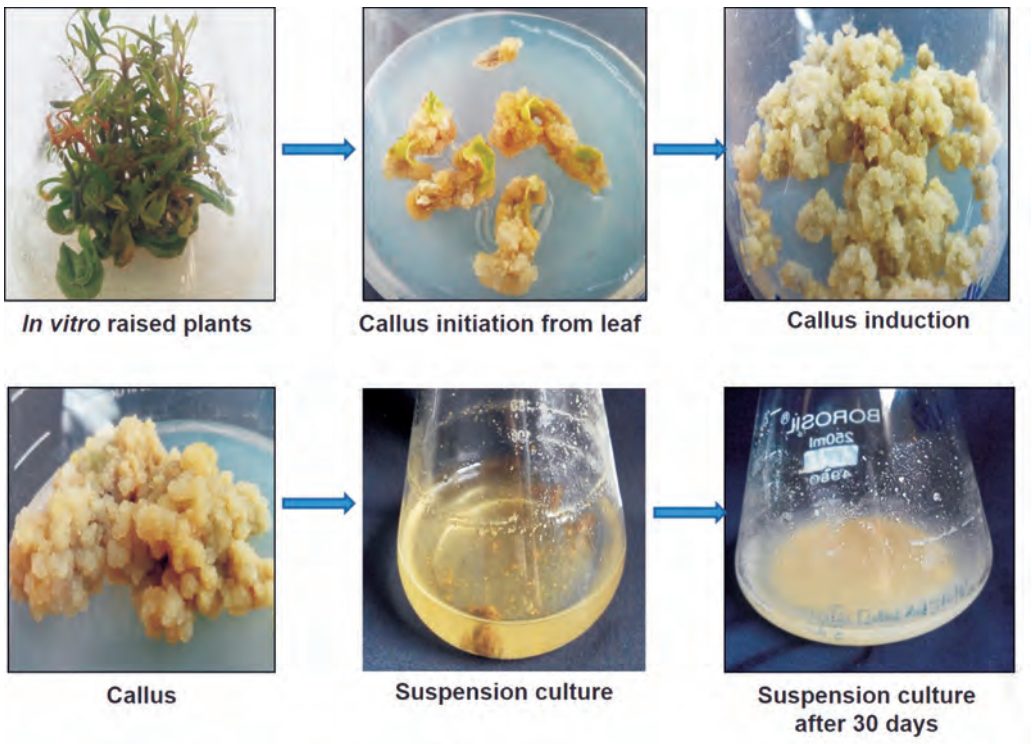


Fig. 15 Callus proliferation and cell suspension cultures of *S. rebaudiana*

Table 3 Analysis of various tissues for Rebaudioside A and stevioside (%)

Sample	Stevioside	Rebaudioside A
Leaves from field	3.08	3.74
Green callus	0.13	0.50
in vitro leaves	0.018	-
in vitro stem	0.08	0.09

Modification of stevioside for improved sweetness

The structure of stevioside, a natural sweetener with mild bitterness was modified chemically and a derivative of stevioside was developed to reduce its bitterness. The compound was conjugated with a zero-calorie artificial sweetener sucralose (Fig. 16).

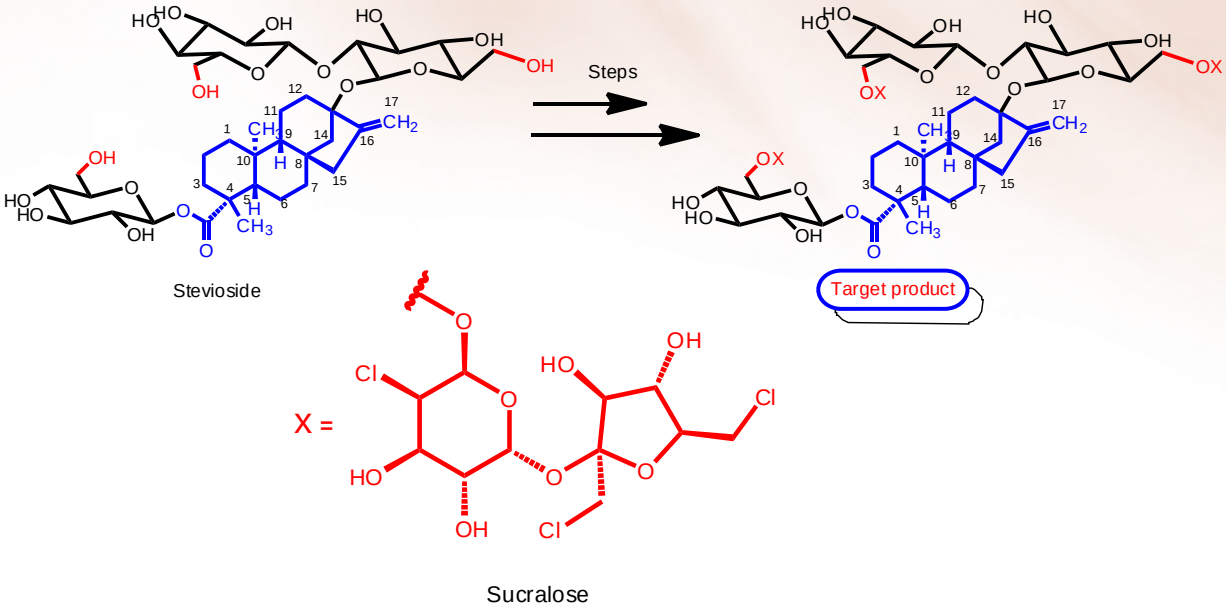


Fig. 16 A pictorial form of modified stevioside molecule

BAMBOOS

Genome wide elucidation of growth mechanism

Bamboo being one of the fastest growing plants, can serve as a promising system for understanding growth. Therefore, the transcriptome of a subtropical bamboo, *Dendrocalamus hamiltonii* (maggar) was studied to understand the complex interplay between the environmental signal and cellular machineries governing initiation and growth. In the study, phenological and spatio-temporal transcriptome analysis of rhizome and shoot during the major vegetative developmental transitions signified a predominant role of rainfall, decreasing day length and high humidity. Dormant buds were activated to produce new shoots possibly through complex molecular interactions between phosphatidylinositol, calcium signaling pathways, phytohormones, circadian rhythm and humidity responses. Growth signaling probably began in rhizomes even before the emergence of new shoots. Putative growth candidates were identified in the study. These can be used to engineer bamboos and timber trees with enhanced growth and biomass potentials.

Bamboos flower once in decades. This imposes severe limitations in its propagation. Moreover, it has a highly out-crossing nature. Therefore, mixed cultivation of genetically diverse genotypes may assist in successful breeding and natural recombination of desirable traits. For this, it is important to characterize the existing genetic diversity and population structure. However, there is a non- availability of sequence based markers in the species. Therefore, during the year, 8121 SSR markers were identified through transcriptome analysis. The SSRs had tri-repeats (47.7%) with an abundance of CCG/CGG motif (Fig. 17). *In silico* functional annotation using protein databases resulted in identification of functionally relevant markers. A set of 114 SSR markers including epigenetic regulators, transcription factors, cell cycle regulators, signaling and cell wall biogenesis were detected. There was polymorphism and interaction with important genes showing their implication in bamboo growth and development.

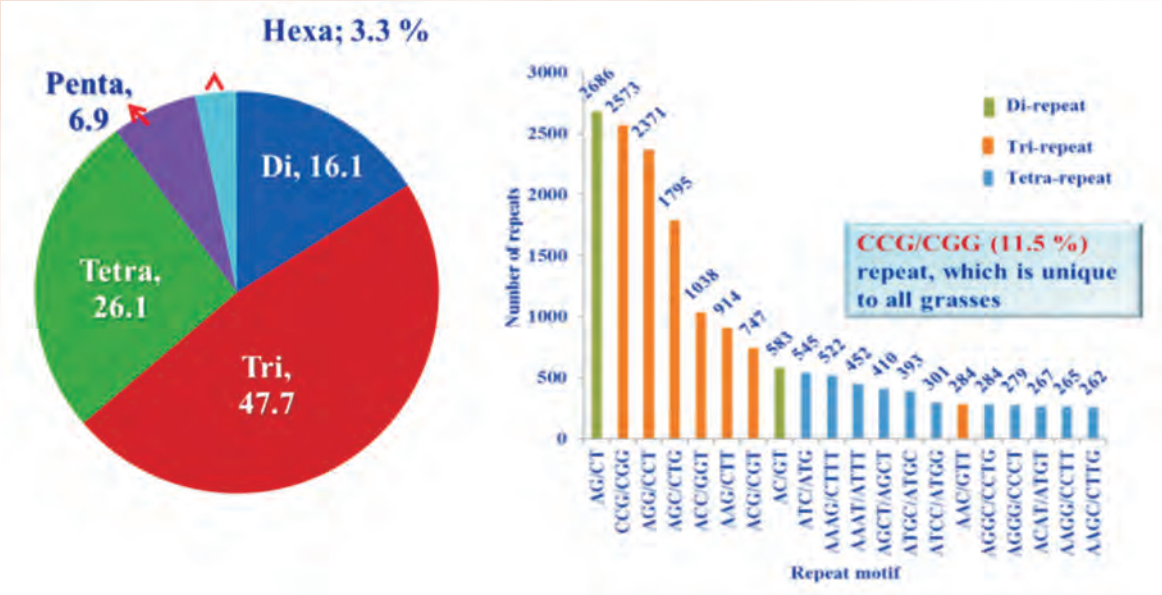
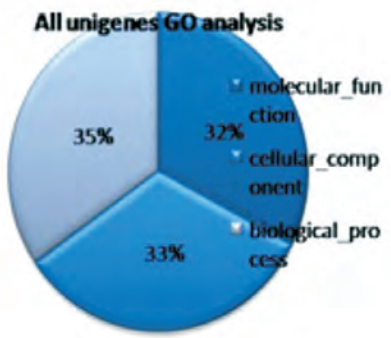


Fig. 17 Abundance of SSR markers in *D. hamiltonii* transcriptome

Understanding the mechanism of floval transition using transcriptomic approach

Bamboos have long juvenile phase and unique flowering behavior - the major deterrents to their conservation and propagation. Most genera/species have a long intermast period of juvenile stage that varies from 40-120 years after which bamboos flower gregariously, irrespective of geographical locations. The entire culms of all clonal individuals from a single mother, flower simultaneously and die *en masse*. This results in huge loss of valuable germplasm and is a continuous but unpredictable threat to all standing populations of bamboos. Besides gregarious flowering, some culms of bamboos flower sporadically, set a few seeds annually and die. Although the process of flowering in bamboos demands attention, it is poorly understood. Therefore, an attempt was made to elucidate the molecular mechanism of floral transition in *Dendrocalamus hamiltonii*, a multipurpose bamboo native to Himalayan region using a transcriptomic approach. The Illumina paired-end sequencing was conducted, and a total of 37862456, 35040478 and 35017513 reads were obtained after filtering by RNA-seq of the vegetative, about-to-flower and flowering stages. These were assembled into 191575 transcripts with mean length of 1005.68 bp. A total of 98,782 unigenes were annotated in the NCBI non-redundant protein database and 86,665 in the Swiss-Prot database. Also, 73,802 annotated unigenes were allocated to gene ontology (GO) categories. By searching against the Kyoto Encyclopedia of Genes and Genomes Pathway database (KEGG), 7,222 unigenes were assigned to 372 KEGG pathways and species distribution analysis assigned more than 80% of the unigenes with significant hits to monocot model plants. In total, 7439 differentially expressed floral specifiers representing the three floral developmental stages were identified (Fig. 18).

Species distribution



KEGG dassification

Fig. 18 Functional annotation of unigenes through Gene ontology analysis, KEGG pathway analysis, species distribution analysis

Molecular evidence of natural occurrence of apple stem grooving virus on bamboos

D. hamiltonii plants growing near the apple germplasm and nursery field of CSIR-IHBT displayed virus-like symptoms such as chlorosis, mosaic, yellow streaks, leaf curling and necrotic spots. Therefore, 38 leaf samples from 10 different genera and 33 species were collected and indexed for ASGV using DAS-ELISA, non-isotopic nucleic acid spot hybridization and RT-PCR. Interestingly, the presence of the apple stem grooving virus (ASGV), an important and abundant virus in apple orchards was confirmed in 76 % of the samples belonging to 27 species and nine genera *viz., Bambusa, Dendrocalamus, Fargesia, Arundinaria, Phyllostachys, Gigantochloa, Sasa, Guadua* and also variegated ornamental bamboo. Seven isolates namely, Bam7(dd), Bam14(pp), Bam28(bn), Bam29(fs), am39(dh), Bam42(dh) and Bam44(dh) were characterized by partial sequencing of the replicase gene. The coat protein gene was also characterized. In phylogenetic analysis, five out of the seven isolates clustered with the apple isolate of the virus from India (LN627003) sharing 98-100 % sequence identity at amino acid (aa) level. The other two isolates also clustered with apple isolates, *viz.* (LN627002, LN627004 and LN901438 from apple germplasm at CSIR-IHBT and shared 98.7-100% sequence identity at aa level. After bamboo mosaic virus and cherry necrotic rusty mottle virus, ASGV happens to be only the third virus to be characterized in bamboo.

SAFFRON (*Crocus sativus* L.)

In India, saffron is produced only in the Kashmir and Kishtwar region of Jammu & Kashmir. There is need to increase the production of saffron to meet the increasing gap between demand and supply. In this regard, different strategies are being employed at CSIR-IHBT with an aim to circumvent the problems that affect saffron production. These include introduction of saffron in H.P., improving crop productivity, generating quality planting material through tissue culture etc.

Introduction of saffron in non-traiditional areas of H.P.

In order to identify alternate sites for cultivation of saffron, the crop was introduced in non-traditional areas *viz.*, Bharmour, Pangi in Chamba district, Rampur in Kullu district, Keylong in Lahaul & Spiti district of H.P.

Characterization of saffron rhizospheric microflora and development of a consortia of beneficial microbes

In order to achieve higher production in Kashmir and for introduction of saffron in H.P., the plant growth-promoting rhizobacteria isolated from rhizosphere of saffron growing in Kashmir were characterized. The PGPRs were evaluated for enhanced growth and flowering in plants maintained under controlled green house conditions at CSIR-IHBT (Fig. 19). Study was also undertaken for optimization and up-scaling of the PGPR production. In this regard, two efficient PGPR isolates namely, *Bacillus siamensis* IHB B 18102 and *Pseudomonas azotoformans* IHB B 15160 were selected on the basis of multiple PGPR attributes, antagonistic activity, stress tolerance and growth performance evaluation in pots under controlled green house conditions as well as in field trials. Based on physico-chemical parameters, a cost-effective method was optimized for maximizing growth of efficient PGPR isolates through RSM (Response surface methodology). Charcoal, talc and vermiculite were selected as solid-carriers of the PGPR with enhanced shelf-life. Six months of storage data on microbial growth status revealed higher population counts (cfu/g of carrier) of efficient PGPR isolates in case of charcoal as compared to talc and vermiculite (Fig. 20).

Fig. 19 Effect of saffron rhizospheric bacteria on flowering under control green house condition

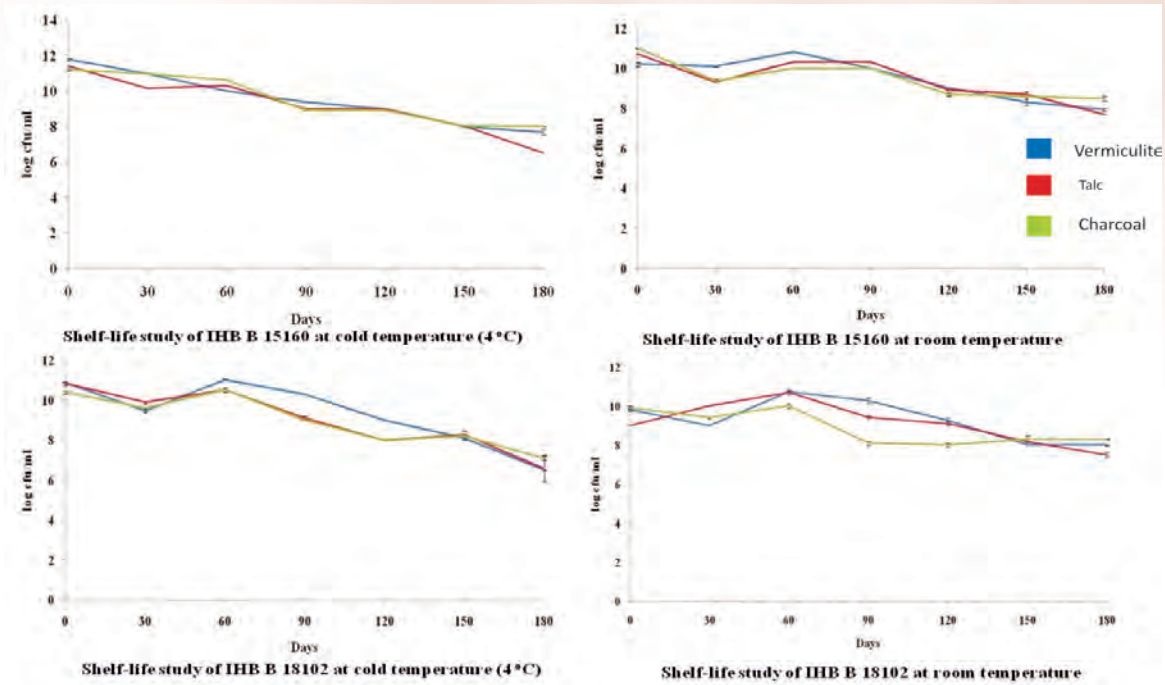


Fig. 20 Effect of charcoal, talc and vermiculite on the shelf-life study of PGPR isolates at different temperatures

Generation of disease free planting material through tissue culture

In previous years, an efficient protocol was standardized for the *in vitro* production of a large number of disease free cormlets. However, the cormlets produced were either very small to medium in size (<0.5 to 3.0 g), whereas, in saffron, only corms of about 8.0 to 12.0 g flower and contribute towards the spice. Therefore, in the current year, different physico-chemical parameters were tested for increasing the size of the *in vitro* raised cormlets.

A slight increase in cormlet size was recorded at 12 % sucrose. However, only thinning i.e., reduction in the number of shoots inoculated per flask in standardized medium increased the size of the cormlets effectively (Fig. 21). Appreciable number of *in vitro* raised corms having an average weight of 4.0-4.5 g and well developed tunics were recorded in about 60% of flasks. The corms were harvested, treated with bavistin and air dried prior to storage in sand for further use.

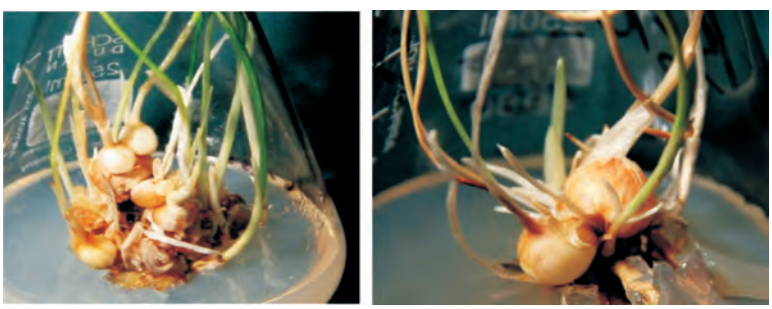


Fig. 21 A 10 fold increase in the weight of in vitro raised cormlets after thinning

In a parallel experiment, manual coating of cormlets with a nutrient formulation of clay, gypsum and antifungal agent prior to sowing in soil:sand:FYM (1:2:1) under controlled greenhouse

condition enhanced the vegetative growth of the plants (Fig. 22). However, there was no significant difference in the size or weight of harvested daughter cormels. In another experiment, the effect of PGPRs identified by CSIR-IHBT from saffron rhizosphere was applied on the freshly harvested *in vitro* cormlets and daughter cormels. The PGPR treated treated cormels and cormlets showed invariably higher aerial growth as compared to control but there was no significant increase in cormel size.

Fig. 22 Manual coating of *in vitro* cormlets with nutrients and subsequent cormel production

Characterization of himalayan microfloa to serve as biofertilizers for improving crop productivity in stressed agriculture

Based on the leads of 'plant microbe and soil Interactions (PMSI)' network, nine stress tolerant plant growth promoting rhizobacteria (PGPRs) were selected and used for field experiments during 2015-16 and 2016-17. Strains of *Arthrobacter psychrochitiniphilus* IHBB 13602, *Pseudomonas trivalis* (IHBB 745), *Pseudomonas grimontii* (IHBB 13611) and *Ochrobactrum pituitosum* (IHBB 9) were found to show plant growth promotion in pea, garlic, potato and wheat **(**Fig. 23 & 24**)**.

Fig. 23 Field trial experiment of pea and wheat at Bajaura, Kullu

Fig. 24 Field trial experiment on PGPRS at Bajaura, Kullu

HORSEGRAM *(Macrotyloma uniflorum)*

Identification of drought responsive gene using protein-protein interaction network and related database

In silico study was carried out on the protein-protein interactions for drought responsive genes in *M. uniflorum* and a related database, MauPIR was developed. Inspired by the availability of *de novo* transcriptome and recent developments in system biology studies, the first ever global protein-protein interactome (PPI) map was constructed for this highly drought-tolerant legume. Large-scale studies of PPIs and the constructed database provided information regarding the interplay at cascading translational levels for drought stress-adaptive mechanisms in *M. uniflorum*. Using interolog and domain-based approaches a high-confidence interactome map and database were constructed. Available transcriptomic information for shoot and root tissues of a sensitive (M-191; genotype 1) and a drought-tolerant (M-249; genotype 2) genotype was utilized to draw comparative PPI subnetworks under drought stress. High-confidence 6804 interactions were predicted among 1812 proteins covering about one-fourth of the proteome. The highest number of interactions (33.86%) in the interactome matched with *Arabidopsis* PPI data. The top five hub nodes included ubiquitin and heat-shock-related proteins. Higher numbers of PPIs were found to be responsive in shoot (416) and root (2228) tissue of genotype 2 as compared to shoot (136) and root (579) tissue of genotype 1. Characterization of PPIs using gene ontology analysis revealed that kinase and transferase activities involved in signal transduction, cellular processes, nucleocytoplasmic transport, protein ubiquitination and localization of molecules were most responsive to drought stress. The information was compiled in the form of a database *Mau*PIR increased efficacy for similar studies on other legumes (http://14.139.59.221/MauPIR/) (Fig. 25).

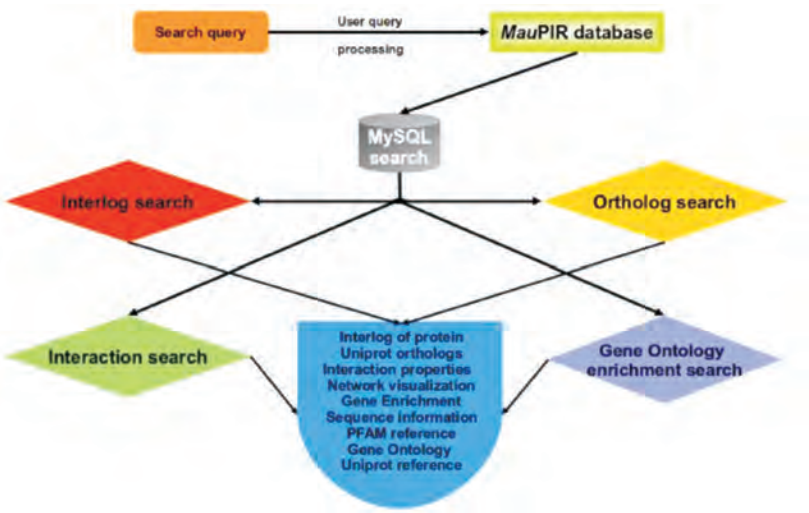


Fig. 25 Workflow for construction of *Mau*PIR database

Unraveling DNA methylation for understanding epigenetic regulation of key drought responsive genes in horse gram

Plants were raised from seeds of drought stress tolerant as well as sensitive genotypes. The seeds were procured from the Department of Plant Breeding and Genetics, CSK HPKV, Palampur,

India. Thirty days old seedlings of each genotype were then subjected to stress treatment by withholding water. The relative water content (RWC), electrolyte leakage content (EC), stomatal conductance, photosynthesis and chlorophyll contents were compared in the leaf samples from control as well as stressed samples of each genotype and control (Fig. 26).

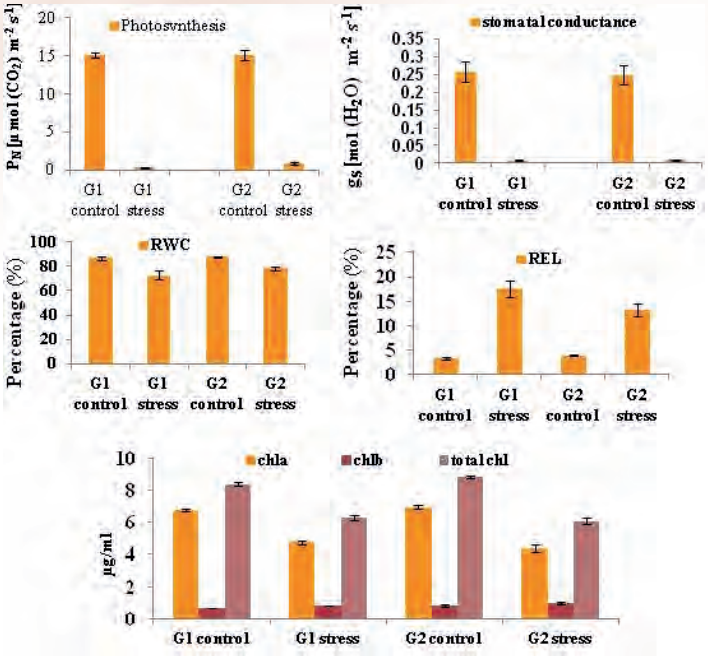


Fig. 26 Biochemical parameters studied under control and drought stress conditions

Introduction of new crops

QUINOA (*Chenopodium quinoa*)

C. quinoa crop was introduced for the first time in the mid hills of western Himalayas. The sowing time for two accessions of quinoa was standardized. Highest seed yield was recorded in crop sown in January 30. The crop required 159 days to attain maturity. In a study on yield and nutrient attributes, the protein content of seeds ranged between 18.1 to 21.6%. In an another experiment, the performance of the crop under poly house was compared with open field conditions during July to December. Results showed that the seed yield of quinoa was higher (14.4 g/plant) under polyhouse conditions as compared to field (10.8 g/plant). Similarly, significantly higher plant height, number of branches and plant spread was observed under polyhouse condition.

CHIA (*Salvia hispanica*)

Performance of two varieties of *S. hispanica* was also evaluated. Variety with purple colour flowers recorded significantly higher seed yield as compared to the variety with white colored flowers. Plant height, number of florets and number of branches/plant were also higher in plants with purple colored flowers. Oil content of purple coloured flower was 30% and the crop took eight months for maturity from April to December.

CROP PROTECTION

ENTOMOLOGY AND PEST MANAGEMENT

Effect of elevated CO_2 and temperature on insect growth & development

Status of atmospheric carbon dioxide (CO_2) has a profound influence on insect populations. Particularly, the ones that feed on plants are most affected because the availability of proper nutrition is far less in plants with poor photosynthetic efficiency. As a result, insects may suffer from delayed larval development and even mortality. The consequences are often serious ranging from changes in endangered/pest status of insects, geographic distribution of insects/pests, host plant-insect interactions, availability of insect pollinators, susceptibility of plants of economic importance to new insect pests etc.

However, as a result of global climate change and various other reasons, the level of CO_2 is invariably rising along with a concomitant increase in temperature. This increase in temperature and CO_2 are expected to affect the interactions between insects and plants that reside in the higher reaches of Himalayas. Therefore, the responses of medicinal plants like *Hypericum perforatum*, *Valeriana jatamansi* and *Rumex nepalensis* to feeding by *Spodoptera litura* larvae under elevated CO_2 and temperature were evaluated in a network mode. It was observed that leaf consumption by *S. littura* was more when fed with leaves of *H. perforatum* and *R. nepalensis* grown under elevated carbon dioxide as compared to elevated temperature and ambient conditions. The carbon and polyphenol content was also higher in *H. perforatum* and *R. nepalensis* grown under elevated carbon dioxide as compared to elevated temperature and ambient condition. In a separate study under simulated environment (FACE and FATI), the infestation of blue beetle (*Crepidodera* sp) on *R. nepalensis* was lower as compared to high and low altitudes. While there was no infestation of insect pests on *H. perforatum* under simulated and ambient environment, infestation of aphids (*Aphis spiraecola*) and *S. litura* on *V. jatamansi* was recorded under simulated and ambient environment as compared to open environment.

Development of Bio-pesticides for pest Management

Identification of promising native strains of entomopathogenic fungi (EPF) for the management of major insect pests

Field surveys were carried out for collecting insect cadavers/soil samples in different ecosystems in H.P. for isolation of EPF. Few strains of EPF were characterized and showed promising pathogenicity against second instar larvae of *Plutella xylostella* and *Aphis craccivora* under laboratory conditions. The isolated strains will be further evaluated against target pests under field conditions.

Insecticidal activities of tea saponin against *P. xylostella* and *A. craccivora*

Insecticidal activity of tea saponin was studied against *P. xylostella* and *A. craccivora* larvae. In residual toxicity assay, saponin was found more effective against second instar larvae of *P. xylostella* (LC_{50}=2106.32 mg/*l*) and *A. craccivora* (LC_{50}=540.79 mg/*l*) after 96 h as compared to positive control. In repellent activity study, saponin at 4000 mg/*l* showed significantly ($p<0.0001$) higher repellency (48.57%) to third instar larvae of *P. xylostella* and was followed

by 3000 mg/*l* (33.33%) as compared to other concentrations. Feeding preference index (PI) of tea saponin against *P. xylostella* was significantly ($F_{3, 23}$=1.64; p<0.05) lesser (0.63) in higher concentration (4000 mg/*l*) and was at par with 3000 mg/*l* as compared to lower concentrations.

Insecticidal activities of essential oils against *Tetranychus urticae*

T. urticae (red spider mite) is an important plant pest. Essential oil from *Mentha longifolia* showed promising fumigant action (LC_{50} =11.08 mg/*l* air) against adult mites of *T. urticae* and was followed by *M. piperita* (LC_{50} =15.86 mg/*l* air). In repellent activity test, *Acorus calamus*, *M. piperita* and *Cymbopogon flexuosus* showed 100% repellency to *T. urticae* as compared to *Cedrus deodara* and *Aegle marmelos* (76.67%).

New report of scale insects in Kangra tea

Four types of scales insects *viz.*, the green scale (*Coccus viridis*), hemispherical scale (*Saissetia coffeae*), brown soft scale (*Coccus hesperidum*) and yellow scale (*Aonidiella citrina*) was reported for first time as a pest on Kangra tea in H.P. The incidence started during April and gradually increased during May/ June and peaked during July.

Seasonal incidence of aphid, *Amphorophora ampullata* on fern, *Hypolepis polypodioides*

Incidence of *A. ampullata* on *H. polypodioides* was recorded throughout the year from November, 2012 to November, 2013 at weekly interval. Peak incidence of *A. ampullata* was recorded during third week of November, 2012 (25.94±2.39 aphids/pinna). Later the aphid population gradually decreased (Fig. 1) from December, 2012 onwards and reached below threshold level during the last week of January (0.1±0.0 aphids/pinna). The aphid population started building up again from first week of February, 2013 (1.6±0.13 aphids/pinna) and attained peak in the last week of August (32.17±1.22 aphids/pinna) then decreased gradually in the first week of September (20.82±4.70 aphids/pinna). Aphid densities again increased gradually from second week of September (21.62±3.02 aphids/pinna) to November, 2013 and reached maximum

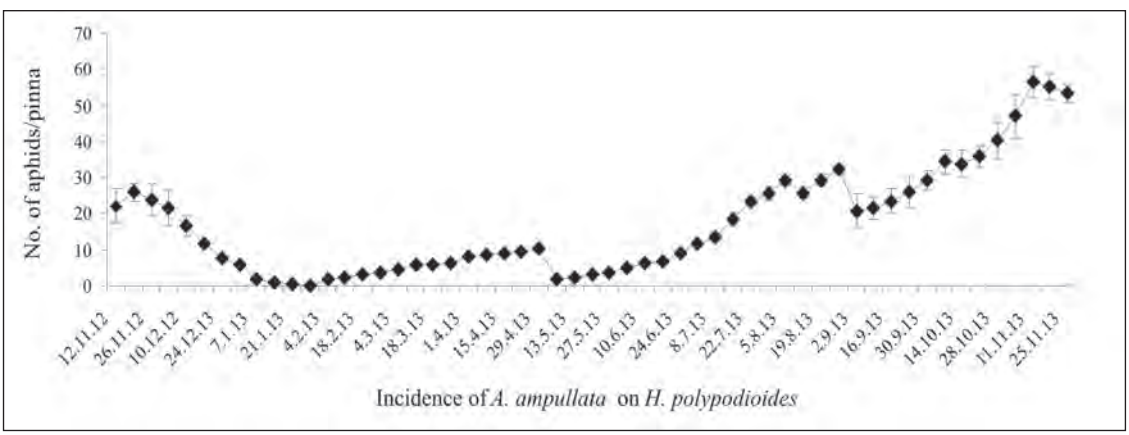


Fig. 1 Incidence of aphid, *A. ampullata* on *H. polypodioides* at weekly interval

aphid densities during November (56.55±4.34 aphids/pinna). Among weather parameters correlated, aphid population showed significant positive correlation (R^2=0.08; $p<0.05$) with relative humidity during morning hours (Fig. 2).

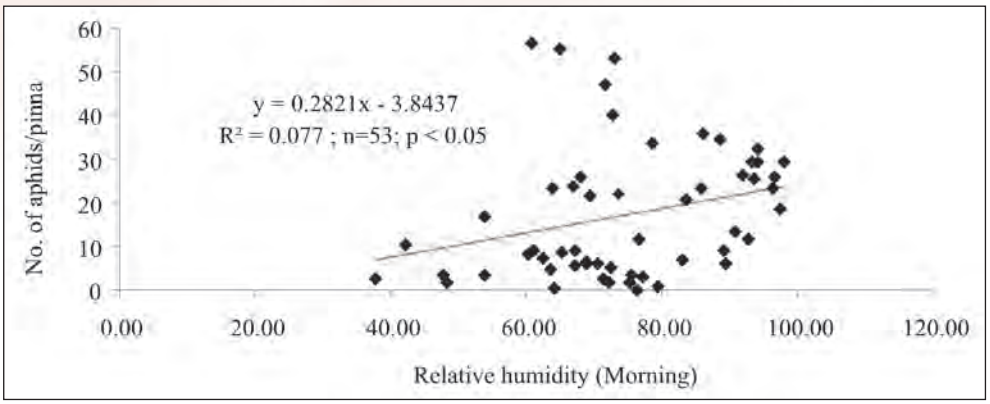


Fig. 2 Correlation between aphid population and relative humidity (morning)

Sequence-independent amplification with genome multiplexing to establish complete genome of multipartite RNA viruses: *Cucumber mosaic virus* as a case study

Replicating forms (RFs) from *Cucumber mosaic virus* infected *Nicotiana tabacum* var. Xanthi was used as a precursor for ligation of self-primed anchor primer at 30-hydroxyl end. This was subsequently used for first strand cDNA synthesis and amplified by sequence-independent single-primer amplification (SISPA) for genome multiplexing of CMV, a tripartite ssRNA positive-sense virus (Fig. 3). The presence of anchor primer was found to aid in the cloning of genome segments. The results demonstrated a new application of SISPA, wherein the genome multiplexing for complete genome characterization of single-stranded, multipartite plant RNA viruses is possible.

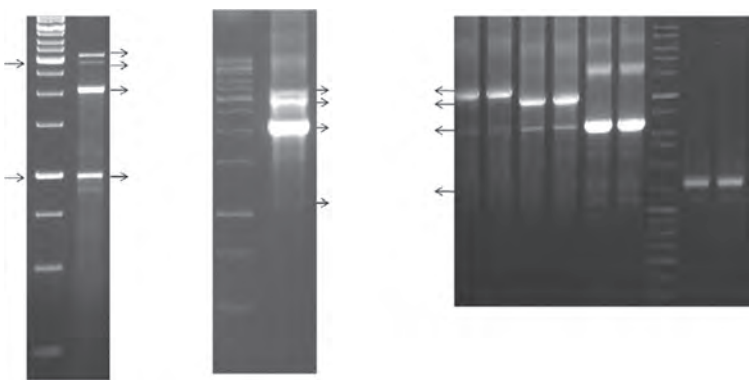


Fig. 3 dsRNA analysis and SISPA for CMV genome multiplexing. (a) Lane 1, dsRNA extracted from CMV-infected *Nicotiana tabacum* L. var Xanthi and its fractionation on 1.5% agarose gel. RFs corresponding to CMV genomic RNAs were designated as dsRNA-1, dsRNA-2 and dsRNA-3. Subgenomic RNA encoding CP was also visualized on gel (as indicated with the help of arrow). (b) CMV single tube genome multiplexing, amplicons fractionated on gel. Specific amplicons corresponding to the RFs of CMV RNA-1, RNA-2, RNA-3 and subgenomic RNA4 on the gel. (c) Simplex RT-PCR for amplification of individual CMV genomic components from individually purified dsRNA. Amplicons specific to RNA-1 (lanes 1–2), RNA-2 (lanes 3–4), RNA-3 (lanes 5–6) and subgenomic RNA-4 (lanes 7–8) as visualized on agarose gel. Lane M contained 1-Kb DNA ladder (Bangalore Genei, Bangalore, India).

Movement protein of *Cucumber mosaic virus* associates with apoplastic ascorbate oxidase

Plant viral movement proteins facilitate its movement by interacting with a number of host factors. In this regard, the association of a cell wall localized ascorbate oxidase (CsAO4) from *Cucumis sativus* and movement protein (MP) of *Cucumber mosaic virus* (CMV) was identified and validated functionally in *Arabidopsis thaliana* and *Nicotiana benthamiana* (Fig. 4). Findings suggested the role of AO and viral MP interaction in early viral movement, targeting of the MP to the apoplast and disruption of functional AO dimers formation for the spread of virus to nearby cells.

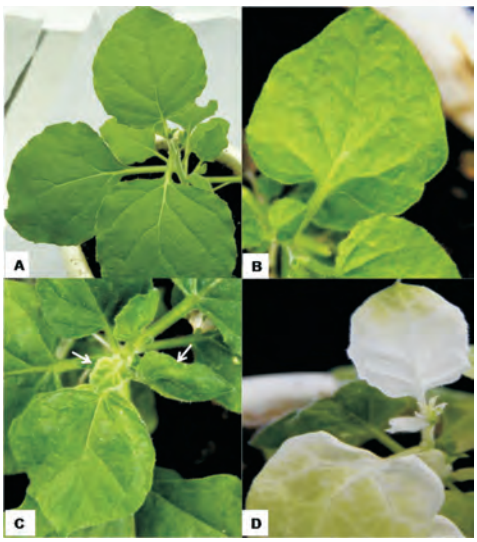


Fig. 4 Effect of *NbAO4* (VIGS) silencing on *N. benthamiana* two weeks post agro-infiltration. A) Mock control plant: developed no symptoms. B) Empty TRV vector: mosaic symptoms. C) Partial *N. benthamiana AO* (*NbΔAO*-pTRV2): caused downward leaf curling at earlier stages, severe leaf distortion affecting leaf lamina and chlorosis, as indicated by arrows. D) *PDS*-pTRV2 control: newly emerging leaves showed photo bleaching effect.

Leaf spot disease adversely affects human health-promoting constituents and withanolide biosynthesis in *Withania somnifera* (L.) Dunal

The implication of the leaf spot disease on the antioxidant potential and pharmaceutically important constituents of *Withania somnifera*, a high-valued medicinal plant was studied. Most of the genes of the MEP and MVA biosynthetic pathways were down-regulated in diseased tissues. While withanolide biosynthesis was down-regulated in diseased samples, coumaric acid was reduced by 88%, chlorogenic acid increased by 67% in diseased samples as compared to healthy plants. Pharmaceutically important withaferin A, withanone and withanolides were also significantly reduced. Analysis of the diseased sample by electron microscopy analysis revealed disintegrated chloroplasts detached from the cell membrane (Fig. 5).

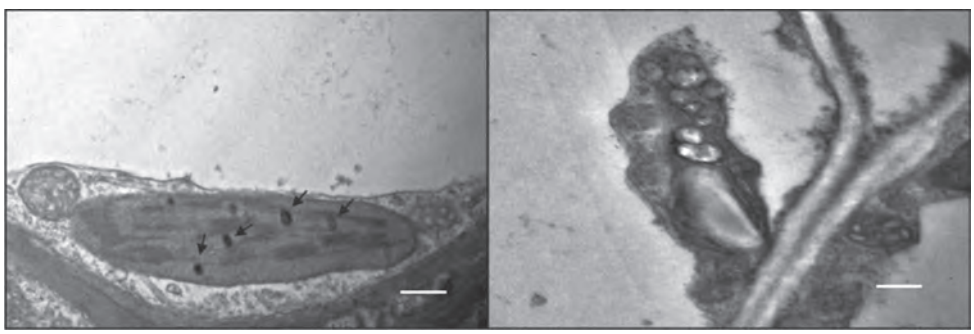


Fig. 5. Ultrastructure of chloroplast and mitochondria of healthy and diseased leaf tissue. Disintegrated chloroplasts and grana thylakoid membrane system are visible in healthy but not diseased leaves. Healthy chloroplasts have large to small starch granules indicated by arrows. Diseased chloroplasts are detached from the cell membrane (a symptom of cell death)

Plant STAND P-loop NTPases: against plant pathogens

STAND P-loop NTPase is a common weapon used by plant and other organisms to defend themselves against pathogen invasion. Prior to this study, the plant STAND P-loop NTPase were known to be comprised of only NBS-LRRs/AP-ATPase/NB-ARC ATPase. However, finding suggested that genome of early green plants comprised of two types of STAND P-loop NTPases: (i) mammalian NACHT NTPases, and (ii) NBS-LRRs. The lineage-specific expansion and genome duplication events is responsible for abundance of plant STAND P-loop NTPases; where "moderate tandem and low segmental duplication" trajectory followed in majority of plant species with few exception.

CENTRE FOR HIGH ALTITUDE BIOLOGY (CeHAB)

The Centre for High Altitude Biology was established in last five year plan period with an aim to align with the National Action Plan on Climate Change by the Prime Minister's Council on Climate Change. Since then, the CeHAB has been diligently working to align with the National Mission for sustaining the Himalayan ecosystem in the wake of climate change and to cater to the strategic requirements of the nation in global context. In this regard, the various activities of the centre continued to be directed towards:

- Generation of data on environmental parameters and high altitude ecosystems for forecasting climate change and its mitigation
- Deciphering plant adaptation strategies and monitoring changes at various biotic and abiotic levels
- Assessment of the impact of climate change using integrated models
- Developing conservatories of high altitude plants of importance
- Bioprospecting commercially important microbes
- Generating and processing raw materials
- Serving as an execution arm of various R&D findings of the Institute

The key achievements in the reporting period included:

(i) Further strengthening of conservatories with additional plants collected during different surveys and field tours,

(ii) Annual monitoring of the 9 permanent monitoring plots (1 hectare size) in treeline zone,

(iii) Nutrient recycling in LTER plots,

(iv) Generation of baseline data on functional traits of high altitude plants,

(v) Exploration of freezing tolerance of representative species,

(vi) Chemical investigation of selected aromatic & medicinal plants growing at high altitude

(vii) Bioprospection for industrial enzymes from microbes and plants from high altitudes niches in the Himalayas and

(viii) Mass production of endangered plants of commercial value using tissue culture techniques.

Importantly, the germplasm resource bank at CeHAB was strengthened through the introduction and maintenance of around 50 rare and economic plant species in the herbal garden. *Aconitum heterophyllum, Carum carvi, Crataegus oxyacantha, Dactylorhiza hatagirea, Fagopyrum esculentum, F. tataricum, Fritillaria roylei*, *Hippophae rhamnoides, H. salicifolia, Lilium* sp. *Panax ginseng*, *Picrorhiza kurroa, Podophyllum hexandrum, Trillidium govanianum* are few of these plants. Additionally, during field study tours, about 750 plant specimens belonging to ~250 species were collected from Kinnaur, Lahaul & Spiti and Pangi areas of H.P. The National Hippophae Germplasm Resource at Ribling farm of the Centre was also fortified by introducing 102 accessions from Sikkim, 110 accessions from Uttarakhand and 176 accessions from Leh and Ladakh region. Presently, it has 660 accessions as per the following:

- *H. rhamnoides* ssp. *rhamnoides* (15 accessions from Russia)
- *H. rhamnoides* ssp. *turkestanica* (281 accessions from Leh & Ladakh)
- *H. rhamnoides* ssp. *turkestanica* (143 accessions from H.P.)
- *H. salicifolia* (212 accessions from Uttarakhand and Sikkim)
- *H. sinensis* (9 accessions from China)

Besides the annual monitoring of the 9 permanent monitoring plots in treeline zone, the seasonal variations in nutrients and other carbon based compounds in *Betula utilis* leaves were studied at five different sites across latitudinal gradients. Litter decomposition in the *B. utilis* dominated patches was also studied.

In a separate study, baseline information was generated on the variations in distribution, habitat, functional traits and threatened status of the high altitude terrestrial orchid, *Dactylorhiza hatagirea* across environmental gradients across ecological scales. Study was also conducted to understand the effect of elevation and seasons on various functional traits of plants growing in four different localities of subalpine forests to tree-line and alpine regions. In each locality, three elevations along North and South aspects were targeted.

Based on the findings of different agrotechnological studies and while serving as an execution arm of the institute, cultivation of several high value MAPs like *Panax ginseng* (ginseng), *Picrorhiza kurrooa* (kutki), *Salvia scleria* (clary-sage) and commercially important plants like *Crocus sativus* (saffron) and liliums were extended to high altitude areas. Trainings and skill development programmes on cultivation of medicinal & aromatic plants, lilium cultivation, essential oil extraction, food processing and preservation technologies were conducted throughout the year. As a result, around 130 farmers were motivated to earn around 4 crores per season by growing liliums and selling the flowers directly in Delhi markets. The tissue culture facility of the centre also played a key role in initiating *in vitro* cultures of several endangered MAPs like *Fritillaria roylei, Trillium govanianum, Dactylorhiza hatagirea* for their further mass multiplication.

Besides the above, the centre facilitated the study of the diversity of plants, insects/pests and microbes (fungi, bacteria & viruses) in the current year. Several high value bioactive molecules and products were bioprospected such as an efficient cellulose degrading bacteria from the higher altitude niches, *Ophiocordyceps* sp. and major quantities of isoalantolactone and alantolactone isolated from *Saussurea lappa*.

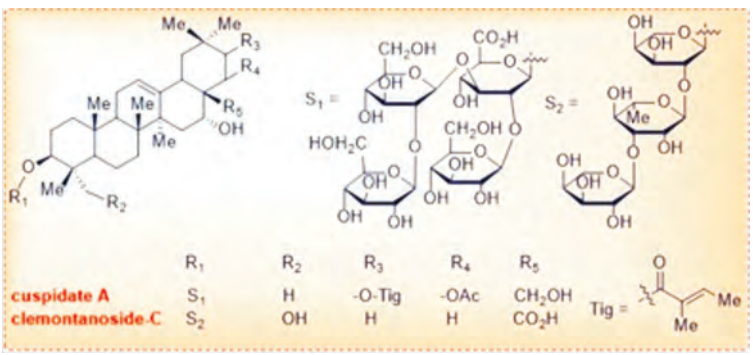
CHEMICAL TECHNOLOGY AND NANOTECHNOLOGY

Natural products continue to play an important role in pharmaceutical, cosmetic and nutraceutical industries. Although, natural product chemistry has made significant progress in 20th century, use of traditional medicines is limited due to lack of authenticity and quality control. Use of modern sophisticated analytical techniques enabled to fill this gap and correlate pharmaceutical properties of traditional medicines with their bioactive natural products.

In this regard in the current year, studies on isolation and characterization of secondary metabolites, and analytical methods for different medicinal plants were carried out.

Lepidagathis cuspidata

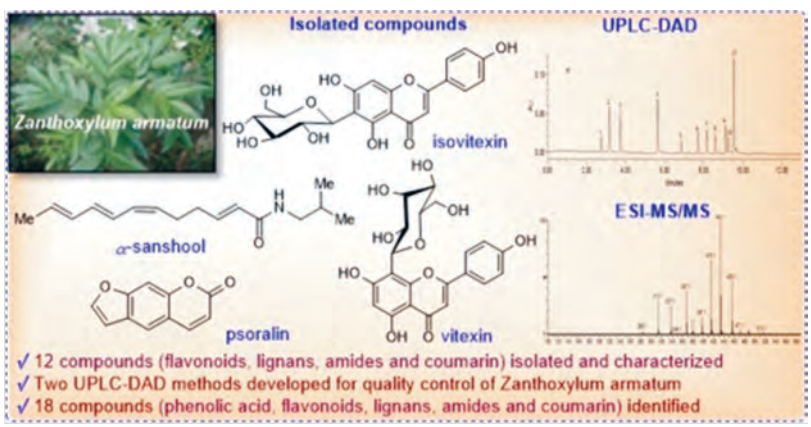
A new triterpenoid saponin named cuspidate A (**1**) along with a known oleanane based triterpenoid saponin clemontanoside-C were isolated from the roots of *L. cuspidata*. The structure of the new compound (**1**) was established after detailed analysis of spectroscopic data including 1D and 2D NMR spectra. Clemontanoside-C was reported from this genus for the first time. The biological evaluation of these compounds against selected fungal strains *Aspergillus flavus, A. fumigates, Rhizopus stolinifer and Penicillum nodatum* was carried out. Cuspidate A showed activity comparable to that of a synthetic drug, while clemontanoside C showed a moderate effect against all studied fungal strains.



Zanthoxylum armatum

Detail phytochemical investigation of *Zanthoxylum armatum,* an important medicinal plant was carried out. Twelve compounds, including catechin, isovitexin, hesperidin, psoralin, eudesmin, kobusin, fargesin, sesamin, asarinin, planispine-A, α-sanshool and vitexin were isolated and characterized from the leaves of *Z. armatum.*

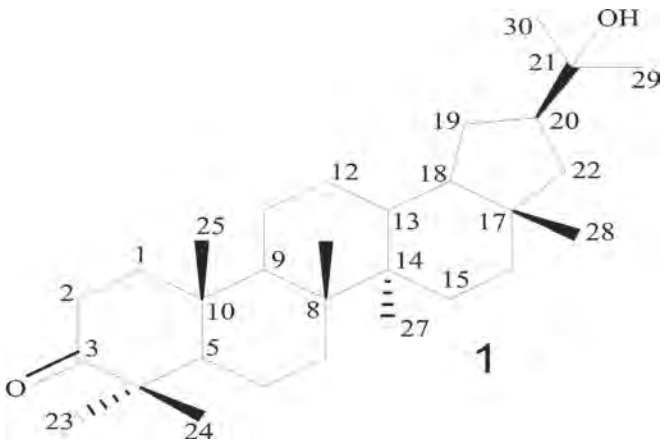
A rapid and simple ultra performance liquid chromatography-diode array detection (UPLC-DAD) method was also developed for the simultaneous quantitative determination of compounds isolated from leaves. The analytical methods were validated for linearity, precision, accuracy, limit of detection (LOD) and limit of quantification (LOQ). The LOD and LOQ were in the range of 0.06-0.21 µg/ml and 0.19-0.69 µg/ml, respectively. The validated method was linear ($R^2 \geq 0.9906$), precise in terms of



peak area (intra-day RSDs < 3.8% and inter-day RSDs < 2.7%), and accurate (92.5-109.6%). This is the first report on the isolation and quantification of catechin, isovitexin, psoralin, and vitexin from *Z. armatum* and hesperidinin *Zanthoxylum* genus. The methods were successfully applied to assess the quality of samples collected from different locations of H.P. The results demonstrated that flavonoids and furofuran lignans were the major constituents of *Z. armatum* leaves. The developed methods were further applied for tandem electrospray ionization-mass spectrometry (UPLC-DAD-ESI-MS/MS) and total eighteen compounds were identified including phenolic acid, flavonoids, furofuran lignans, coumarin and isobutyl amides.

Commiphora wightii

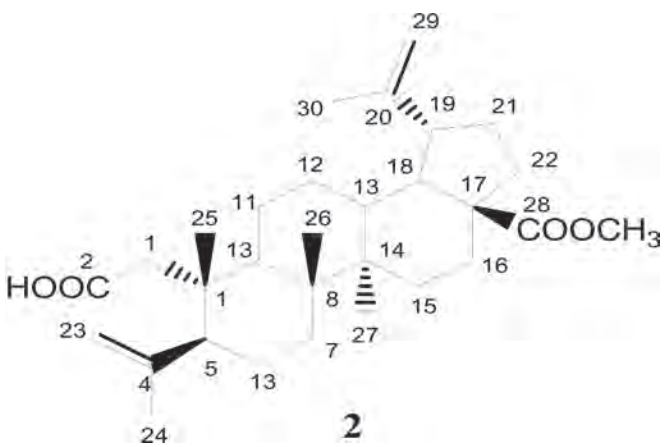
A new triterpenoid was isolated from the resin of *C. wightii*. Structure of the isolated compound was elucidated using different spectroscopic techniques (1D, 2D NMR (^{1}H-^{1}H-COSY, HMQC, HMBC and NOESY) and characterized as 21-hydroxy-8*R*, 10*R*, 14*R*, 17*S*, 20*R*-lupan-3-one (**1**). The cytotoxicity of the isolated compound was evaluated against human cervical cancer (SiHa), human mouth epidermal carcinoma (KB) and human adenocarcinoma (Colo-205) cells at 48 h. The compound was found inactive against all the tested cells.



Structure of Compound 1.

Potentilla atrosanguinea

A new bioactive nortriterpene, 28-methyl-acanthochlamate was isolated from the roots of *P. atrosanguinea*. Structure of the compound was established on the basis of NMR and HR-ESI-MS spectral analysis. The stereochemistry was described with the help of NOESY correlation experiment. *In-vitro* cytotoxicity of the isolated compound was evaluated by sulforhodamine B assay against three cancer cells; human cervical cancer (SiHa), epidermal carcinoma (KB) and human adenocarcinoma (Colo-205). The compound showed significantly higher cytotoxicity against all the cells (SiHa, IC_{50} 30.5 µg/ml; KB, IC_{50} 22.6 µg/ml and Colo-205, IC_{50} 18.8 µg/ml). Further, a new UPLC-DAD method was developed and used for the quantification of the compound. The roots were found to contain 1.1 mg/g of the compound.



Structure of Compound 2.

Fiddle Head Ferns (*Diplazium* spp.)

Diplazium esculentum and *D. maximum* are edible ferns of western Himalayas. In the present work, the nutritional value, total phenolic content, total flavonoid content and antioxidant activity of these two species were determined. The results revealed that the protein content in *D. esculentum* and *D. maximum* were 1.73 mg/g and 1.5 mg/g, respectively. The total carbohydrate content of *D. esculentum* and *D. maximum* were 0.15 mg/g and 0.16 mg/g, respectively. Evaluation of antioxidant activity of different extracts (methanol, chloroform, butanol and water) revealed highest activity in methanolic extract of *D. maximum*. Further, the active extract was analyzed by UPLC-DAD method and lutein was quantified as major compound in both the species which was higher (6.1 mg/g) in *D. maximum* as compared to *D. esculentum* (1.4 mg/g).

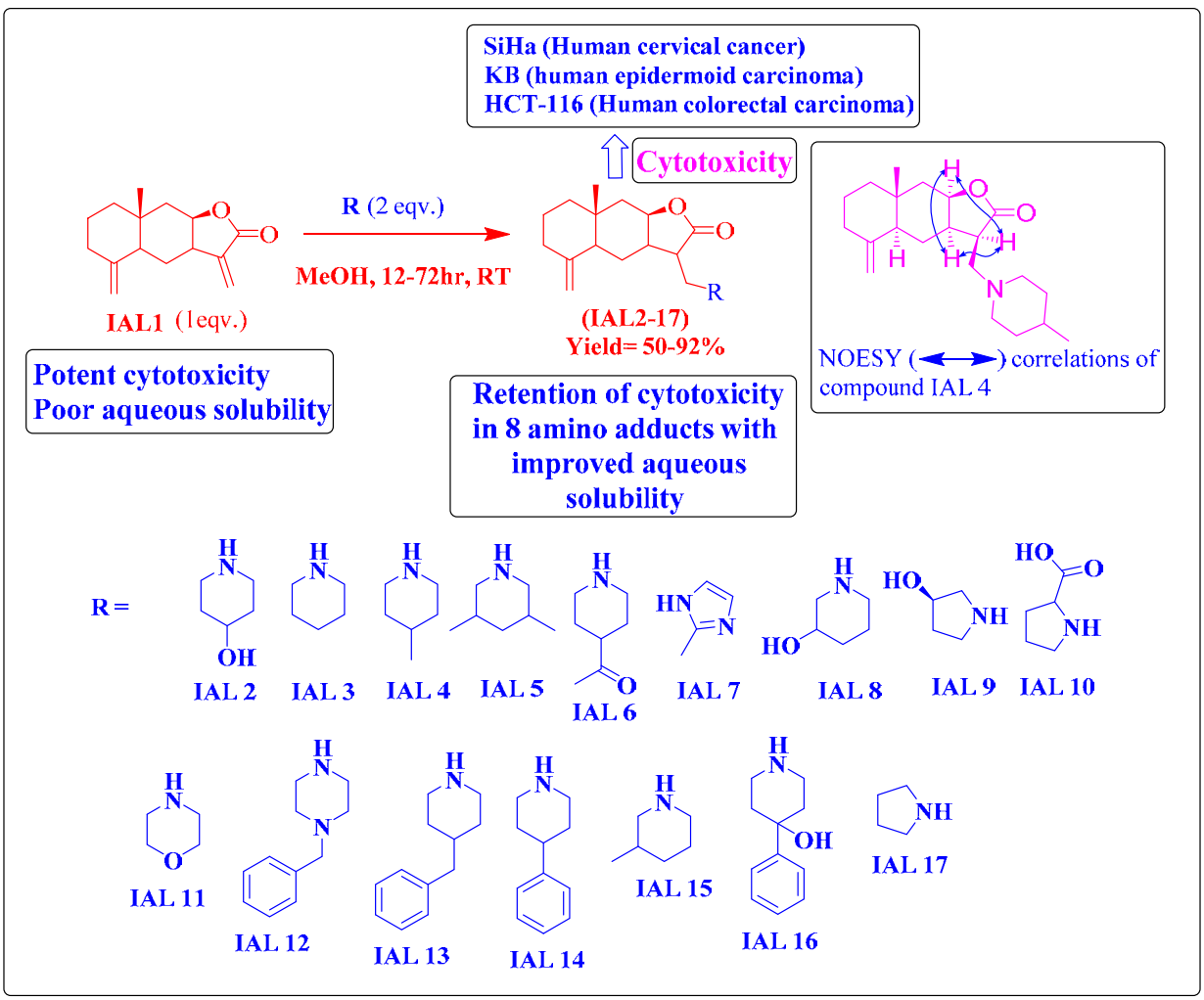
Hazelnut (*Corylus jacquemontii*)

A rapid and selective UHPLC-DAD method was developed for simultaneous quantification of seven phenolic acids namely, gallic acid, catechin, epicatechin, quercetin, kaempferol, syringic acid and p-coumaric acid. The method was further applied for identification of 15 phenolic compounds in 80% ethanolic extracts of jacquemont's *C. jacquemontii* kernels and its by products from western Himalaya. The developed analytical method showed excellent linearity ($r^2 \geq 0.99$), repeatability (intra-day RSDs < 2.30% and inter-day RSDs < 0.75%) and accuracy (88.1-111.0%). Total phenols concentrations were found to be 4446.0, 1199.0 and 105.0 mg gallic acid equivalent (GAE)/kg of dried extracts of skin, hard shell and kernels, respectively. Screening of antioxidant potential of defatted raw skin, hard shell and kernel extracts was carried out by 2,2′-azino-bis (3-ethylybenzothiazoline-6-sulfonic acid) diammonium salt (ABTS), 2,2′-diphenyl-1-picrylhydrazyl (DPPH) methods. The IC_{50} values were 13.12, 51.32, 136.46 and 45.73, 63.65, 169.30 µg/ml for skin, hard shell, and kernels by DPPH and ABTS assays, respectively. The high phenolic contents in the skin contributed towards their free radical scavenging capacities.

Saussurea lappa

Isoalantolactone is a sesquiterpene lactone (SL) found in major quantity in essential oil from *S. lappa* roots. Isoalantolactone has diverse bioactivities including significant anticancer property due to the presence of a α-methylene-γ-lactone moiety. However, its poor water solubility limits its therapeutic application. Therefore, 16 new series of isoalantolactone (IAL 1) amino derivatives (IAL 2 - IAL 17) were synthesized in the current reporting period. Aza-michael addition of IAL 1 with cyclic aliphatic amines created one more chiral center at C-11 position, whose configuration was established on the basis of correlations deduced from NOESY experiment. In the NOE experiment of IAL 4, the NOESY correlation was observed between H-7, H-8 and H-11. On the basis of literature and NOESY correlations, the stereochemistry of C-11 was unambiguously assigned as *R*. The aza-Michael addition at exocyclic double

bond of sesquiterpene lactones proceeded with high diastereoselectivity at position-11 giving preferentially the less hindered *R* isomer. IAL 1 and its synthesized analogues were evaluated for *in vitro* cytotoxicity against three human cancer cell lines including cervical cancer (SiHa), epidermoid carcinoma (KB) and colorectal carcinoma (HCT116). The compounds IAL 2, 8, 9, 10, 12 and 17 were found to be nearly as equally active as IAL 1 against all the three tested cell lines, whereas IAL 4 and 16 against HCT116 cells. Findings of the cytotoxicity provided a correlation on the structure activity relationship of IAL 1 and its derivatized analogues against tested cells. The retention of cytotoxicity with enhanced water solubility in derivatized amino adducts including IAL 2, 4, 8, 9, 10, 12, 16 and 17 suggested their potential for drug development.



Amino isoalantolactone derivatives and their cytotoxic activity[a]

Compound	Yield (%)	Melting point (°C)	Concentration (μM)	Cell lines (% Inhibition)		
				SiHa	KB	HCT116
IAL1	-	109-111	43.1	57.1 ± 1.7	77.6 ± 4.4	80.9 ± 5.6
IAL2	92	128-130	30.0	58.7 ± 2.5	54.8 ± 0.8	56.1 ± 3.2
IAL3	78	158-160	31.5	47.3 ± 4.5	42.6 ± 3.1	73.5 ± 2.2
IAL4	85	130-132	30.2	18.3 ± 4.4	25.9 ± 4.4	83.9 ± 0.6
IAL5	78	130-132	29.0	4.1 ± 3.2	10.3 ± 3.6	61.8 ± 0.6
IAL6	63	158-160	25.6	10.4 ± 2.1	14.3 ± 1.9	50.4 ± 0.8
IAL7	52	95-97	31.8	4.3 ± 1.8	5.3 ± 1.5	14.3 ± 4.0
IAL8	62	118-120	30.0	58.2 ± 3.1	57.2 ± 4.3	78.4 ± 2.0
IAL9	58	138-140	31.3	61.1 ± 1.6	68.1 ± 4.4	78.6 ± 2.4
IAL10	50	175-177	28.8	55.7 ± 2.2	51.1 ± 2.3	72.7 ± 0.2
IAL11	62	170-172	31.3	4.6 ± 2.1	23.0 ± 3.2	44.0 ± 1.4
IAL12	68	123-125	23.7	53.2 ± 4.7	51.9 ± 3.9	70.3 ± 1.3
IAL13	80	127-129	24.5	4.6 ± 2.1	15.1 ± 1.1	17.6 ± 2.9
IAL14	82	148-150	25.0	21.3 ± 1.9	33.2 ± 2.5	34.3 ± 1.5
IAL15	74	101-103	30.2	36.3 ± 2.1	41.7 ± 4.9	68.4 ± 1.5
IAL16	86	125-127	24.1	36.0 ± 3.0	38.1 ± 2.4	81.2 ± 4.8
IAL17	58	154-156	33.0	51.2 ± 1.6	47.6 ± 3.2	72.8 ± 0.7
Vinblastine[b]			1.0	84.2 ± 1.1	90.0 ± 1.3	84.5 ± 1.1

[a]Cell lines, SiHa (Human cervical cancer), KB (human epidermoid carcinoma), HCT-116 (Human colorectal cancer cell). [b]1 μM (tested Concentration)

Essential oils of *Acorus calamus*, *Mentha* sp. and *Hedychium spicatum* showed promising toxicity to second instar larvae of diamondback moth (Plutellaxylostella) under laboratory conditions.

ARTEMISIA (*Artemisia maritima*)

Besides standardizing the harvesting time of *A. maritima*, chemical analysis was carried out in the current year. It was found that 1,8-cineole, bornyl acetate and santolina triene were the major compounds in the essential oil of *A. maritima*. When the effect of season on the content of 1,8-cineole was studied, the highest content (58.08±7.12%) was recorded in the month of October.

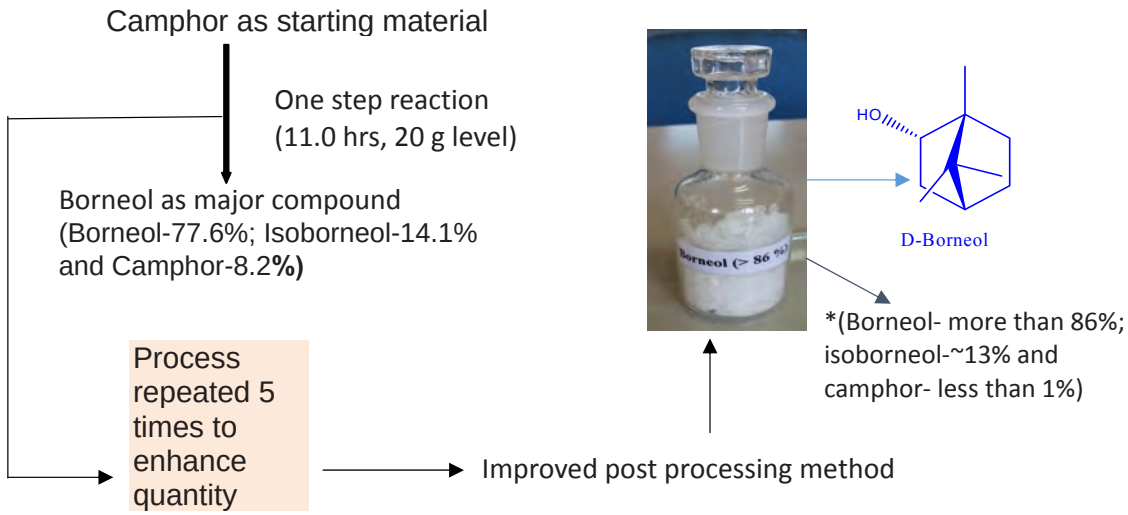
SAGE (*Salvia spp.*)

Metabolomic profiling based intrinsic action of salvianolic acid F (hydroxylated styryl–cinnamate hybrids) was identified. The lead molecule involved quinonemethide pathway as reported on the basis of ^{1}H NMR spectroscopy guided metabolomic profiling. The role of hybrid molecules, analogues of salvianolic acid F in forcing glioma cells towards apoptosis by specifically perturbing the concentration of glutathione along with that of caspase 6 was demonstrated.

ESSENTIAL OIL CHEMISTRY

Process for the conversion of d-camphor into d-borneol

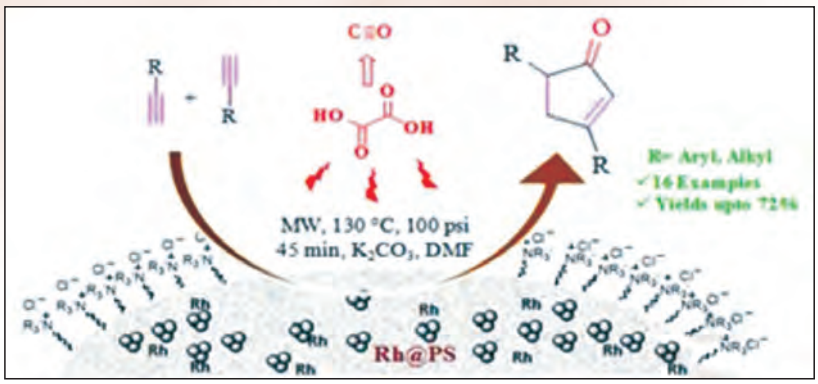
Himalaya is rich in aromatic crops and most of the crops are commercially important. However, it is not fully explored and still several aromatic crops are underutilized such as *Curcuma aromatica*, camphor tree etc. having camphor as a major constituent. Camphor can be reduced to a high value compound, *d*-borneol worth Rs. 40000 to 80000 per kg. The compound is also traditionally used to relieve anxiety, restlessness and insomnia. Due to abundance of *d*-camphor in *C. aromatica*, a synthetic process was developed for the preparation of *d*-borneol from *d*-camphor (US Patent 0331467 A1). The technology has the potential to impact the perfumery and pharmaceutical industries.



SYNTHETIC ORGANIC CHEMISTRY

Supported rhodium nanoparticle catalyzed carbonylative cyclization of alkynes using oxalic acid as sustainable C1 source

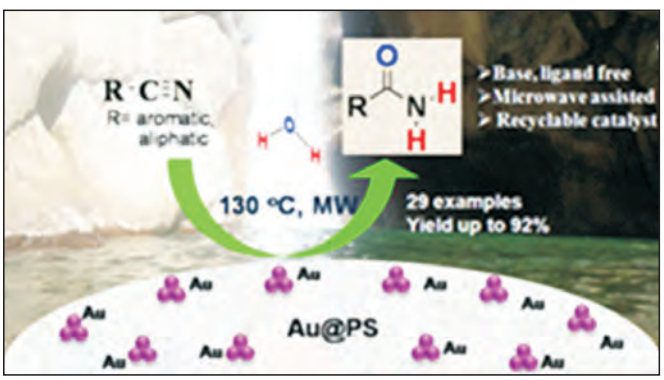
Polystyrene-supported rhodium(0) (Rh@PS) nanoparticles (NPs) as a heterogeneous catalyst were used for the synthesis of monocyclic 3,5-disubstituted cyclopent-2-enones from terminal alkynes and oxalic acid as the *in situ* C1 source following intermolecular [2+2+1]-reductive-carbonylative-cyclization (RCC) reaction. Oxalic acid in presence of Rh@PS catalyst plays a dual role by acting as CO source and also as reducing agent (H_2), thereby, enabling the process for desired product synthesis. The ionic interaction of oxalic acid to PS surface of Rh@PS helps to maintain close vicinity and fruitful interaction with substrates and catalyst required for product formation.



Carbonylative cyclization reaction

Supported gold nanoparticles catalyzed microwave assisted hydration of nitriles to amides

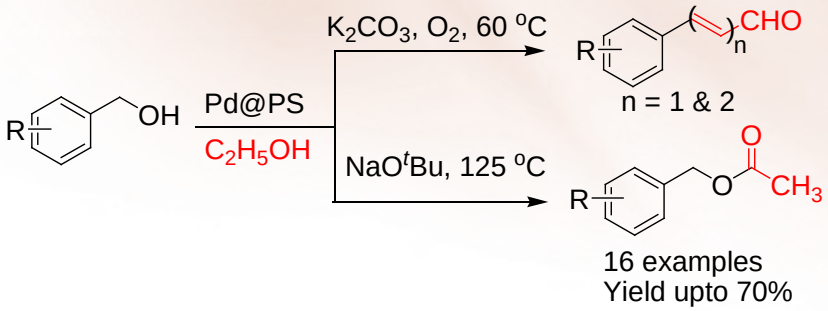
The polystyrene-supported gold (Au@PS) nanoparticles were synthesized by reduction deposition approach and was well characterized by UV-visible, XRD, TEM, SAED, EDX, and XPS studies. The Au@PS was applied as catalyst for hydration of nitriles to amides in water under microwave irradiation. Several functionalized aromatic, heterocyclic and aliphatic nitriles were found to be active for corresponding amides synthesis where no activation of water by base, ligand and support was needed. Easy recovery, negligible leaching and recyclability up to eight runs are added advantage of the catalyst under water mediated reaction condition.



Hydration of nitrile to amide

Supported palladium nanoparticles as switchable catalyst for aldehyde conjugate/s and acetate ester syntheses from alcohols

The potential of polymer supported Pd(0) (Pd@PS) NPs were explored as switchable catalyst for oxidative aldehyde conjugate/s (AC/s) and acetate esters (AEs) synthesis from alcohols. Using the same substrates, the catalyst in the presence of oxygen and K_2CO_3 participates in AC/s synthesis and in traces of air and NaO^{t}Bu condition give unusual AEs as products.

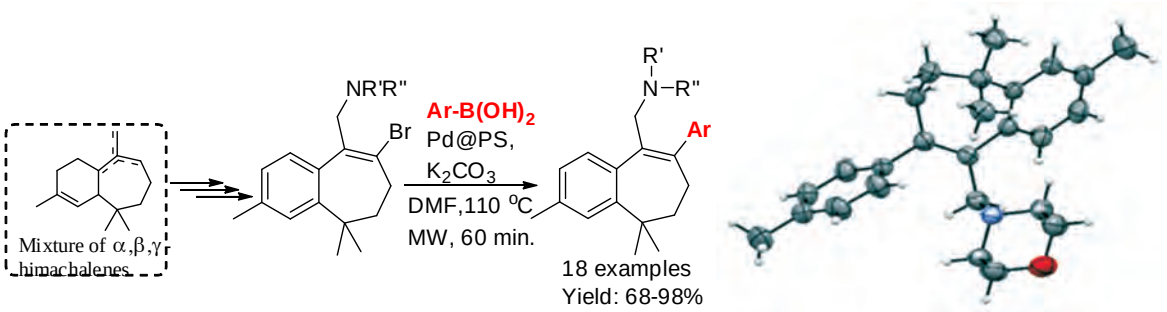


Aldehyde conjugate/s and acetate esters synthesis

VALUE ADDED PRODUCTS FROM HIMALAYAN BIORESOURCES

Himachalenes to aminoarylbenzosuberene analogues synthesis

A semi-synthetic method was developed for the synthesis of aminoarylbenzosuberenes (AABs) from naturally occurring himachalenes, an isomeric mixture of sesquiterpenes present in *Cedrus deodara* oil. Polymer-stabilized Pd(0) nanoparticle-catalysed Suzuki–Miyaura cross-coupling reaction of aminovinyl bromide-substituted benzosuberenes was adopted for AAB synthesis. The catalyst performed well with different amine substituents, and was recycled up to five times. The synthesis of such arylated benzosuberene class of compounds from natural precursors following semi-synthetic approaches provided an attractive alternative method with reduced number of steps.

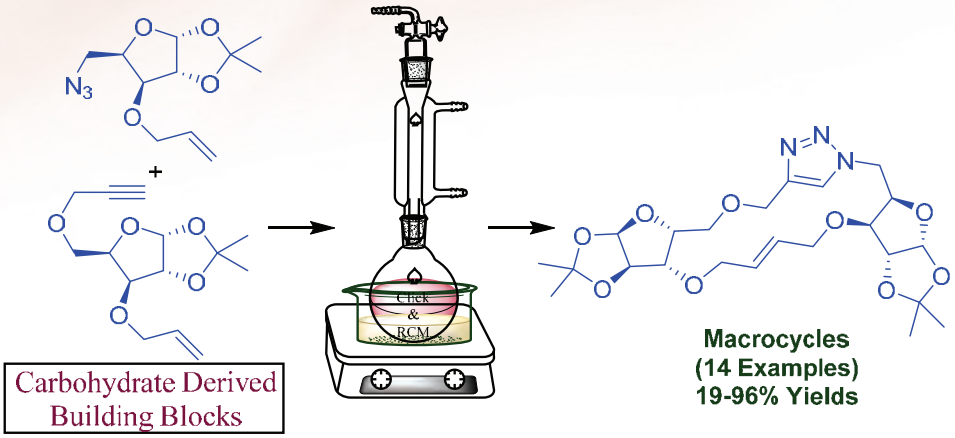


Modification of Himachalenes for aminoarylbenzosuberene analogues

Synthesis of macrocycles

Macrocyclic compounds represent an important class of bioactive molecules, often used to regulate difficult target biological systems such as protein-protein interactions (PPIs). There are more than 100 macrocyclic drugs in clinical practice. However, macrocycles are under-represented in pharmaceutical drug screening libraries because of their poor synthetic tractability and complex structures. Advances in organic synthesis and the use of reactions such as ring closing metathesis (RCM) and azide/alkyne cycloaddition can enable the synthesis of such compounds. Therefore, various macrocycles were synthesized using an eco-compatible strategy for diversity-oriented synthesis (DOS). The strategy involved iterative use of readily available sugar derived alkyne/

azide-alkene building blocks (BBs). The BBs were coupled through copper catalysed azide-alkyne cyclo-addition (CuAAC) reaction followed by pairing of linear cyclo-adduct using build/couple/pair (BCP) approach.



Carbohydrate derived macrocyclic library

Natural Product Synthesis

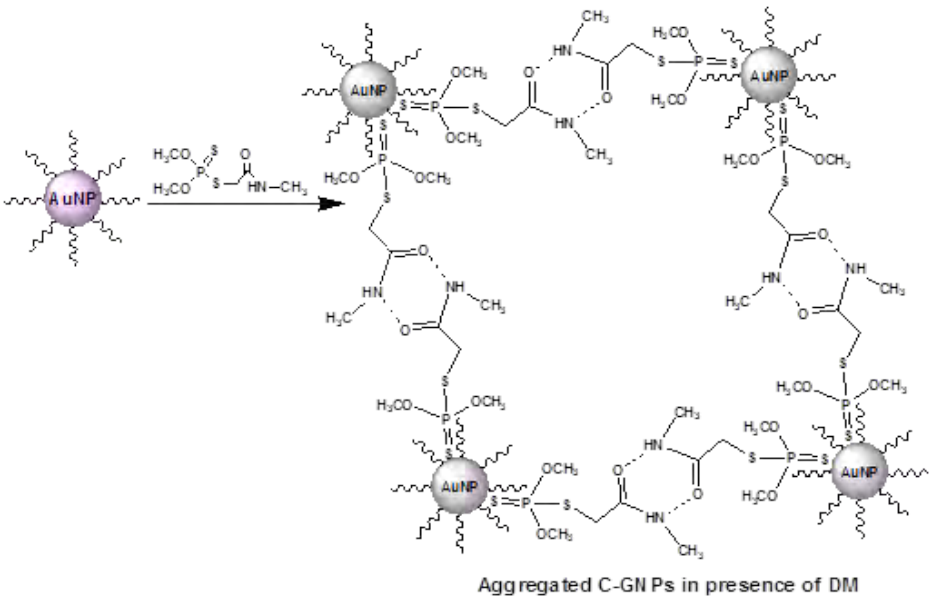
Curculigo species are widely distributed in the tropical and subtropical areas of Africa, Australia and Asia, and are well known for their application in traditional medicine. Since the rhizomes of *C. crassifolia* are used as folk medicine for treating child pneumonitis, crassifoside F, a novel glucoside was isolated from the rhizomes. However, the compound exhibited dose-dependent angiotensin converting enzyme (ACE) inhibition. Therefore, the skeleton of crassifoside F was constructed using three key reactions. A dithiane was used to open an enantiomerically enriched epoxide, prepared from vanillin using a sharpless asymmetric epoxidation (SAE). A novel, β-selective glycosidation reaction using a propargyl glucoorthoester glycosyl donor allowed the preparation of the glycoside. Finally, although ring-closing metathesis (RCM) of the diene was unsuccessful, the cyclized product was prepared by dihydroxylation, tosylation and cyclisation by S_N2 reaction.

Studies on vasicine based organocatalyst for coupling and reduction reactions C-H activation/functionalization: synthesis and functionalization of valuable molecules

Vasicine is a quinazoline alkaloid and a moiety containing Lewis acidic and basic sites (both hydroxyl and tertiary amine group). Therefore, it enables the activation of nucleophile and electrophile simultaneously. The 0.5-2.0% of the compound has been reported in the leaves of *Adhatoda vasica*, found abundantly across India. Vasicine and related alkaloids were isolated and the major alkaloids (vasicine and vasicinone) evaluated for their catalytic potential in inter as well as intramolecular C-H arylation of arenes with aryl halides. Vasicine and vasicinone were also modified synthetically in order to develop them as tertiary amine-hydrogen bond donor bifunctional organocatalysts. The synthesized organocatalysts and vasicine were further evaluated for their ability to catalyse the Henry's reaction and reduction reactions.

Nanoparticle based detection of analytes

The plausible mechanism for the aggregation of citric acid-coated gold NPs in the presence of dimethoate was proposed. A colorimetric chemo-sensor based on citric acid-coated gold NPs showed linear increase in fluorescence intensity with increasing concentration of the pesticide, dimethoate. The increase in fluorescence intensity was due to the soft–soft interaction between C-GNPs and DM via sulfur group, absent in pesticide dicofol. The limit of detection of the pesticide was ~8.25± 0.3 and 20 ± 9.5 ppm. In contrast, no change in the fluorescence intensity was recorded in similar studies with citric acid-coated silver NPs. There was aggregation of gold NPs in the presence of dimethoate but not in case of dicofol.



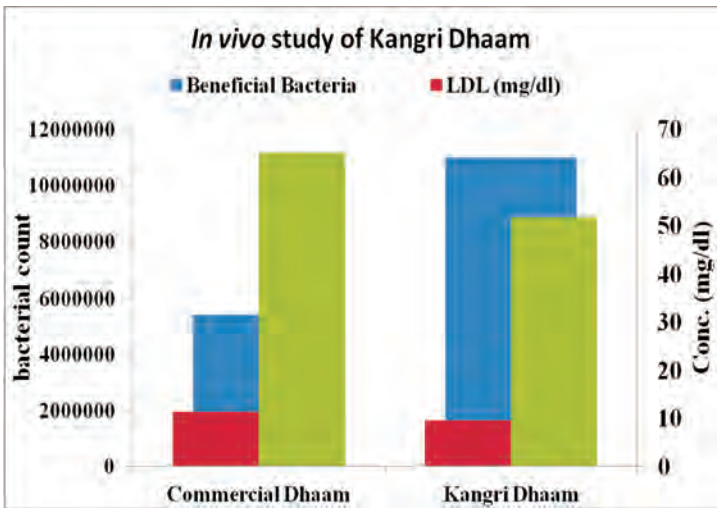
Plausible mechanism for the aggregation of citric acid-coated gold NPs in presence of dimethoate

FOOD & NUTRACEUTICALS

PRESERVATIVE FREE READY TO EAT FOODS

CSIR-IHBT has developed an indigenous process technology for commercial production of ready-to-eat foods. The technology ensures that packed ready to eat foods remains fresh for seven months without adding any chemical/preservatives. As a first step, we deploy the technology on Kangtri Dham. Kangri Dham, the famous cuisine of Kangra region of Himachal Pradesh. It is comprised of a series of individual relishing dishes like "Rajma ka Madra", "Retta", "Khatte Chane" and many more.

Interestingly, *In vivo* studies on rats and mice have shown prebiotic health benefits of these products.



Impact of developed products

- The developed products are new of their kind.
- Changing food habits and life style attracts demand for ready to eat foods.
- Long shelf-life and availability throughout the year in convenience packages
- Prebiotic health benefits
- It will help to generate higher income for local farmers of the region by growing selected legumes, pulses and other ingredients used in Kangri Dham
- It will help in improving the quality of life
- The technology will generate employment opportunities for the local people

Value added crispy fruits

Himachal Pradesh is known as the fruit basket of the country by virtue of its agro-climatic conditions suitable for growing a variety of fruits. These fruits are either sold directly to the market or processed in the form of jam, jelly and squash. However, there is still a loss of 25%

of the total produce due to their post-harvest spoilage during storage. Thus, there is a need to develop technology for fruit preservation and value addition.

About the technology

CSIR-IHBT has developed technology to prepare crispy fruits with unique features as detailed below:

- Crispy fruits in addition to prolonged shelf-life also retain near original colour, texture, taste and aroma.
- Crispy fruits regain their original characteristics on reconstitution in water.
- Retain nutritional values of fresh fruits.

- Does not contain any added preservatives.
- Stable at room temperature for easy storage.
- Easy to transport due to 80% reduced weight on processing.

Benefits/Applications

Crispy fruits serve as health snacks and a good substitute to unhealthy snacks like potato chips and other fried products available in the market. It can be used as convenience foods, as ingredients for ice creams, smoothies, thick shakes, yogurts, desserts, flavouring infant foods, preparing food premixes and bakery products.

Societal applications

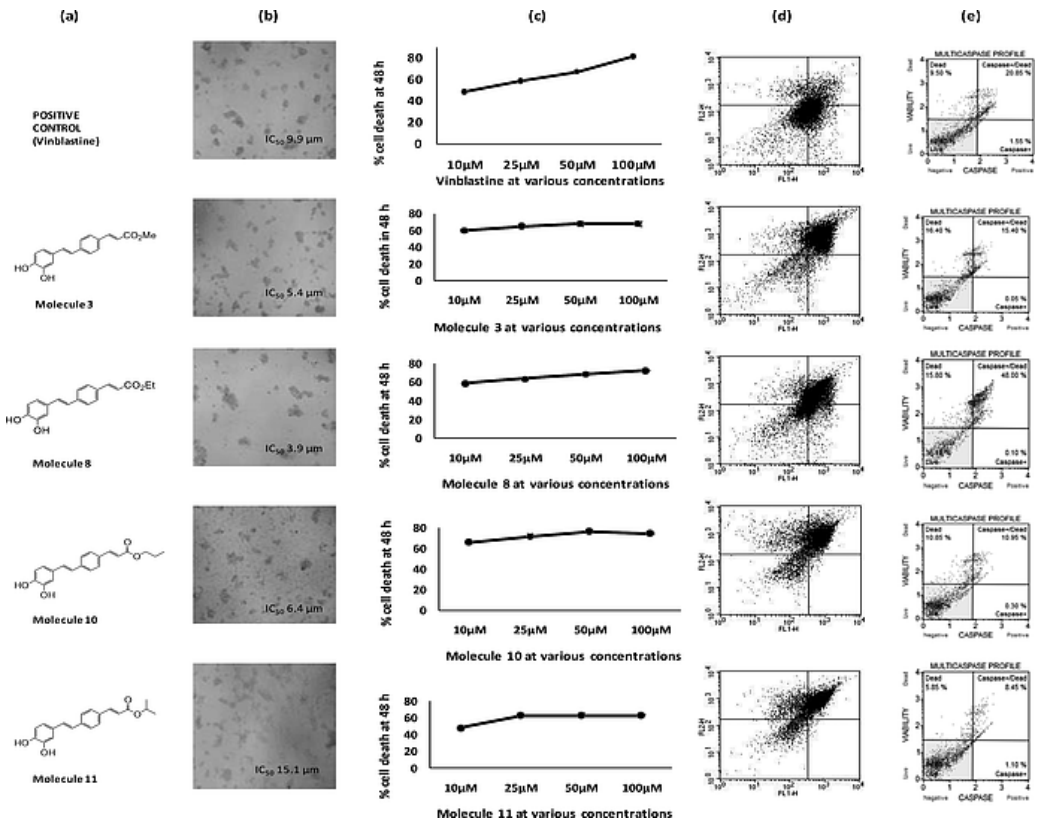
This technology will provide benefit to farmers and local growers for remunerative returns, particularly those engaged in growing apple, banana, apricot and mango. Also this technology can be easily applied to bulk preservation of onion, tomato and turmeric.

The institute is striving to apply this technology to generate higher income for the farmers in the north-eastern region where the farmers are forced to sell their produce at low prices to avoid spoilage of unsold large quantities of pineapple and other fruits.

COMBATING DISEASES

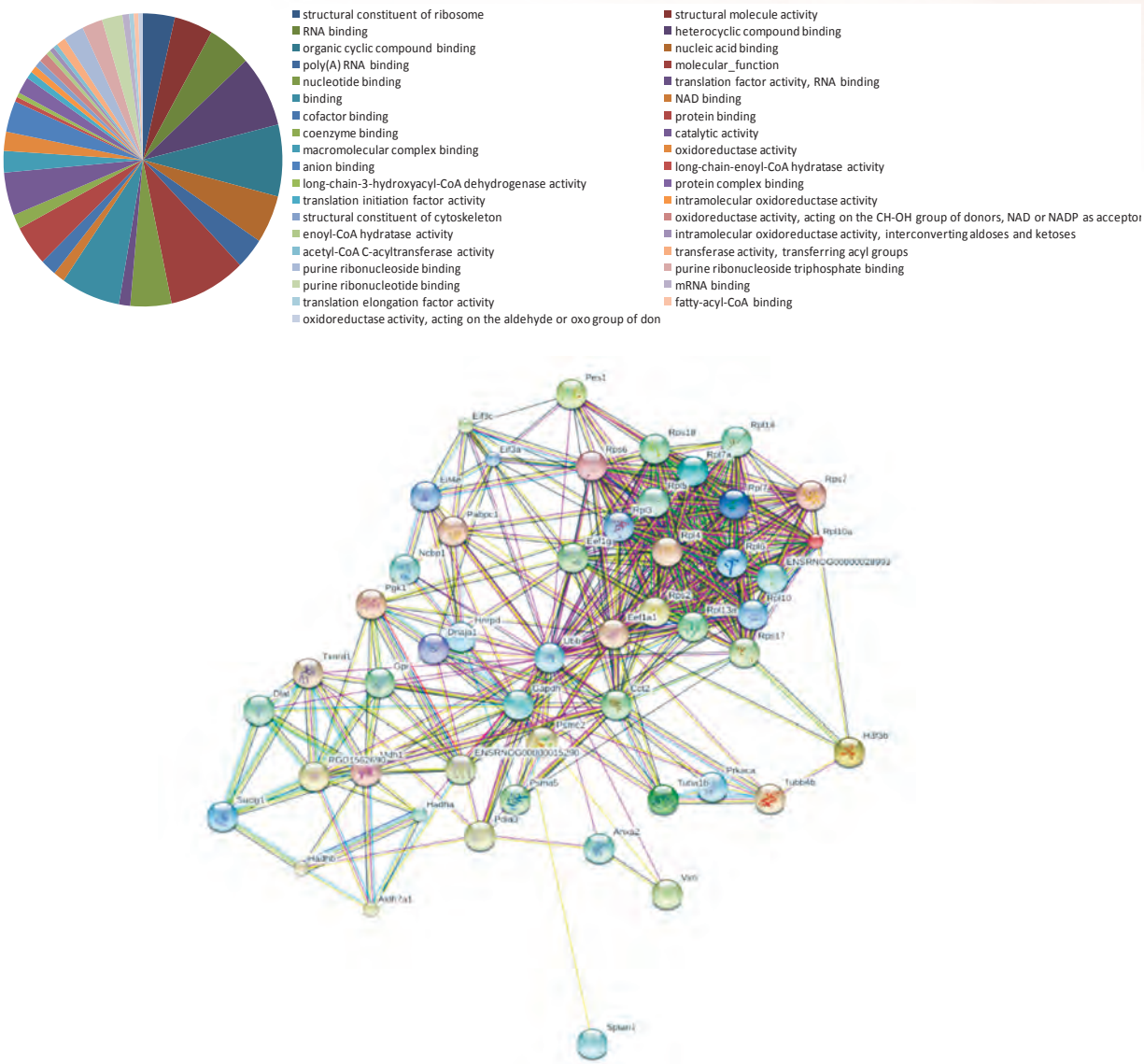
Natural product salvionolic acid f inspired hydroxylated styryl–cinnamate hybrids for the management of glioma

Gliomas are lethal and aggressive form of brain tumors with resistance to conventional radiation and cytotoxic chemotherapies; inviting continuous efforts for drug discovery and drug delivery. Interestingly, small molecule hybrids are pharmacophore that continue to capture interest owing to their pluripotent medicinal effects. Inspired from natural product salvianolic acid F protecting-group-free synthesis of hydroxylated styryl–cinnamate hybrids (C6–C2–C6–C3 unit) was achieved by a step-economical route involving sequential C–C double bond formation in one pot. Apart from an economical synthesis and product diversity, these hybrid molecules have a potential with the catechol core to selectively inhibit glioma cells. The intrinsic mode of action of the lead molecule, involving caspase 6 and the quinonemethide pathway, is also reported on the basis of ^{1}H NMR spectroscopy guided metabolomic profiling. The role of hybrid molecules, analogues of salvianolic acid F, in forcing glioma cells towards apoptosis by specifically perturbing the concentration of glutathione along with that of caspase 6 was demonstrated. Further in-depth proteomics profiling was explored based on specific cellular responses. iTRAQ-LC/MS-MS technique was used to deduce differentially expressed landscape of native & phospho-proteins in treated glioma cells. Based on this Protein-Protein Interactome (PPI) was looked into by employing computational tools and further validated *in vitro*.



Cytotoxicity profile and apoptotic potential of lead hybrid molecules

It was found that the styryl-cinnamate hybrid, an analogue of salvianolic acid f, alters key regulatory proteins involved in translation, cytoskeleton development, bioenergetics, DNA repair, angiogenesis and ubiquitination. Cell cycle analysis dictates arrest at G0/G1 stage along with reduced levels of cyclin D; involved in G1 progression. This study clearly adds to the intrinsic mode of action of lead molecule that creates DNA damage and metabolites mediated stress.

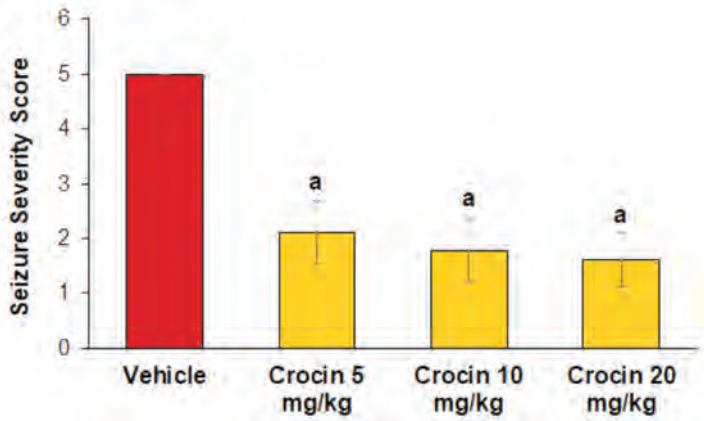


Interactome study and analysis at molecular level to the cellular responses against hybrid molecules

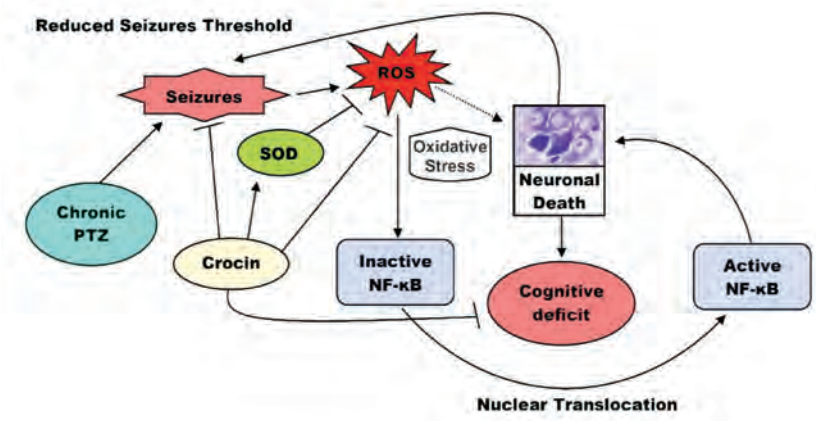
Role of *Crocus sativus* on kindling development and linked cognitive impairments

Crocin (a major carotenoid pigment of *Crocus sativus*) was studied in seizure development and its associated cognition deficits. Crocin at three different doses (5, 10 and 20 mg/kg *p.o.*) were daily administered to different groups of Swiss albino mice. All the animals were subjected to

pentylenetetrazol (PTZ) treatment at 48 ± 2 h intervals and seizures were recorded according to a seven-point severity scale. There was significant reduction in severity of PTZ-induced seizures in crocin treated groups in all the tested doses on day 29 i.e. following 15th PTZ injection. The treatment showed marked increase in discrimination ratio and preference index toward novel object in "novel object recognition test". Furthermore, spatial memory functions were also improved in crocin treated groups. The analysis of Nissl stained brain sections showed decreased neuronal damage as there was reduction in dark neurons in the hippocampal pyramidal layer of treated animals in comparison to control. Hippocampal biochemistry showed marked increase in superoxide dismutase activity and decrease in reactive oxygen species (ROS) in the tissue homogenates of the crocin treated animals. Protein expression studies showed attenuation in the levels of nuclear factor-κB (NF-κB) and phosphorylated NF-κB in the hippocampus of treated animal as compared to control group. The results revealed that crocin might have increased seizure threshold thereby inhibiting PTZ-induced kindling development and improved cognitive functions. It was correlated that the observed protective effects were due to decrease in seizure mediated ROS production and its associated NF-κB pathway-induced neuronal damage.



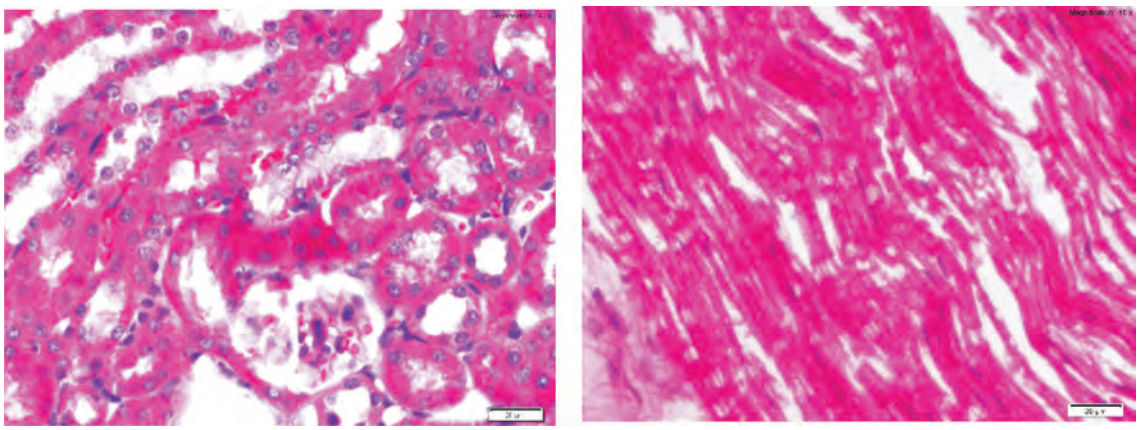
Effect of crocin on seizure severity score following 15th PTZ injection. $^{a}P < 0.05$ as compared to vehicle control



Proposed mechanism of crocin in suppression of kindling development and attenuation of linked cognition deficits. NF-κB: Nuclear factor-Kb; PTZ: Pentylenetetrazol; ROS: Reactive oxygen species; and SOD: Superoxide dismutase

Picrorhiza kurroa for protection from renal damage and peripheral neuropathy

Treatment with iridoid glycoside (IGs) fraction from *P. kurroa* decreased the hyperalgesic responses toward acetone and heat in cyclophosphamide (CP) induced toxicity. Histopathology of sciatic nerve showed reduced intramyelin odema, cytoplasmic vacuolization and axonal degeneration after IGs treatment. IGs also improved serum biochemical markers for renal injury in mice. In kidneys tubular swelling, granular degeneration and glomerular damage were prevented. The levels of inflammatory cytokines like IL-1β, TNFα and NF-*k*B were also improved by IGs in renal tissue. Anti-apoptotic effect of IGs was also evaluated by Bax/Bcl-2 expressions and caspase 3/9 activity in renal tissues. Overall it was concluded that IGs prevented the CP induced renal damage and peripheral neuropathy via anti-inflammatory and anti-apoptotic pathways.

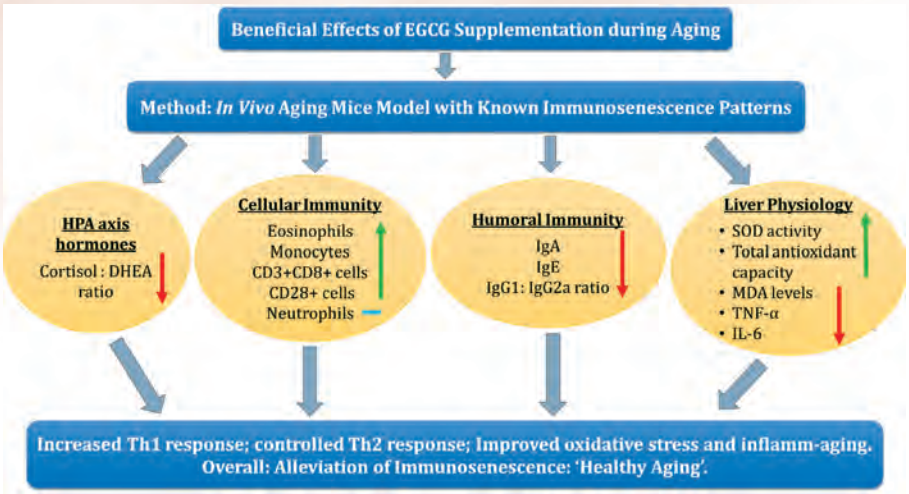


(A) **(B)**

(A) Showing damaged kidney and (B) sciatic nerve

Analysis of Kangra tea catechins for anti-immunosenescence attributes

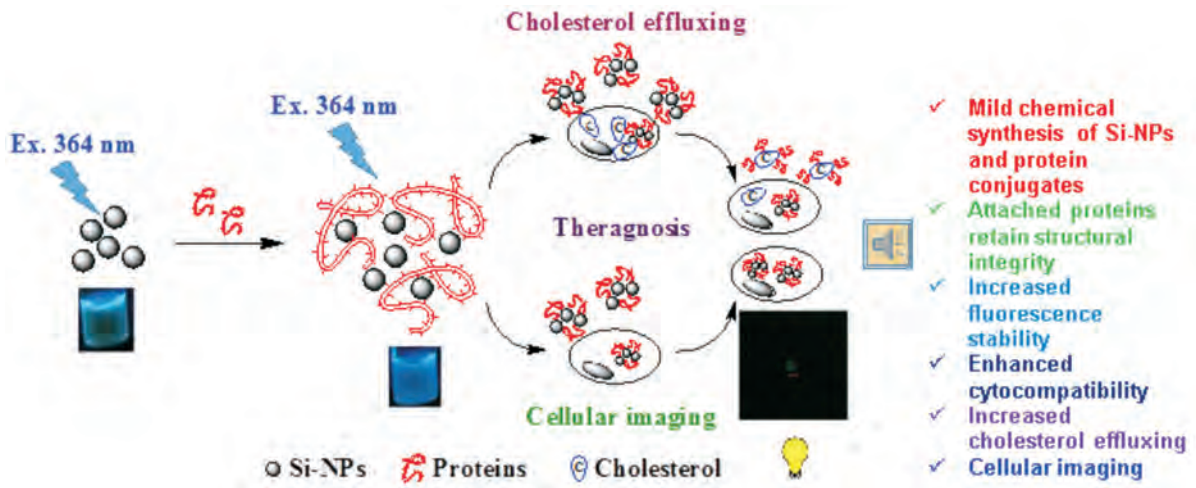
The immune rejuvenating potential of Kangra tea epigallocatechin gallate (EGCG) was assessed using an aging murine model. EGCG was found to exert immunomodulatory effects by directly enhancing the circulatory number of eosinophils and monocytes in aging animals as compared to control group**.** T cell population analysis by imaging flow cytometry revealed that EGCG supplementation increased $CD3^+CD8^+$ fractions in splenocytes, while no changes in $CD3^+CD4^+$ cells could be observed. Immunoglobulin levels in intestinal fluid showed a dramatic decrease in secretory IgE and IgG1 levels. Enhanced DHEA levels in plasma were observed which could further enhance Th1 immune functions**.** In liver, EGCG administration increased SOD enzyme activity and total antioxidant capacity while inflammation decreased. Green tea was found to have a strong beneficial effect on the health of the elderly and also support the rationale of drug development from bioactive phytochemicals.



Anti-immunosenescence effects of EGCG

Functional nanomaterials (FNM) as cellular imaging probe for bio-medical applications

Fluorescent silicon NPs (Si-NPs) and 3-mercaptopropionic acid coated CdS NPs (MPA-NPs) were prepared and conjugated with BSA and HSA. Spectroscopic and gel electrophoresis studies confirmed the conjugation of proteins to NPs. Even after chemical modifications, the functional activity of the conjugated proteins was retained. The sizes of Si-NPs were ~8.7 ± 2 nm. The NPs were found to be highly biocompatible in *in vitro* studies. In HCAEC and HUVEC, cell lines the HSA-conjugated NPs showed better cholesterol effluxing and superior penetration ability towards the treated cells. Confocal microscopy confirmed the intracellular presence of Si-NPs. The Si-NPs can serve as potential theragnosis probe for future biomedical applications.



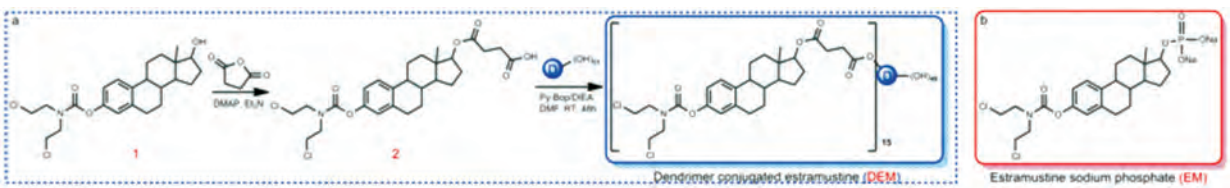
Schematic representation of the role of protein conjugated Si-NPs as theragnosis probe

Nanobiocomposites (NCs) for wound healing

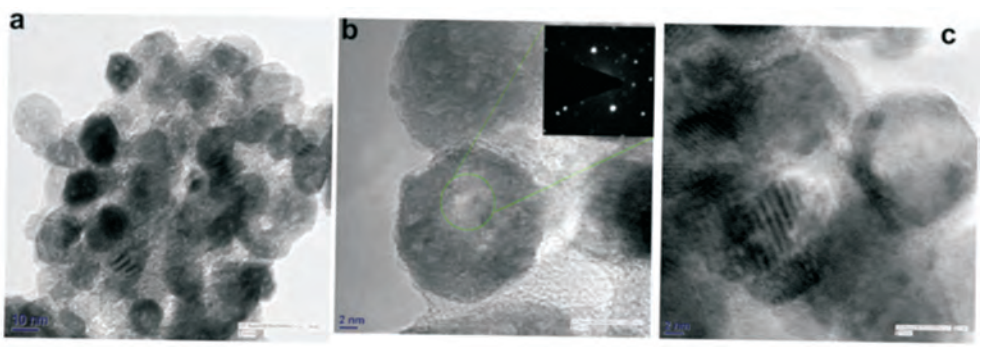
Biomaterial nanobiocomposites (NCs) containing plant Cellulose nano crystals (CNCs) functionalized with green AgNPs were developed in ointment and film form and their wound healing potential in mice was studied. Plant CNCs were found suitable as an alternate to bacterial cellulose for developing wound dressings for rapid skin repair. Briefly, NCs were found to significantly enhance *in vivo* skin tissue repair by decreasing production of inflammatory cytokines and increasing fibroblast proliferation, angiogenesis, and finally tissue neo-epithelization and regeneration in less than 14 days by favouring collagen deposition.

Development of polymer drug conjugated nanomaterials for enhanced anticancer activity

Polymer-drug conjugated nano-devices of lipophilic drug candidates was developed against cancer to enhance the circulation time, bioavailability and sustained release capacity. Oral formulation of nanometer sized dendrimer-estramustine, an anticancer drug (DEM) conjugate with low toxicity but effective antitumor activity was developed and compared with the commercially available estramustine phosphate (EMP). The nano-crystalline 'DenDot' of DEM on HR-TEM image provided a direct proof of the polymer drug conjugated nanomaterials. A comparative anti-papilloma study was also performed with EMP and dendrimer conjugate (DEM) using a skin carcinogenesis model. Results indicated higher efficacy of DEM in inhibiting skin tumor formation as compared to EMP. Histopathology and immunohistochemistry studies further indicated increased cell apoptosis and reduced epithelial hyperplasia, cell proliferation and inflammation in skin tissues of mice after DEM treatment. The synthetic DEM conjugate also inhibited skin tumour progression more effectively than EM.



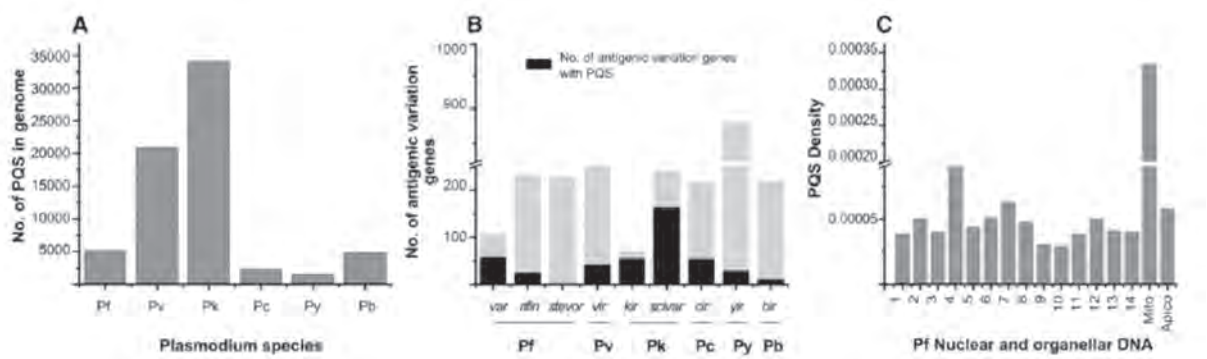
Synthesis of dendrimer-estramustine conjugate



HR-TEM image of polymer-drug conjugate

Study of genome wide G-quadruplex analysis in *Plasmodium* genome for combating malaria

The AT-rich genome of *P. falciparum* has uniquely localized G-rich stretches that have propensity to form G-quadruplexes. However, their global occurrence and potential biological roles in the parasite are poorly explored. Genome-wide analysis revealed unique enrichment of quadruplexes in *P. falciparum* genome which was remarkably different from other *Plasmodium* species. A distinct predominance of quadruplexes was observed in nuclear and organellar genes that participate in antigenic variation, pathogenesis, DNA/RNA regulation, metabolic and protein quality control processes. Data also suggested association of quadruplexes with SNPs and DNA methylation. Furthermore, analysis of steady state mRNA (RNA-seq) and polysome-associated mRNA (ribosome profiling) data revealed stage-specific differences in translational efficiency of quadruplex harboring genes. The findings hinted towards existence of regulatory dynamics associated with quadruplexes that may modulate translational efficiency of quadruplex harboring genes to provide survival advantage to the parasite against host immune response and antimalarial drug pressure.



Genomic localization of PQS. (A). Potential quadruplex forming sequences (PQS) in various *Plasmodium* species (Pf: *P. falciparum,* Pv: *P. vivax,* Pk: *P. knowlesi,* Pc: *P. chaubadi,* Py: *P. yoelii,* Pb: *P. berghei*). (B) PQS enrichment in multigene families involved in antigenic variation in different *Plasmodium* species. (C) PQS occurrence in nuclear and organellar (mitochondria and apicoplast) genomes of *P. faciparum*

LABORATORY ANIMAL FACILITY

Management of laboratory animal house facility is an important aspect of regulatory research for providing thoroughbred laboratory animals for carrying out preclinical trials in order to take a novel compound/formulation to the market. A new breeding colonies from CSIR-CCMB were introduced to support research activities at the Institute. Permission for breeding and trading of laboratory animals was granted by CPCSEA, New Delhi, which enabled the supply of different strains of animals to nearby institutes to cater to their research needs. During this year mice were provided to Dr. G. C. Negi College of Veterinary and Animal Sciences, CSKHPKV, Palampur and Rats to Khalsa College of Pharmacy, Amritsar. All breeding colonies are now maintained in individual ventilated cage (IVC) facility. The

primary focus is to house all breeding as well as experimental stock in the IVC system in order to provide them uniform environment as per the national and international guidelines.

Showing IVC cage system in the animal house

RRC **is** involved the safety /toxicity and efficacy evaluation of natural drug molecules, therapeutic enzymes, nutraceuticals and nanomaterials. The preclinical toxicity studies are conducted as per standard International guidelines.

For better ethical practice and to comply with the 3 R's principle to reduce the number of laboratory animals in testing, zebrafish facility was established in the RRC for screening of a large number of compounds. As per the directions of CPCSEA, New Delhi the "Guidelines for the Care and Use of Zebrafish in Biomedical Research" were formulated in accordance with international guidelines and were duly approved by IAEC.

PROCESS AND PRODUCT DEVELOPMENT

Mechanization in tea farm operations

A study was conducted to understand the impact of mechanization on the production and quality of tea. A trial was laid out in China hybrid tea at Tea Experimental Farm, Banuri to assess the four plucking methods *viz*., one man plucking machine, two men plucking machine, hand shear and hand plucking. Hand plucking method was considered as control for the study. The impact on the tea leaf yield was recorded. Results showed that green tea leaf yield was significantly increased in two men harvesting machine as compared to other methods (Fig. 1). Mechanized shear harvester enhanced the working capacity of individual labourer and could be used for selective plucking.

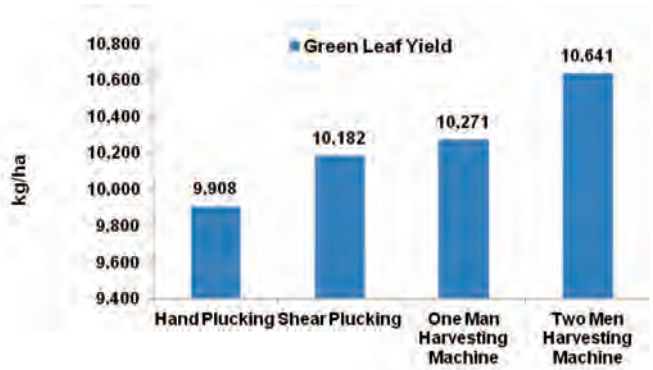


Fig. 1 Effect of methods of plucking on green leaf yield

Samples of tea leaves were also drawn from leaf plucked in respective plots for evaluation of quality parameters. Green tea and orthodox black tea were made in the Tea Processing Unit of CSIR-IHBT, Palampur. Total polyphenols, catechins and flavonoids were quantified by spectrophotometric method. Aroma compounds were also extracted and identified. Extraction of aroma compounds were done by simultaneous distillation extraction (SDE) method and identification of compounds was done using mass spectral libraries. Results showed sharp decline in the total polyphenolic content in the one man and two men plucking methods. A noticeable drop in the total catechin content in one man and two men plucking methods with respect to hand plucking was also observed. Similar trend was observed for the total flavonoid content. Thus, a decline in the shear plucking, one man and two men plucking methods as compared to hand plucking was recorded (Fig. 2).

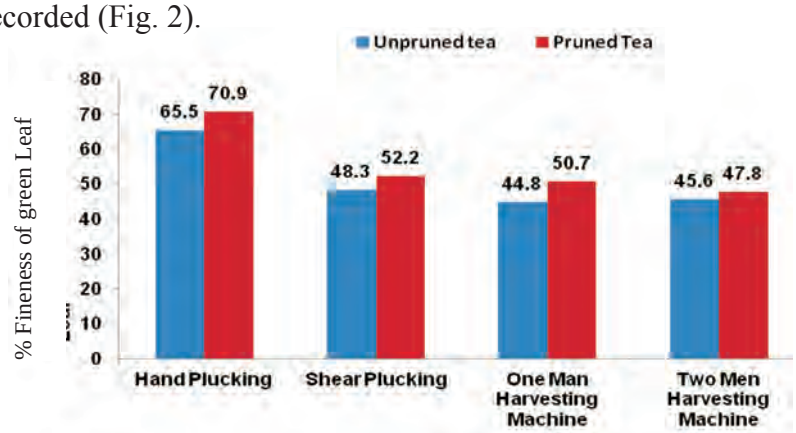


Fig. 2 Effect of methods of plucking on leaf grade (fineness of leaf)

The data for aroma compounds in orthodox black tea and green tea showed a sharp decline of linalool in one man and two men plucking methods. Geraniol was found in very less quantity in orthodox black tea and was not detected in green tea. Methyl salicylate did not show any major difference in the treatments with exception to two men plucking method in orthodox black tea and green tea. Except for some compounds, no major differences were observed in hand plucking and shear plucking methods.

One man and two men skiffing machines were used to assess the operational efficiency. One man handle held circular disc cutter (model Ochiai) was also used for different depths of pruning. These machines were found to cover larger area but reduced the time required for the operation. A comparative study on the working efficiency of automatic spray pump (Model ASPEE 20 BEPK) over manual pump (Model ASPEE Napsak) for spraying agrochemicals was also carried out. Automatic spray pump was found to cover more area and proved to be a time saver (Fig. 3).

(A) Hand plucking

(B) Shear plucking

(C) One man harvesting machine

(D) Two men harvesting machine

(E) One man skiffing machine (STHIL HS81R)

(F) Two Men skiffing machine (Ochiai R-8GA1 1200)

(G) Manual sprayer (ASPEE Napsak)

(H) Power sprayer (ASPEE 20 BEPK)

Fig. 3 Methods of plucking leaves

Process improvement and scale up of tea catechins production from green tea shoots:

Process improvement and scale up studies were standardized & validated on pilot scale. The process was scaled up to 100 kg/batch green tea leaf processing (Fig. 4). A project proposal titled "Development, adoption of green technology for commercial production of tea catechins and formulation (Funded by DBT- BIRAC Govt. of India)" was sanctioned to M/s Baijnath Pharmaceutical Pvt. Ltd., Paprola in collaboration with CSIR-IHBT Palampur (Fig. 4).

An improved low cost green tea leaf shoot sorter was also partially installed in the Banuri tea garden of the institute for full scale commission and testing.

Fig. 4 Standardization and validation at 100 kg per batch green tea processing at M/s Baijnath Pharmaceuticals Pvt. Ltd., Paprola factory premises

Preparation of ready to serve instant teas

A new process technology was developed for the preparation of natural and refreshing instant teas in the form of liquid as well as granules. These can be used in the preparation of hot beverage as well as ice teas (Table 1, Figs. 5 & 6).

Table 1 Quality profile of instant teas developed at the Institute

Compound	Amount (µg/ml)
GC	22.60
EGC	141.04
CAT	4.40
CAF	164.60
EC	42.10
EGCG	254.00
ECG	64.20
CG	0.71

Fig. 5 Made Tea

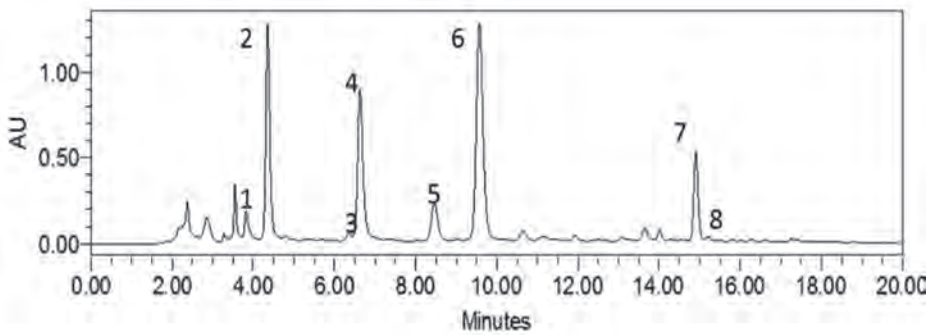


Fig. 6 HPLC profile of instant tea showing major tea constituents

Preparation of wine from SDZ Cha Sarl Mozambique tea

An MoU was signed with SDZ Cha Sarl, Mozambique for transfer of tea wines production technology. Before processing of tea wines, the quality of the Mozambique teas were tested and compared with CSIR-IHBT teas **(**Fig. 7**)**. Based on the comparative qualitative studies, (Table 2), a process was optimized for wine preparation from these teas.

Table 2 Comparative quality data of wines made from Kangra tea grown at CSIR-IHBT and Mozambique tea

Wine	*TEAC mg/ml	**GAEP mg/ml	Brix	Alcohol
Mozambique tea wine	6.0	0.8	5	10.0%
CSIR-IHBT tea wine	8.8	1.3	6	10.9%
*TEAC=Trolox equivalent antioxidant capacity; ** GAEP= Gallic acid equivalent phenolics				

Fig. 7 Infusions of teas from SDZ Cha Sarl and CSIR-IHBT

Portable type biochar unit

Portable type biochar unit was designed and fabricated for conversion of fairly small quantity of charcoal.

Production of charcoal

In continuation to previous work, charcoal was produced from different bamboo species. Bio char was produced from pine cone, pine needle, congress weed (*Parthenium hysterophorus*) and camphor wood (kapoor). Pine needle took 125-150 % more time in conversion into bio char and its charcoal recovery was 18-22%. Other biomass showed 25-30% recovery.

Design of pilot scale process equipments and process scale up for natural products from medicinal and aromatic plants

Work on development of processes and scale-up of laboratory processes on pilot plant was continued in the current year. In this regard, extraction processes on steviol glycosides from *S. rebaudiana*, tea catechins from green tea shoots, rose oil from damask rose and other important aromatic crops were developed. The pilot plant is equipped with a wide range of equipments and lab scale facilities for carrying out research and development for processing of medicinal and aromatic plants.

Software system to identify wrong de novo genome assembly

With the advent of short-reads-based genome sequencing approaches, large number of organisms are being sequenced all over the world. Most of these assemblies are done using some de novo short read assemblers and other related approaches. However, the contigs produced this way are prone to wrong assembly. So far, there is a conspicuous dearth of reliable tools to identify mis-assembled contigs. Mis-assemblies can result from incorrectly deleted or wrongly arranged genomic sequences. In the present work, various factors related to sequence, sequencing and assembling were assessed for their role in causing mis-assembly by using different genome sequencing data. Finally, some mis-assembly detecting tools were evaluated for their ability to

detect the wrongly assembled primary contigs, The present work, proposes a simple unsupervised learning-based novel approach to identify mis-assemblies in the contigs which were performing reasonably well when compared to the already existing tools. The proposed methodology may work as a complementary system to the existing tools for enhanced accuracy **(**Fig. 8**)**.

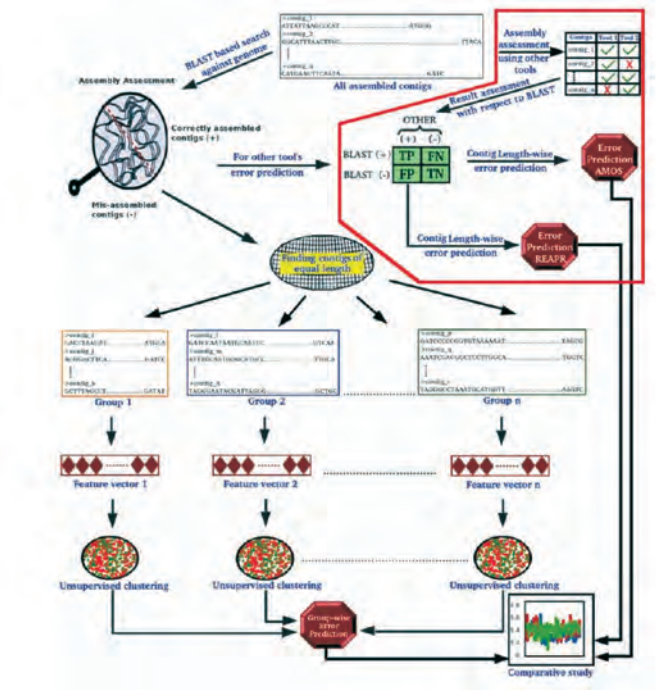


Fig. 8 Schematic representation of lengthwise selection and error fraction calculation

HIGH VALUE FLORICULTURE CROPS

GERBERA

Selection and evaluation of potential gerbera genotypes

New hybrid F_1 genotypes of gerbera were developed through controlled crossing program. Selected genotypes are under evaluation and will be utilized for the establishment of *in vitro* gerbera cultures. Selections were based on double flower shapes and new flower colors.

Table 1 Details of floral features of new gerbera F_1 selections

S. No.	Plant No.	Flower colour	Peduncle length (cm)	Flower diameter (cm)	Flower shape	Disc colour	Flower type
1.	IHBT-Gr-17-1	Bright red	46.0	10.3	Semi-double	Green	Standard
2.	IHBT-Gr-17-2	Yellow orange	39.0	10.1	Semi-double	Green	Standard
3.	IHBT-Gr-17-3	Light red	48.6	11.7	Double	Green	Standard
4.	IHBT-Gr-17-4	Red purple	42.6	10.2	Double	Green	Standard

Fig. 1 Potential gerbera genotypes under field conditions (left to right: IHBT-Gr-17-1, IHBT-Gr-17-2, IHBT-Gr-17-3 and IHBT-Gr-17-4)

CALLA LILY

Selection and evaluation of potential calla lily genotypes

Zantedeschia aethiopica (white calla lily) hybridization programme was undertaken using diverse parental genotypes selected on the basis of morphological traits. The F1 population obtained was screened for variability and 17 selections were made from F1 hybrid population for desirable floral traits and other morphological characteristics. The selected genotypes were multiplied and grown under open field conditions for evaluation (Fig. 2).

The evaluation of selections was done for first year with respect to flower production and agronomic parameters (Table 2).

Fig. 2 Flower and field view of *Z. aethiopica*

Table 2 Morphological features of *Z. aethiopica* selections under field evaluation trial (1st year)

Morphological traits	Field condition data (1st year)	
	Mean	Range
Plant height (cm)	40.17	32.05 - 50.72
Stalk length (cm)	42.98	34.15 - 43.75
Stalk diameter (mm)	10.35	8.50 - 9.73
Total no. of leaves	8.62	10.17 - 6.75
Leaf length (cm)	17.74	18.63 - 19.65
Leaf width (cm)	11.71	11.33 - 11.93
Petiole length (cm)	22.07	20.25 - 21.72
No. of shoots	4.16	3.33 - 2.67
No. of flowers/plant	2.41	1.92 - 2.64
Spathe length (cm)	12.32	13.85 - 14.56
Spathe width (cm)	8.12	8.29 - 9.46
Spadix length (cm)	6.43	5.44 - 7.85

New cultivars released

Two new cultivars 'Him Sumukh' and 'Him Shweta' of calla lily and five new cultivars 'Him Saumya, Him Gaurav, Him Aabha, Him Apoorva and Him Keerti' of *Gerbera jamesonii* were released by Hon'ble Prime Minister of India and President of CSIR Sh. Narendra Modi on CSIR foundation day 26 September, 2016 (Fig. 3).

Fig. 3 Prime minister releases calla lily cv. 'Him Sumukh'

Brief outline of calla lily cultivars

The cultivar 'Him Sumukh' (CSIR-IHBT-CL-Y-1) of *Zantedeschia elliottiana* and cultivar 'Him Shweta' (CSIR-IHBT-CL-W-1) of *Z. aethiopica* were developed by CSIR-IHBT through hybridization and selection (Fig. 4). The parental genotypes were crossed and variations in calla lilies were obtained in the progenies which were morphologically characterized for floral traits. The selection was made for its unique flower shape and attractive bright colours. These selections were evaluated for two years with respect to flower production potential and other agronomic attributes.

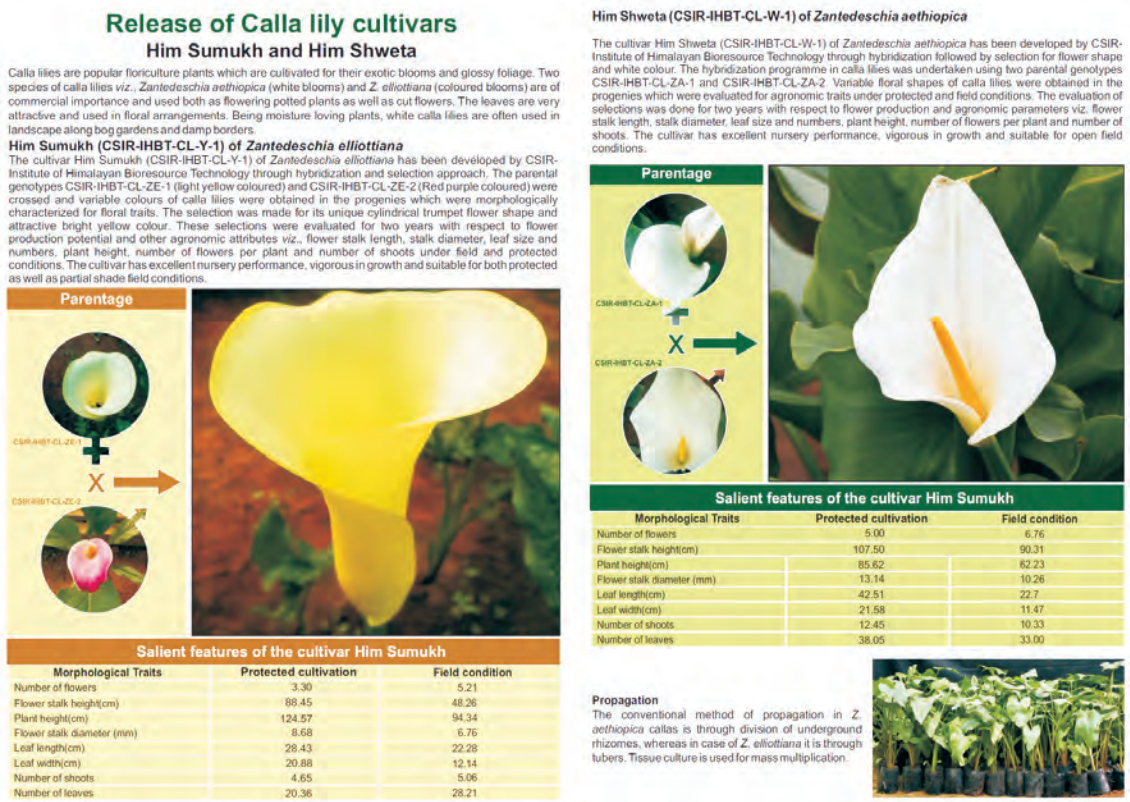


Fig. 4 Release of new cultivars 'Him Sumukh' and 'Him Shweta' of calla lily

Brief outline of gerbera cultivars

The cultivars Him Saumya (CSIR-IHBT-Gr-11-6), Him Gaurav (CSIR-IHBT-Gr-13-1), Him Aabha (CSIR-IHBT-Gr-24-6), Him Apoorva (CSIR-IHBT-Gr-29-1) and Him Keerti (CSIR-IHBT-Gr-Y-1) of *Gerbera jamesonii* were developed by CSIR-IHBT through hybridization and selection programme (Fig. 5). Using characterized parental lines, a controlled hybridization programme was carried out followed by selection of promising hybrid genotypes which were superior to the parents for morphological and floral attributes. The criteria for selections were unique flower shapes and bright colors. These selections were evaluated for agronomic performance for two years under protected cultivation. The cultivars having good tissue culture response, nursery performance, vigorous growth and suitable for protected cultivation were finally selected.

Fig. 5 Release of new cultivars 'Him Saumya, Him Gaurav, Him Aabha, Him Apoorva and Him Keerti' of *Gerbera jamesonii*

LILIUM

Comparative studies on lilium growth and flowering in hydroponics and open field

Asiatic lilium variety, Novcento were grown in hydroponics and open field conditions (Fig. 6). Hydroponics grown lilies recorded maximum plant height, number of leaves and leaf length as compared to open field (Table 3). Date of flowering reduced in hydroponically grown lilies (55.20 days) as compared to flowering in open field (83.60 days).

Table 3 Morphological parameters of lilium var. Novcento in hydroponic and open field

Parameters	Hydroponics system	Open field conditions
Plant height	62.94 cm	30.51 cm
Number of leaves	45.08	35.7
Leaf length	9.51 cm	9.33 cm
Date of flowering	55.20 days	83.60 days

Fig. 6 Lilium cv. 'Novcento' in Hydroponic system

Evaluation of lilium cultivars 'Ercalono' and 'Pavia' under protected cultivation

Lilium varieties Ercalano and Pavia were grown under protected conditions. Growth parameters (Fig. 7) *viz.*, plant height (83.18 cm), number of leaves (65.00) and leaf length (15.29 cm) were maximum in Ercalano as compared to Pavia. Ercalano took lesser time for flowering (74 days) as compared to Pavia (90 days). Number of buds/plant was more in Pavia (4.2) as compared to Ercalano (3.8). However, flower diameter of Ercalano (18.43 cm) was more than Pavia (17.3 cm) (Fig. 8).

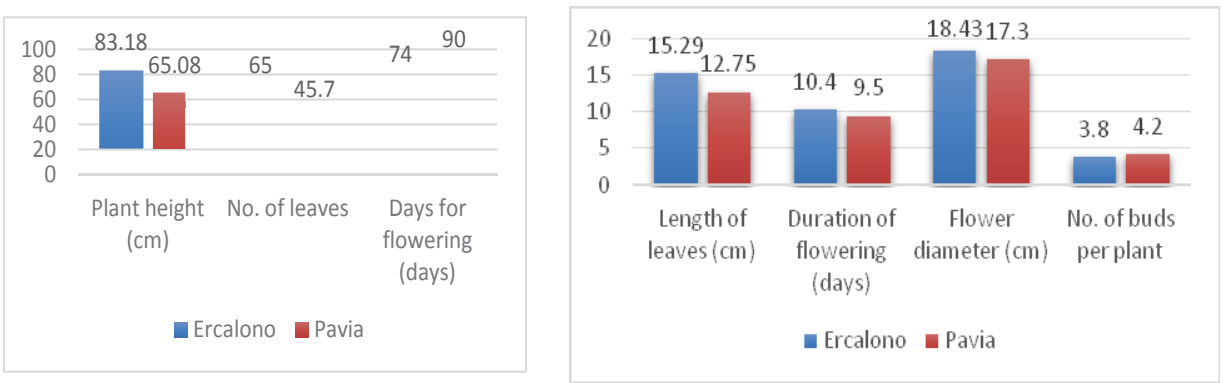


Fig. 7 Evaluation of lilium cvs. 'Ercalano' and 'Pavia' in protected conditions

Fig. 8 Evaluation of Lilium cv. 'Ercalano' in polyhouse

MARIGOLD

Evaluation of potential marigold selection-1

Out of 99 breeding lines of marigold developed through hybridization and selection approach, 10 breeding lines were selected and evaluated for morpho-agronomic traits for two years. Among

them one selection was identified as selection-1 with desirable morphological and floral traits and tested in the institute's floriculture farm and farmer's field (Fig. 9).

Fig. 9 Marigold selection-1

Table 4 Morphological characteristics of marigold selection-1

S. No.	Morphological parameters	Mean	Range	
			Minimum	Maximum
1	Plant height (cm)	50.50	36	69
2	Leaf length (cm)	9.35	6	15.5
3	Leaf width (cm)	6.46	3	10
4	Flower head diameter (cm)	10.08	6	12.5
5	Outer ligulate floretlength (cm)	4.46	2.2	6
6	Outer ligulate floret width (cm)	1.74	1.2	2.3
7	No. of flowers/plant	27.88	14	48
8	Stem thickness (mm)	9.96	8.15	12.45
9	No. of leaflets	11.80	11	13
10	Leaflet length (cm)	4.49	2.8	6.4
11	Leaflet width (cm)	1.09	0.6	1.7
12	Flower weight (g)	21.71	9.51	49.72
13	No. of petals	410.55	251	703

CHRYSANTHEMUM

Selection and evaluation of potential chrysanthemum genotypes

Under chrysanthemum improvement programme, hybridization was done among the selected diverse parental groups to generate novel variations for flower colour, shape and size. The F1 hybrid seeds were sown and hybrid populations were raised. Selection was performed among

the hybrid populations for flower colour, shape and size. The selected genotypes were further multiplied and evaluated under polyhouse conditions (Fig. 10).

Yellow Puma x Shyamal (19) **Yellow Puma x Shyamal (27)**

Fig. 10 Selected chrysanthemum F1 hybrids for further multiplication and evaluation

TULIPS

Introduction of tulips in high altitudes of Himachal Pradesh

Tulips are third most traded flower in the world. In India, the tulip bulbs are imported from other countries. There are limited locations in the country where commercial cultivation of tulips is in practice. As a result of CSIR-IHBT interventions in Lahaul valley, lilium emerged as a new off season cash crop for the farmers. In the year 2016-17, institute introduced tulip crop in the region for the first time and three trails were carried out at farmer's fields i.e. Udaipur, Shansha and Jagla (Fig. 11).

Fig. 11 Performance of tulips at Udaipur, Shansha and Jagla locations of Lahaul, H.P.

ORCHIDS

Development of agro-technologies for orchids

In 2016, three accessions of cymbidium orchids (CM01, CM04 and CM07) were collected from Uttarakhand and planted in coco peat under shade net conditions. Morphological parameters of nine hybrids of cymbidium (Pink Clash Moon Venus, Winter Beach Sea Green, Eushi Kam,

Sleeping Nymph, Soul Hunt 6, CM12, CM03, CM02, and CM06) along with other orchid species (*Arundina graminfolia*, *Zygopatalum lutermilium*, *Cattleya* sp., *Paphiopedilum* sp. and *Dendrobium aphyllum*) were recorded.

Fig. 12 Field and flower view of *Cymbidium*

Table 5 Morphological characteristics of *Cymbidium*

S. No.	Morphological parameters	Mean
1	Length of spike (cm)	71.80
2	Leaf length (cm)	99.92
3	Leaf width (cm)	2.64
4	Number of spikes per pot	2.00
5	Number of leaves per pot	70.80
6	Number of florets per spike	11.20

RURAL DEVELOPMENT

During the year the various activities were pursued in the western Himalayan region and other places under CSIR Rural Development programme, CSIR-800:

1. TRANSFER OF AGRO-TECHNIQUES AND POST-HARVEST MANAGEMENT TECHNOLOGY OF COMMERCIALLY IMPORTANT CUT FLOWER CROPS

Promotion of cut flower crops through agro-technologies and post-harvest management

Floriculture is emerging as an important component of agri-business that sustains livelihood options of growers/ entrepreneurs. The institute has been involved in establishing and promoting floriculture industry in the hilly regions of the country. The flower crops produced in the hill regions during natural season are generally off-season for the plains of India. Therefore, farmers get good returns for their flower produce. During the year 2016-17, eight training programmes on commercial cultivation of flower crops were organized and fifteen demonstration units were established at farmers' field. It resulted in 20.46 acres of area expansion under floricultural crops in H.P. and neighboring states. This benefited 120 farmers.

Socio-economic impact of lilium agro-technologies

Lilium plantation was spread in 5.8 hectares (14.5 lakhs lilium plants). The net return with lilium cultivation was 5 to 6.67 times higher than that obtained from the traditional crops *viz*. pea and potato, respectively. Consequently, 40-50% of acreage under these crops was diversified to lilium cultivation.

Lilium cultivation at Shansha and Madgran, Udaipur, Lahaul & Spiti

Demonstration plots

Fifteen demonstrations plots of tulips, marigold, calla lily and bird of paradise were set up in the farmers field during 2016-17 at Udaipur, Shansha and Jagla villages (Lahaul & Spiti), Palampur, Jwalamukhi, Baijnath, Sakri, Dharamshala, Rajpur, Sloh, Jia and Baijnath (Kangra), Jogindernagar (Mandi), Bharmaur (Chamba) and Theog (Shimla).

Demonstration plots of tulip at Udaipur and Jagla, Lahaul & Spiti

Demonstration plot of Calla lily cv. 'Him Shweta' at village Jia, Distt. Kangra

Demonstration plot of marigold selection-1 at Jwalamukhi, Distt. Kangra

Planting of carnation at farmers field at Kural, Distt. Kangra


Advisory visits to farmers field for carnation cultivation at Mandi

Demonstration plots were also laid out at CSIR-IHBT for generating awareness about cultivation practices of floriculture crops among farmers and visitors

Demonstration plot of marigold at CSIR-IHBT

Demonstration plot of lilium, CSIR-IHBT

Raising of chrysanthemum cuttings in propagation chamber floriculture farm, CSIR-IHBT

Raising marigold seedlings in nursery at CSIR-IHBT

Multiplication and distribution of planting material

Planting material of flower crops *viz.*, marigold, tulip, calla lily, agapanthus, chrysanthemum, lilium, carnations, gerbera, alstroemeria and bird of paradise were multiplied and distributed to the growers. Jars of gerbera cultivars, 'Him Saumya', 'Him Gaurav', 'Him Aabha', 'Him Apoorva', 'Him Keerti', 'Him Glow' and 'Him Peace' of *Gerbera jamesonii* were supplied to M/s Sashanka Agro Tech Pvt. Ltd, Ranchi, Jharkhand for mass multiplication under material transfer agreement.

Multiplication of Bird of Paradise

Multiplication of Calla lily cv. Him Shweta

Extension of area for cultivation of commercial floriculture crops in H.P.

Crop	Area of Distribution	No. of farmers	Area covered (acres)
Lilium	Kangra	2	0.07
Chrysanthemum	Kangra, Mandi	1	0.29
Marigold	Palampur, Jwalamukhi, Baijnath Dharamshala, Chamba, Sakri, Kangra, Rajpur, Sloh and Droh	60	14.52
Alstroemeria	Shimla, Chamba	2	0.15
Agapanthus	Kullu, Kangra	15	2.26
Bird of Paradise	Kangra, Kullu	10	0.39
Carnation	Chamba, Kangra	4	2.25
Tulips	Madgram, Shansha, Jagla (Lahaul & Spiti)	3	0.12
Gerbera	Kangra, Ranchi	8	0.20
Calla lily	Jia, Baijnath (Kangra), Joginder Nagar, (Mandi), Bharmaur, (Chamba), Shimla	03	0.21
Total		**105**	**20.46**

Planting materials of floriculture crops distributed to farmers

Crop	Form of planting materials	Qty./ No. distributed	Location of supply
Lilium	Bulbs	1474	Kangra
Chrysanthemum	Cuttings	1010	Kangra, Mandi
Marigold	Seedlings	141486	Kangra, Una, Jammu
Alstroemeria	Plants	209	Shimla, Chamba
Agapanthus	Plants	2380	Kullu, Kangra
Bird of Paradise	Plants	614	Kangra, Kullu
Carnation	Cuttings	2000	Chamba, Kangra
Tulips	Bulbs	5000	Lahaul & Spiti
Gerbera	Plants	346	Kangra, Ranchi
Calla lily	Plants	3500	Kangra, Shimla
Tuberose	Bulbs	1000	Kangra

Training programmes organized

Demonstration-cum-training programmes	Date	Coordinator/ Team	No. of growers
Commercial cultivation of lilium and tulips at Jagla village, distt. Lahaul & Spiti (H.P.)	30.06.2016	Bhavya Bhargava/ Ashok Singh	55
Commercial cultivation of lilium and tulips at Jhalma village, distt. Lahaul & Spiti (H.P.)	01.07.2016	Bhavya Bhargava	22
Tissue culture and cultivation techniques of floriculture crops at CSIR-IHBT	26-30.07.2016	Bhavya Bhargava/ Sanatsujat Singh/ Ashok Kumar/ Ashish R Warghat/ RK Sud/ Amita Bhattacharya	7
Kisan Mela for floriculture farmers of H.P. at CSIR-IHBT	26.09.2016	Bhavya Bhargava/ Sanatsujat Singh/ Ashok Kumar	78
Commercial cultivation of flower crops organized at CSIR-IHBT	23-25.01.2017	Bhavya Bhargava/ Sanatsujat Singh/ Ashok Kumar	19
Commercial cultivation of flower crops organized at Sakri village, Teh. Haripur, distt. Kangra, H.P.	13.02.2016	Bhavya Bhargava/ Ashok Kumar/ Arvind Verma	90
Prospects of lilium in Kinnaur at CSIR-IHBT	15.03.2017	Bhavya Bhargava	15
Commercial cultivation of flower crops organized at CSIR-IHBT	22-24.03.2017	Bhavya Bhargava/ Sanatsujat Singh/ Ashok Kumar/ Arvind Verma	26
Four hundred and seventy five farmers and students visited the demonstration plots of commercially important cut flower crops at CSIR-IHBT, Palampur during the year			

Training imparted to farmers of Jagla, Gondhla, Khangsar, Khinning and Ralling villages of Lahaul (H.P.)

Hands on training on soil sterilization

Hands on propagation technique of chrysanthemum

Participants of Kisan Mela

Field visit of farmers at CSIR-IHBT floriculture farm

Workshop on commercial cultivation of floriculture crops

Interaction with farmers of Kinnaur distt., H.P.

Hands on training on preparation of chrysanthemum cuttings

Hands on planting of marigold seedlings

Participation in exhibition/ Flower Show

CSIR-IHBT also participated in a flower show organized by the Department of Horticulture, H.P.

CSIR-IHBT got "flower of the show" award for Bird of Paradise in State level Holi festival organized by State Horticulture department dt. 14.03.2017

CSIR-IHBT got first prize for lilium cut flowers in State level Shivratri festival organized by State Horticulture department dt. 24.02.2017

Linkages developed

CSIR-IHBT developed linkages with the local administration and line departments for extension activities. In order to promote cultivation of medicinal, aromatic and floriculture crops in Lahaul valley, planting materials (seeds/roots) of some potential plants of *Aconitum heterophyllum*, *Panax ginseng*, *Picrorhiza kurrooa*, *Salvia sclarea*, *Lilium* and *Tuips* were distributed to progressive farmers.

Capacity building and training programmes in Lahaul valley

Demonstrations and trainings organized

Training on MAP's and floriculture crops imparted to tribal farmers

Sr. no.	Title	Conducted on	Conducted at	Participating villages	Number of participants
1.	Cultivation technology of important medicinal and aromatic plants	22 May, 2016	CeHAB, Ribling (Tandi), Keylong, distt. Lahaul & Spiti	Malang, Jahlma, Tigrit	3
2.	Cultivation technology of important aromatic plants	23 May, 2016	Gondhla	Jagla	4
3.	One day awareness programme on "Value added food product on buckwheat based food products"	25 May, 2016	Keylong	Keylong	15
4.	One-day training cum demonstration programme entitled "Agro and process technology of important medicinal and aromatic plants"	10 August, 2016	CeHAB, Ribling (Tandi), Keylong, dist. Lahaul & Spiti	Tandi, Mooling, Tholang, Jahlma, Gondhla	22
5.	Demonstrated food processing and preservation technologies in Tribal Fair	14 -16 August, 2016	Keylong	Keylong	300
6.	Nutri Mix and Fruit bar were demonstrated during one day awareness programme on "Value added food products"	22nd September, 2016	Kaza	Kaza	25
7.	Training cum field demonstration of plantation techniques of saffron	September 30 - October 1, 2016	Killar, Pangi, dist. Chamba	Killar, Pangi, distt. Chamba	13
8.	Agrotechnology and processing techniques of important medicinal and aromatic plants	October 3, 2016	CeHAB, Tandi, Keylong, distt. Lahaul & Spiti (H.P.)	Udaipur, Lahaul	23
9.	Demonstration cum training programme on "Production and post-harvest technology of commercially important cut flower crops"	June 30, 2016	Jagla	Gondhla, Khining, Jagla, Khangsar, Bhugu, Ralling and Thorang	55
10.	Commercial cultivation of flower crops	July 01, 2016	Jhalma	Phura, Shansha and Jhalma	22

Gene sequence submitted:

Nadda, G., Sharma, A., Kumari, P., Kumar, S. and Singh, D. 2016. Identification and molecular characterization of *Ophiocordyceps* sp. from low altitude areas of H.P., India. (Accession No. KX679571.1).

2. PRODUCTION OF CHARACTERIZED PLANTING MATERIALS FOR FACILITATING CROP DIVERSIFICATION

Generation of quality planting materials of important medicinal and their distribution to farmers was continued in the present year.

Planting material of MAPs supplied to farmers

S. no.	Crop	Planting material supplied to farmers/growers	Area planted (ha)
1	Damask rose plants	15000 nos.	1.5
2	Rosemary	6000 nos.	0.5
3	Stevia seed	4.5 kg	15
4	Wild marigold	144 kg	36
5	Miscellaneous crops	--	5.0

Damask rose

Lavender

Stevia

Rosemary

Nursery grown quality planting material of MAPs

Field demonstrations of MAPs at high altitude regions

Field demonstration trials on *Picrorhiza kurrooa*, *Salvia sclarea*, *Artemisia* spp., *Panax ginseng* were laid out at Centre for High Altitude Biology, CSIR-IHBT, Ribling, Keylong, Lahaul & Spiti research farm and also at farmers field in five locations namely, Tandi, Goshal, Sansha, Tholang, Jagla villages to create awareness among farmers about these crops and to analyse their productivity and quality.

Ginseng at farmer's field, distt. Lahaul & Spiti

***Salvia sclarea* intercropped with apple at Sansha village**

***Picrorhiza kurrooa* at Ribling farm, CeHAB, Keylong**

***Aconitum heterophyllum* at farmers field, distt. Lahaul & Spiti**

***Salvia sclarea* at CeHAB Ribling farm**

***Artemisia maritima* grown in wild**

Saffron (*Crocus sativus* L.) at different places of H.P. were set up to for quality saffron production.

Kothgarh, Shimla

Bharmour, Chamba

Nirmand, Kullu

Jagla, Lahaul & Spiti

Demonstration plots of saffron

Activities undertaken for apple introduction at Champhai district of Mizoram

Earlier, apple cultivation was never tried in Mizoram state of India. Therefore, keeping in view the importance of apple cultivation for boosting rural economy, the institute made first attempt to introduce this fruit plant in Champhai district in 2016 as out of the 8 districts in Mizoram, this district is relatively cool and the mean monthly minimum temperature ranges between 8.4-

9.3°C during December and January. The work was initiated jointly with Project Director of DRDA of Champhai district. Two sets of cultivars with low chilling requirement, between 300-500 hours, were selected for introduction. Set I comprised of cultivars, Anna and Dorsett Golden with chilling requirement of below 300 hours and another set of cultivars comprised of Fuji and Gala having chilling requirement of nearly 500 hours. Demonstration plots were set up at 10 locations, accommodating a total of 210 apple sapling. On the spot training was also organized for capacity building of staff of DRDA and farmers.

Introduction of new apple varieties in Mizoram

In addition to the low chilling varieties introduced last year, this year 200 plants of two low chilling varieties *viz*., Red Chief and Red Lum Gala were planted in 8 new locations at Champhai district. Planting proportion of 13:12 plants of each cultivar was adopted. Apple plants planted last year were observed to grow satisfactorily.

Apple plants introduced in different locations of Champai district during February, 2017

Site no.	Name of village	Farmer Name	No. of plants
1	Midum Zau	Mr. K. Lalmawia	25
2	Baulzang Hnahlan	Mr. Dorikhuma	25
3	Baulzang Hnahlan	Mr. K. Zoliana	25
4	Baulzang Hnahlan	Mr. Lal Panmeka	25
5	Baulzang Hnahlan	Mr. Lal Rose II	25
6	Seduh- Zau	Mr. Lal Nilian	25
7	Baungbung	Mr. K. Laltlanzaua	25

Apple plantation at farmers field Champai, Mizoram

Wild marigold (*Tagetes minuta)*

Wild marigold is one of the important aromatic crops suitable for hilly region. Therefore, effect of pinching and harvesting time on the essential oil content of *T. minuta* was studied. The oil was significantly higher in plants pinched after 45 days of transplanting, provided harvesting was done at 100% flowering stage.

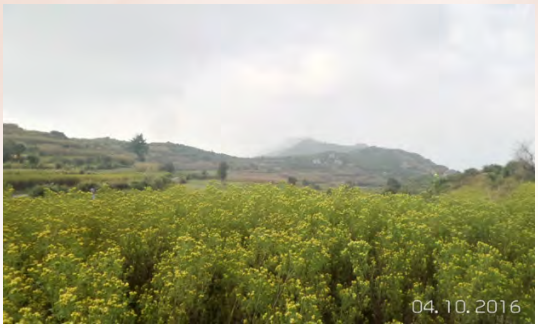
Promotion of wild marigold cultivation

During the year 2016, awareness campaign about the crop among the farmers of state was started. Seeds of improved variety (Him Gold) were also distributed to the farmers for cultivation. Demonstration plots of the crop were established at different sites where improved agro- and process technologies of the crop were demonstrated to the farmers. A total 40.44 ha area was brought under wild marigold cultivation. Details of farmers who benefited from this activity are given as under:

Locations in H.P.	No. of farmers	Area covered (ha)
Sainj valley, Kullu	8	2.96
Banjar Kullu	7	3.50
Manikaran valley, Kullu	2	3.50
Kalwari, Banjar, Kullu	9	2.80
Shirikot, Banjar, Kullu	5	0.88
Samot Bhattiyat, Chamba	8	2.50
Bhattiyat, Chamba	7	2.40
Jandrog, Chamba	6	1.44
Thalla, Chamba	6	2.20
Maniyara, Kangra	5	1.04
Badgaon, Bilaspur	10	2.00
Paddhar, Mandi	29	6.50
Nohali & Chaam, Mandi	8	2.16
Sundernagar, Mandi	13	6.56
Total	**123**	**40.44**

Distribution of seeds to the farmers

Crop at early growth stage



Crop at flowering stage

Carriage of biomass to extraction site

Mobile distillation unit

Essential oil distilled at site

Extraction of essential oil from wild marigold

Valeriana jatamansi

In order to identify elite planting materials, different accessions were collected from Banjar (Kullu), Holi, Bharmour (Chamba), Salooni region (Solan) and Kukurgunda, Zhitingri (Mandi) localities of H.P. and Gangtok area of Sikkim along with soil samples, GPS coordinates were also recorded. Seeds of the species were collected during January and February, 2017 and the same were sown for nursery raising in March, 2017. Additionally, around thousand plants were planted in earthen beds in open environmental conditions at CeHAB Ribling centre of CSIR-IHBT (Fig. 3). Screening of elite clones in terms of quality and quantity of oil is under process. Besides, 2800 plants of *V. jatamansi* were provided to H.P. State Council of Science, Technology and Environment (HIMCOSTE) Shimla.

Nursery of *Valeriana jatamansi*

Dracocephalum heterophyllum

Seed were collected from Spiti area of H.P. in the month of September. The growth performance of *D. heterophyllum* was studied under nursery condition, CSIR-IHBT, Palampur. About 5000 plants were transferred from nursery to poly sleeves .

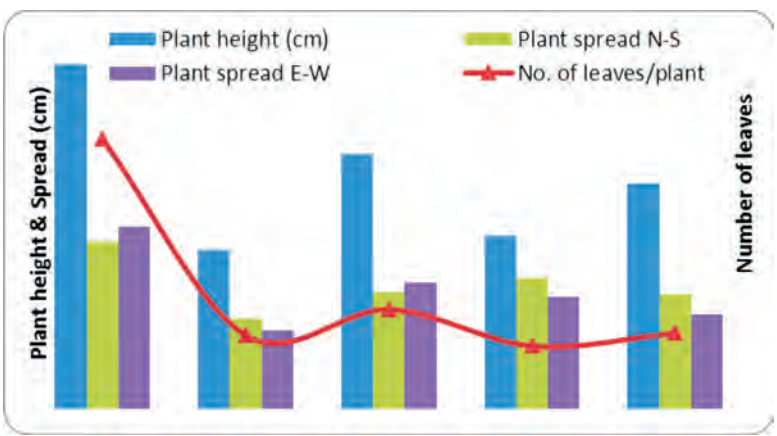
Raising of *D. heterophyllum* plant under nursery condition (B) Plants transferred to poly sleeves

Ginkgo biloba

In continuation to earlier experiments on *G. biloba*, the effect of FYM application at 15, 30, 45 and 60 t/ha were studied. Results revealed no significant difference in plant growth parameters. However, leaf growth recorded significant difference on fresh and dry weight basis. Thus, *G. biloba* was planted in about 2 acres area in the month of September 2016 in high altitude area of Lahaul valley.

Clary sage (*Salvia sclarea*)

Growth performance in terms of plant height, plant spread and numb er of leaves was recorded in *S. sclarea* from different sites of Lahaul & Spiti district. Plant height, number of leaves, plant spread in E-W and N-S direction were maximum in site 1 followed by site 3 and site 5.



Growth data of clary sage plants collected from different sites of Lahaul & Spiti during 2016

Improving productivity and quality of tea

Strengthening of the tea industry in this region by improving crop quality and cost reduction through mechanization of farm operations is prime need of small tea growers in the current scenario of scarcity of farm labour and rising costs. Therefore, emphasis was given for promotion of tea farm mechanization to cope with these problems. An area of 30 ha was brought under mechanization in Kangra valley. Various training programmes were conducted and demonstrations were held on different issues of plantation management, including a joint workshop on Kangra tea geographical indication in association with State Council for Science, Technology & Environment. Advisory services were extended for improving productivity and quality of Kangra tea and promotion of mechanization.

Tea workshop and training programme conducted

S. no.	Particulars of training	Date	Area	No. of growers
1.	Tea workshop-cum-training camp on tea: Quality production of green tea and plucking management organised by State Agri Deptt., Palampur	24.05.2016	Kangra district	35
2.	Workshop on marketing of tea organised by State Agri Deptt., Palampur	28.06.2016	Kangra district	30
3.	Tea workshop-cum-training camp for tea growers of Bhawarna, Panchrukhi and Dharmshala Development blocks organised by State Agri Deptt., Palampur	07.11.2016	Bhawarna, Panchrukhi and Dharmshala Development blocks	40
4.	Revival of tea plantations in Baijnath area	02.12.2016	Baijnath	40
5.	Manufacturing methods, pruning and skiffing in tea: Exposure visit of small tea planters of Panchrukhi area to CSIR-IHBT arranged by State Agri Deptt., Palampur	03.12.2016	Panchrukhi Development block	30
6.	Training of field workers on different tea husbandry practices and skill development for farm mechanization	14-15.03.2017	Jogindernagar and Palampur	30
7.	Hands on practical demonstration training on tea nursery, field operations and farm mechanization	16-17.03.2017	Baijnath	10
8.	Hands on practical demonstration training on tea nursery, field operations and farm mechanization	18-19.03.2017	Palampur	30
9.	Training of field workers on different tea husbandry practices	20.03.2017	Dharamshala	25
10.	Workshop on Kangra tea GI organised by H.P. State Council for S&T	24.03.2017	Kangra and Mandi districts	100

Workshop on Kangra tea Geographical Indication

Advisory services extended to the tea growers

Sl. no.	Date	Location	No. of growers
1.	14/04/2016	Chambi Tea estate, Kangra Valley Tea Estate, Pattiar tea estate, Darang tea estate	4
2.	14/06/2016	Zikkar tea estate, Mann tea estate, Chakvan tea estate	3
3.	16/06/2016	Thandol tea estate, Bhawarna tea estate, Khalate tea estate, Khyapat tea estate, Bundla tea estate,	5
4.	23/06/2016	Thandol tea estate, Bhawarna tea estate, Saloh tea estate, Bhadal Devi area, Rajan chuhans tea estate, Nagari area, Chambi area, Lahla area, Gopalpur area, Kangra Valley tea estate	9
5.	01/08/2016	Dharamshala tea estate (for the control of tea mites)	3
6.	26/08/2016	Mansimbal tea estate (for the control of tea mites)	5
7.	21/09/2016	Thandol tea estate, Bhawarna tea estate, Sullah tea estate, Saloh tea estate, Darang tea estate, Pathiar tea estate, Sidhbari tea estate, Zikkar tea estate, Kangra Valley tea estate, Chambi tea estate	11
8.	23/09/2016	Sungal tea estate, Deogram area, Raipur tea estate, Mansimbal tea estate, Khalate tea estate, Bundla tea estate	8
9.	24/09/2016	Baijnath tea estate, Langau Sakri tea estate, Bir area, Chauntra area, Dheluhar area,	5
10.	11/11/2016	Chakvan tea estate, Dharamshala tea estate, Towa tea estate	8
10.	17/11/2016	Thandol tea estate, Bhawarna tea estate, Sullah tea estate, Khalate tea estate	3
11.	29/11/2016	Thandol tea estate, Bhawarna tea estate, Sullah tea estate, Hoodle tea estate, Mann tea estate	5
12.	15/12/2016	Kangra valley tea estate, Chakvan tea estate area, Patta tea estate, Patta tea estate, Chakvan tea estate	4

Sl. no.	Date	Location	No. of growers
13.	16/12/2016	Bhawarna tea estate area, Thandol tea estate, Sullah tea estate, Keshav Singh tea estate, Saloh area	5
14.	21/02/2016	Chambi tea estate, Bullah tea estate, Patiala tea estate, Pathiar tea estate and Khalate tea estate	7
15.	18/01/2017	Kangra Valley tea estate, Sidhbari tea estate area, Dharamshala tea estate	8
16.	10/02/2017	Chowki tea estate, Khalate tea esate, Raipur tea estate, Bhawarna tea estate, Sullah tea estate	7
17.	13/02/2017	Chambi tea estate, Kangra Valley tea estate, Sidhbari tea estate area, Dharamshala tea estate, Zikkar tea estate	6
18.	10/03/2017	Chambi tea estate, Kangra Valley tea estate, Pathiar tea estate, Sidhbari tea estate, Mann tea estate	5
19.	21/03/2017	Darang tea estate, Pathiar tea estate, Zen tea estate, J.L Butail tea estate	4
20.	22/03/2017	Chambi tea estate, Kangra Valley tea estate, Gopalpur tea estate, Chakvan tea estate, Dharamshala tea estate, Hoodle tea estate, Zikkar tea estate	8
21.	23/03/2017	Sullah tea estate, Saloh tea estate, Badhal Devi tea estate, Sungal tea estate, Bhawarna tea estate, Thandol tea estate, Baijnath area, Chauntra tea estate	11

Distillation of aromatic crops

Demonstration of essential oil production technologies were held for educating tea growers. Lemongrass grown at 3 sites *viz*. Lagru, Kandwari and Jaisinghpur were distilled at Institute's Chandpur pilot plant. Lemongrass oil measuring 9.3 litres was collected from 32.94 quintal raw material showing recovery percentage of 0.28%. It fetched a price of Rs.1000/litre. It was an additional income for the farmers. Detail of the oil recovery is given below.

Eessential oil distillation of lemon grass

Batch no.	Weight of raw material (kg)	Oil distilled (ml)	Oil yield (%)	Beneficiaries
1	1057.7	2560	0.24	Sh. Amar Singh, vill. Lagru, Tehsil Khundian
2	997.5	2150	0.22	Sh. Narinder Jamwal, vill. Kandwari, Tehsil Palampur
3	885.0	2850	0.32	Sh. Surjeet Singh, vill. Gandar, Tehsil Jaisinghpur
4	354.0	1750	0.49	Sh. Surjeet Singh, vill. Gandar, Tehsil Jaisinghpur
Total	**3294.2**	**9310**	**0.28**	

Similarly, distillation of wild marigold introduced by the Institute in different parts of the state was demonstrated at the Institute's Chandpur pilot plant and some of the locations in the farmers field using Institute's mobile distillation unit. Total 42 quintal biomass of crop was distilled at the Institute and at farmers site and total 16.36 litres of tagetes oil was collected. The market price of the oil is Rs.8,000/litre. So, income generation of the growers were Rs. 1.31 lakhs for all beneficiaries during the project duration. Details of the oil was recovery and procedure involved in operating oil distillation are shown below.

Essential oil distillation of wild marigold

Batch no.	Weight of raw material (kg)	Oil distilled (ml)	Oil yield (%)	Beneficiaries in H.P.
1	600	1150	0.19	Farmer from Padhar, Distt. Mandi
2	1382	6260	0.45	Farmer from Sainj, Distt. Kullu
3	1015	4330	0.43	Farmer from Nohli, Distt. Mandi
4	830	2660	0.32	Farmer from Jharet, Distt. Chamba
5	142	720	0.51	Farmer from Ghoghaddhar, Distt. Mandi
6	230	1240	0.54	Farmer from Goshaini, Distt. Kullu
Total	**4199**	**16360**	**0.39**	

Demonstration of procedures involved in essential oil distillation

Promotion of Apple Cultivation

Virus-tested *in vitro* cultures of apple rootstocks were developed at CSIR-IHBT for multiplication by tissue culture industry and dissemination to the apple grown. A total of about 30 jars of virus-tested planting material of apple rootstock having potential to generate over 40,000 plants were supplied.

Promotion and utilization of bamboos for livelihood and environment

Important bamboo species such as *Phyllostachys pubescens, Dendrocalamus hamiltonii, Bambusa bambos, B. multiplex, Sasa auricoma* etc. were raised in nurseries under field condition. Nearly 3.5 lakh plants of different bamboo species were supplied to various government and non-government agencies. These include Directorate of Horticulture, Govt. of Sikkim, State Forest Department of J&K, H.P., Punjab, Haryana, Uttrakhand, Mizoram, M.P., A. P., Manipur, HP Agriculture University, State Department of Science and Technology of West Bengal and Indian Army Cantt of Ferozepur, Palampur and Alhilal, individual farmers and other non-government

enterprises to cover more than 100 ha. A total of over 700 ha area was covered under bamboo plantation using plants supplied by the institute to different parts of the country. Trainings were also imparted to more than 900 farmers and villagers two self help groups and 4 small scale enterprises.

Propagation and greening of degraded lands in Kangra district

Plants of important bamboo species such as *Phyllostachys pubescens, Dendrocalamus hamiltonii* and ornamental species were raised from cuttings in nurseries. The cutting raised plants were then transplanted to the fields of CSIR-IHBT. Well established plants were then supplied to different agencies for plantation in various degraded lands of Punjab and Himachal Pradesh for preventing soil erosion. More than 3400 plants were supplied to various individuals of Kangra district of H.P.

Trainings imparted

A total of 178 people including villagers, foresters and forest officials were trained in the methods of micropropagation and raising nurseries for establishment of plantations. Demonstration on the standardized methods of preparing and raising of bamboo nurseries were also given.

Extension activities (a-b) training of forest guards on bamboo propagation (c) bamboo nursery (d) establishment of plantations

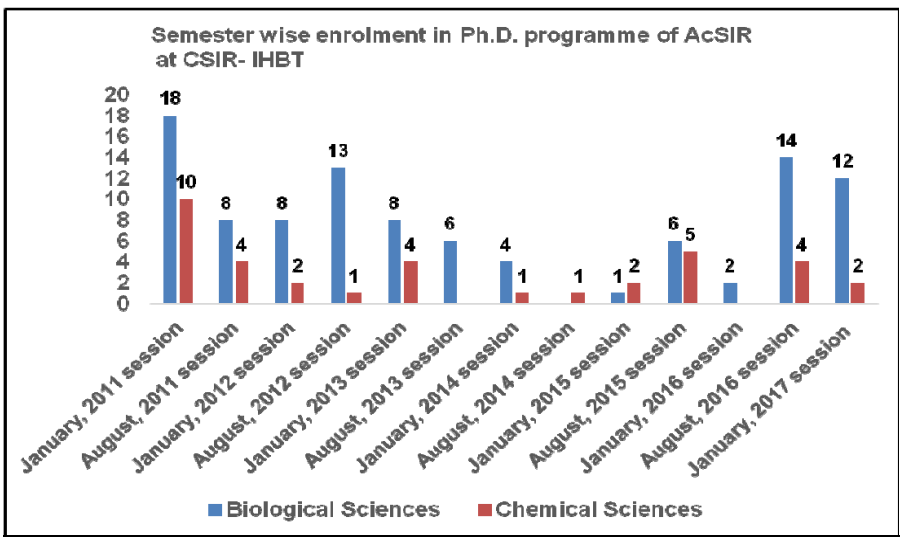
Supply of bamboo plants to different people

S. no.	Date	Bamboo genus/ species	No. of plants	Supplied to
1	4/11/2016	*Dendrocalamus strictus*	50	Prof. Sushil Kumar Gupta J&K
		D. hamiltonii	50	
		D. giganteous	50	
		D. asper	50	
		Bambusa multiplex	50	
		B. bambos	50	
2	6/10/2016	*B. multiplex*	15	Radhika Sharma, Dhadh, near Chamunda Mandir
		Sasa auricoma	15	
3	6/17/2016	*S. auricoma*	20	Viveka Foundation School Manshimbal
4	7/16/2016	*D. hamiltonii* *D. strictus*	5 5	Dr. S. G Reddy, CSIR-IHBT, Palampur, H.P.
5	7/26/2016	*B. multiplex*	10	Mr. Anant Bhagat, Alhilal Camp, Palampur
6	7/26/2016	*B. multiplex*	25	Officer Mess Alhilal Camp Palampur
7	7/26/2016	*Phyllostachys aurea*	100	Shiri Simrat Sekho Maurya
		B. bambos	150	Vill. Bhitlu, Dharamshala
		B. multiplex	20	
8	8/2/2016	*P. aurea*	10	539 ASC Battalian, Alhilal Camp, Palampur
9	8/5/2016	*P. pubescens*	30	Dev Cottage Dharmacot, Dharmshala
10	8/5/2016	*D. hamiltonii*	15	Dr. Anil Sood, Sungal
11	8/9/2016	*S. auricoma*	5	Jasbant Paul, Bir, Baijnath
12	8/10/2016	*B. bambos* *D. hamiltonii*	1200 300	Unnati Cooperative Society Ltd., Talwara, Punjab
13	8/16/2016	*P. aurea*	5	Rakesh Kumar, Rajpur, Tanda
14	8/19/2016	*S. auricoma*	1	Miss Bharti, Parour
15	8/26/2016	*D. strictus*	2	Pawan Giri, Panchrukhi
16	9/9/2016	*D. hamiltonii* *S. auricoma*	3 2	Nandita Mehta, CSIR-IHBT, Palampur
17	9/30/2016	*P. pubescens*	4	Pyaar Chand, Bharmat, Palampur
18	10/21/2016	*B. multiplex* *S. auricoma* Ornamental bamboos *B. multiplex*	4	Swati Choudhary, Palampur
19	10/21/2016	*S. auricoma*	2	Priyanka, CSIR-IHBT, Palampur
		Ornamental bamboos		
20	10/24/2016	*B. multiplex* *S. auricoma* Ornamental bamboos	3	Swati Choudhary, Palampur
21	12/23/2016	*P. pubescens*	3	Manoj Kumar, Bharmat, Palampur
22	2/8/2017	*P. pubescens*	6	Pritam Singh, Senjh, Kullu
23	2/27/2017	*B. bambos*	1200	Unnati Cooperative Society Ltd., Talwara, Punjab
24	3/24/2017	*P. pubescens*	2	Vishal Kumar, Vill. Tanda, Palampur
		Total plants		**3462**

AcSIR-IHBT

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; that is the Academy of Scientific and Innovative Research Act, 2011 vide The Gazette of India dated February 7, 2012 and notified on April 3, 2012 as an institution of national importance. It was set up based on a 'Hub and Spoke' model where the hub (AcSIR offices) is responsible for centralized administrative functions. The spokes are located across the 37 laboratories and six units of CSIR spread along the length and breadth of India. These act as actual campuses for different subject areas.

Under the banner of Academy of Scientific and Innovative Research (AcSIR), CSIR- IHBT has initiated Ph.D. (Sciences) programme. Since January, 2011 up to March, 2017 a total of 116 students enrolled for Ph.D. at CSIR-IHBT. Admissions in the Ph.D. program in various faculties *viz.* Biological Sciences & Chemical Sciences are summarized in the following graph:



A total of 13 students presented their research work in Open Colloquium and 16 students successfully defended their theses during the viva voce examination in the current year and were awarded Ph.D. degree.

The details of the students who were awarded Ph.D. degree prior to March, 2017 is as under:

S. no.	Name	Supervisor	Thesis title	Year of completion
1.	Praveen Guleria	Dr. Sudesh Kumar	Functional evaluation of steviol glycoside biosynthesis genes from *Stevia rebaudiana* by combined approach of gene silencing and overexpression	2014
2.	Ajay Rana	Dr. Ashu Gulati/ Dr. H.P. Singh	Exploration of major phytochemicals and development of value added products from underutilized parts of *Camellia sinensis* (L.) O. Kuntze	2015
3.	Richa Salwan	Dr. Arvind Gulati	Screening, production and molecular characterization of low temperature active and alkaline stable protease from psychrotrophic bacteria	2015
4.	Rajesh Kumar	Dr. Arun Kumar Sinha	Development of green synthetic methodologies for S-S, C-S and C-C bond forming reactions and their mechanistic studies	2015
5.	Akshay Nag	Dr. Ram Kumar Sharma	Development of genomic resources and genetic diversity characterization of Indian Himalayan populations of *Podophyllum hexandrum* Royle	2015
6.	Praveen Kumar Verma	Dr. Bikram Singh	Synthesis of metal phthalocyanine complexes and their catalytic applications in reduction reactions	2015
7.	Robin Joshi	Dr. Ashu Gulati	Characterization of secondary metabolites of Tea [I (L.) O. Kuntze] in Kangra and development of value added products	2015
8.	Ramdhan	Dr. Sudesh Kumar	Development of nanocomposites of bioactive molecules	2015
9.	Arun Kumar Shil	Dr. Pralay Das	Development of solid supported palladium(0) and platinum(0) nanoparticles as heterogeneous catalyst and their applications in reduction and cross-coupling reactions	2015
10.	Amrina Shafi	Late Dr. Paramvir Singh Ahuja	Structural and functional changes in response to abiotic stress in *Arabidopsis thaliana* (Ecotype Col-0) overexpressing PaSOD and RaAPX	2015
11.	Nitul Ranjan Guha	Dr. Pralay Das	Studies on nano-impregnated transition metals as heterogeneous catalyst for coupling, reduction and oxidation reactions	2016

S. no.	Name	Supervisor	Thesis title	Year of completion
12.	Hena Dhar	Dr. Arvind Gulati	Exploring endoglucanase producing bacteria from the cold environments of the Western Himalayas and molecular characterization of extracellular endoglucanases	2016
13.	Piar Chand	Dr. Yogesh B. Pakade	Surface modification of Apple Pomace as biosorbent for removal of toxic metals from industrial wastewater	2016
14.	Amit Shard	Dr. Arun Kumar Sinha	Development of green synthetic protocols for C-C, C-S and S-S bond forming reactions: Evaluation of hydroxylated styryl-cinnamate hybrids as potent anticancer agents	2016
15.	Vinay Randhawa	Dr. Anil Kumar Singh	Computational systems biology and cheminformatics approaches for analysis of complex diseases	2016
16.	Manju Bala	Dr. Bikram Singh	Phytochemical studies on Tinospora cordifolia and Cissampelos pareira and synthetic approaches for heterocyclic Scaffolds	2016
17.	Prachi Awasthi	Dr. Vipin Hallan	Molecular characterization and development of diagnostics for Cherry necrotic rusty mottle virus	2016
18.	Gulshan Kumar	Dr. Anil Kumar Singh	Understanding the molecular mechanism of dormancy release under differential availability of chilling in Apple (*Malus domestica* Borkh.)	2016
19.	Ashwani Jha	Dr. Ravi Shankar	Computational analysis of sRNAs and their regulatory system	2016
20.	Mrigaya Mehra	Dr. Ravi Shankar	Computational analysis of complex repeats, miRNAs and their associations	2016
21.	Sushila Sharma	Dr. Bikram Singh	Studies on vasicine based organocatalyst for coupling and reduction reactions	2016
22.	Sunny Dhir	Dr. Vipin Hallan	Complete genome characterization and effectivity analyses of *Apple stem pitting* and *Apple stem grooving virus* infecting apple	2016
23.	Pooja Bhardwaj	Dr. Vipin Hallan	Molecular characterization and development of diagnostics for *Apple stem grooving virus*	2016
24.	Mayanka	Dr.Vijai Kant Agnihotri	Phytochemical and pharmacological studies of Malus domestica, Potentilla atrosanguinea and synthesis of furanic compounds from saccharides	2017
25.	Preeti Arya	Dr. Vishal Acharya	Elucidating the evolution and role of STAND P-loop NTPase involved in plant defense response using computational approaches	2017
26.	Parul Goel	Dr. Anil K. Singh	Understanding physiological and molecular responses of *Brassica juncea* under nitrate limiting conditions	2017

IMPORTANT EVENTS

Sidhu Memeorial Table Tennis Tournament- 2016

Sidhu Memorial Table Tennis Tournament-2016 was organized in the institute during April 5-7, 2016

Rose plucking and distillation was inaugurated for the season by Dr. Sanjay Kumar, Director, CSIR-IHBT on April 18, 2016 in the presence of scientists and staffs of the Institute

Dr. Girish Sahni, Director General, CSIR and Secretary, DSIR visited the institute during May 5-8, 2016

Dr. Sanjay Kumar, Director CSIR-IHBT honouring Dr. Girish Sahni, DG CSIR

Interaction of Dr. Girish Sahni, DG CSIR with scientists of the CSIR-IHBT

Dr. Girish Sahni, DG CSIR visited Banuri Tea Farm of the institute and was apprised of the working of various equipments and apparatus used in mechanization of tea farming

Dr. Girish Sahni, Director General, CSIR and Secretary, DSIR with staff and researchers during his visit from May 5-8, 2016

Dr. Girish Sahni, Director General, CSIR and Secretary, DSIR laid the foundation stone of the Sabbatical Home in the institute on May 6, 2016 in the presence of distinguished guests, Director & staff of the institute

Independence Day Celebration

Dr. Sanjay Kumar, Director of the institute unfurled the National Flag on Independence Day and inspired the staff through a motivating speech on the occasion. The institute celebrated Independence Day with great enthusiasm

Staff Club organized games for staff and families in the institute on the occasion of Independence Day. Family members participated in various games and enjoyed happy moments

Dr. Sanjay Kumar, Director, CSIR-IHBT launched the Manthan- an inhouse magazine of Staff Club and directory of the Institute on August 15, 2016

Ayurvedic Pharmacopoeia Committee (APC) - Industry Interaction Workshop for the Classical Ayurvedic Drugs Manufacturers of Northern Region by Central Council for Research in Ayurvedic Sciences, Ministry of AYUSH, Govt of India and supported by the Pharmacopoeia Commission for Indian Medicine & Homeopathy (PCIM&H), Ghaziabad in CSIR-IHBT, August 29, 2016

CSIR-IHBT celebrated the 75th year of CSIR foundation day on September 26, 2016

Honorable Prime Minister, Shri Narendra Modi released three varieties of calla lily and gerbera developed by CSIR-IHBT on the occasion of 75th year of CSIR foundation day on September 26, 2016

Kisan Mela at CSIR-IHBT






CSIR-Institute of Himalayan Bioresource Technology celebrated the CSIR Platinum Jubilee Foundation Day on September 26, 2016. On this day, the institute was made open for all to view and get acquainted with the research and development activities being carried out. A fair "Kisan Mela" was also organized in the institute for showcasing the scientific achievements of the institute to the farmers, growers, entrepreneurs, students, and other dignitaries in and around Palampur

Dr. Harsh Vardhan, Hon'ble Union Minister for Science & Technology and Earth Science, and Vice President of Council of Scientific and Industrial Research (CSIR) visited CSIR-Institute of Himalayan Bioresource Technology and addressed the staff on October 18, 2016

Glimpses of visit at CSIR-IHBT by Dr. Harsh Vardhan, Hon'ble Union Minister for Science & Technology and Earth Sciences, and Vice President of Council of Scientific and Industrial Research (CSIR)


Interaction of Dr. AK Puri, FORE School of Management with scientists of the institute on June 3, 2016

The institute hosted a meeting of the International Centre for Genomics Engineering and Biotechnology (ICGEB) on May 7, 2016

National Technology Day

Celebrated National Technology Day on May 11, 2016. Dr. K.C. Gupta, Ex-Director, CSIR-lndian lnstitute of Toxicology Research (llTR), Lucknow (U.P.) delivered the National Technology day lecture on "Natural polysaccharides as efficient carriers for biomolecules". Prof. V.L. Chopra, Chancellor, Central University of Kerala and Former Member, Planning Commission, Government of India presided over the function

Dr. Gopal Kundu National Centre for Cell Science, Pune delivered a lecture on "Therapeutic Implications of Osteopontin and CD133+ Cancer Stem Cells in Breast Cancer and Melanoma Progression" in the institute on May 23, 2016

Tibetan spiritual leader, the Dalai Lama during the 26th Annual Conference of The Glaucoma Society of India's GSICON-2016 held at CSIR-IHBT, Palampur on November 5, 2016

CSIR-IHBT Open Day

As a prelude to "India International Science Festival", CSIR-Institute of Himalayan Bioresource Technology organised an open day on November 23, 2016 to showcase various scientific activities of the institute. About 500 children from various schools of Palampur, Nagrota Bagwan, Baijnath and Dharamshala participated enthusiastically in the programme. Representatives from various Gram Panchayats of the adjoining areas expressed to have been greatly benefited by the visit and lauded the work being carried out by the institute

Dr. G.S. Khush renowned scientist and Prof. Ashok Kumar Sarial, Vice Chancellor, CSKHPKV, Palampur visited the Institute and interacted with scientists on March 28, 2017

CSIR-IHBT participated in "Destination North East - 2017" organized by Ministry of Development of North Eastern Region at Chandigarh during March 6-8, 2017

राजभाषा गतिविधियां

हिंदी दिवस

प्रशासन, वित्त एवं लेखा, क्रय एवं भण्डार, इएसयू तथा पुस्तकालय में कार्यरत सभी कर्मियों के लिए सोमवार, दिनांक 12.09. 2016 दोपहर 2.00 बजे निदेशक कार्यालय के सभाकक्ष में हिंदी दिवस समारोह का आयोजन किया गया। कार्यक्रम का संचालन करते हुए हिंदी अनुवादक श्री संजय कुमार ने हिंदी दिवस के बारे में संक्षिप्त जानकारी प्रदान की। इसके बाद श्री आलोक शर्मा, प्रशासन अधिकारी ने कर्मचारियों को राजभाषा सम्बन्धी आवश्यक निर्देशों एवं जांच बिन्दुओं की जानकारी दी तथा सभी से निवेदन किया कि वे अपना अधिक से अधिक कार्य हिंदी में करें। अपने अध्यक्षीय संबोधन में संस्थान के निदेशक डॉ. संजय कुमार ने सभी कर्मचारियों से निवेदन भी किया कि राजभाषा में अधिक से अधिक कार्य करें। संस्थान की राजभाषा नीति प्रेरणा, प्रोत्साहन की है। परन्तु इसका मतलब यह नहीं कि राजभाषा नीति के अनुपालन की अवहेलना की जाए। उन्होंने आशा व्यक्त करते हुए कहा कि भविष्य में संस्थान में राजभाषा नीति के अनुपालन में प्रगति दिखाई देगी। पीपीएमई प्रभारी डॉ. अपर्णा मैत्रा पति ने धन्यवाद प्रस्ताव प्रस्तुत किया।

हिंदी कार्यशाला

संस्थान में दिनांक 07.03.2017 को हिंदी कार्यशाला का आयोजन किया गया। इस कार्यशाला का मुख्य उद्देश्य हिंदी भाषा का दैनिक कार्यालयी काम–काज में उपयोग करना था। परिषद मुख्यालय से वरिष्ठ हिंदी अधिकारी डॉ. पूरनपाल ने अपने संबोधन में राजभाषा नीति और हमारा दायित्व विषय पर बड़ी सहज एंव सरल भाषा में प्रकाश डाला।

उन्होंने राजभाषा नीति में विभिन्न प्रावधानों के विषय में बताया और उदाहरण सहित यह भी बताया कि कैसे हम अपने कार्य करते हुये सहज ही राजभाषा का अनुपालन कर सकते है। कार्यशाला में प्रतिभागियों द्वारा हिंदी भाषा के उपयोग में आ रही कुछ समस्याओं का भी निवारण किया। संस्थान के वरिष्ठतम वैज्ञानिक डॉ. बिक्रम सिंह ने अपने अध्यक्षीय संबोधन में सभी कर्मियों से आह्वान किया कि वे अपना दैनिक कार्यालय का कामकाज हिंदी में ही करें। संसदीय राजभाषा समिति के निरीक्षण के दौरान किसी प्रकार की कोताही को सहन नहीं किया जाता है। अतः हम सभी को राजभाषा नीति का अनुपालन करना चाहिए। श्री आलोक शर्मा ने धन्यवाद प्रस्ताव प्रस्तुत किया।

हिंदी व्याख्यान

दिनांक 16.03.2017 प्रातः 10.30 बजे डॉ. क्षमा मेत्रे, राष्ट्रीय निदेशिका, चिन्मय ग्रामीण विकास संस्था, धर्मशाला ने ^^विज्ञानों का विज्ञानः आत्मचिन्तन** विषय पर व्याख्यान दिया। इसमें संस्थान के सभी वैज्ञानिकों, अधिकारियों, कर्मचारियों एवं रिसर्च स्कालर ने प्रतिभागिता की।

राष्ट्रीय संगोष्ठी में प्रतिभागिता

आईआईसीटी, सीसीएमबी और एनजीआरआई, हैदराबाद द्वारा 25–27 मई 2016 को 'मेक इन इंडियाः सीएसआईआर की भूमिका' विषय पर आयोजित राष्ट्रीय वैज्ञानिक संगोष्ठी में संस्थान की ओर से श्री संजय कुमार, वरिष्ठ अनुवादक ने प्रतिभागिता की तथा स्मारिका में एक लेख 'मेक इन इंडियाः सीएसआईआर–आईएचबीटी का योगदान' प्रकाशित किया।

सीएसआईआर–आईआईटीआर द्वारा 20–21 अक्तूबर 2016 को आयोजित 'पर्यावरण प्रदूषणःकारण एवं निवारण' में संस्थान की ओर से डॉ. मनोज कुमार, वैज्ञानिक तथा श्री संजय कुमार, वरिष्ठ अनुवादक ने प्रतिभागिता की। डॉ. मनोज कुमार, वैज्ञानिक ने एक पेपर प्रस्तुत किया।

वेबसाइट अद्यतनीकरण

संस्थान की नई वेबसाइट बनाई गई जिसकी सामग्री को अनुवाद, टंकण एवं यूनिकोड में उपलब्ध कराया गया।

पुस्तकें, पत्रिकाएं एवं संदर्भ सामग्रियों को उपलब्ध कराना

राजभाषा विभाग, भारत सरकार एवं परिषद् मुख्यालय द्वारा समय–समय पर जारी निर्देशों के अनुरूप हिंदी में कार्य करने के लिए उचित वातावरण बनाने और राजभाषा 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 करवाया। इसके अतिरिक्त विभिन्न प्रयोगशालाओं/संस्थानों द्वारा प्रकाशित पत्रिकाओं को भी संस्थान में उपलब्ध करवाया गया। इस वर्ष 55709 रुपये की 241 हिंदी पुस्तकों की खरीद की गई। हिंदी पुस्तकों की सूची को संस्थान की वेबसाइट पर उपलब्ध करवाया गया।

राजभाषा संबन्धी कार्यान्वय

संस्थान में नए कार्यभार ग्रहण करने वाले कर्मचारियों को राजभाषा नीति एवं राजभाषा अनुभाग के कार्यों के बारे में व्यक्तिगत रूप से अवगत करवाया गया। इसके अतिरिक्त प्रशासन में संदर्भ सामग्री भी हिंदी में उपलब्ध कराई गई। हिंदी की तिमाही रिपोर्ट के लिए विभिन्न अनुभागों/प्रभागों से आंकड़े प्राप्त कर रिपोर्ट सीएसआईआर मुख्यालय नियमित रूप से भेजी गई।

विभिन्न प्रभागों में राजभाषा संबंधी कार्यों का निरीक्षण किया गया तथा उनमें आ रही समस्याओं का निराकरण किया गया।

विभिन्न अनुभागों से प्राप्त दस्तावेजों का हिंदी अनुवाद उपलब्ध किया गया तथा संस्थान द्वारा किये जा रहे शोध कार्यों को आम जनता तक पहुंचाने के उद्देश्य से ब्रोशर आदि के लिए सामग्री का अनुवाद एवं प्रकाशन किया गया।

विविध कार्य

संस्थान द्वारा आयोजित किए जाने वाले विभिन्न समारोहों जैसे सतर्कता, जागरुकता, कौमी एकता सप्ताह, सद्भावना दिवस, सीएसआईआर स्थापना दिवस, आईएचबीटी स्थापना दिवस, विभिन्न कार्यशालाओं, समारोहों के आयोजनों हेतु निमंत्रण पत्र, विज्ञापन, प्रेस नोट आदि को हिंदी में तैयार किया गया।

SUPPORT SERVICES

BUSINESS DEVELOPMENT AND MARKETING UNIT (BDMU)

The ongoing efforts of this unit are directed towards conversion of high end R&D technologies into the business. The unit is involved in economic and social impact analysis, organizing scientific & industrial meets, promoting technologies, responding to queries of farmers and entrepreneurs regarding different technologies, facilitating technology transfers through MoU, MTA and disseminating technologies and products to the society.

In the current year BDMU assisted in seven technology transfers. Nine MoU's were signed for technology transfers, material transfer and need based projects. Impact analysis conducted for stevia, damask rose, wild marigold, lavender and floriculture technology. BDMU was also intensively involved in showcasing institute's technologies & products in various market & business meetings, fairs and exhibitions at regional as well as national levels.

Other activities of the unit include to evaluation of techno-economic feasibilities of technologies developed at CSIR-IHBT, drafting agreements for transfer of technology, responding queries of clients, raising expression of interest (EOI) for different technologies, raising FVC for timely payment of service taxes and VAT related to CSIR-IHBT, impact analysis of technologies/services from third parties and providing inputs for drafting technology specific documents.

Technology Transfer

Recently, CSIR-IHBT has transferred the technology for ready-to-eat Kangri Dham to M/s Sai Foods at Baijnath (Distt. Kangra) H.P. The firm started commercial production of Kangri Dham and invested more than Rs. 14 lakhs for up-gradation of the processing plant. Ten new employees were inducted for manufacturing the products at large-scale. The company has sold more than sixty thousand packs of Kangri Dham. Negotiations are in progress to establish a chain of distributors for supply of the products in the national and international markets.

An MoU for crispy fruit technology transfer was also signed with M/s. Roots and Flowers, Palampur on 21st November, 2016. The company is producing and marketing the products in the metropolitan cities of the country.

List of Agreement signed during 2016-17

S. No.	Title of agreement	Name of company to which the technology was transferred	Date of signing
1.	Technology for processing and packaging of Kangri Dham	M/s Sai Foods Baijnath district Kangra (H.P.)	09/06/2016
2.	Material transfer agreement for HIMSTEVIA raised through tissue culture to establish stevia cultivation in central India	M/s Svyam Agro Indore, (M.P.)	18/07/2016
3.	Processing technology for value added crispy fruit products	M/s Roots and Flowers, Palampur, district Kangra (H.P.)	21/11/2016
4.	Material transfer agreement for HIMGLOW and HIMPEACE gerbera varieties raised through tissue culture for cultivation in Jharkhand	M/s Sashanka Agro Tech Pvt Limited Ranchi, Jharkhand	09/12/2016
5.	For processing of dry stevia leaves and conversion of pure steviol glycosides powder into tablets	M/s Himalaya Natural and Herbal Products, Bundla Palampur (H.P.)	13/12/2016
6.	Establishment of 7 acre stevia plantation	Virendra Kumar, Rajora Village Hazratpur, Bohich, district Bulandshahr (U.P.)	30/12/2016
7.	Establishment of 10 acre stevia plantation in Hoshiarpur	M/s DLB Herbs India Pvt. Ltd., Safdarjung Extn. New Delhi	02/02/2017
8.	Agreement for "Utilization of Funds under the Chief Minister's Startup/ Innovation Projects/ New Industries Scheme" for providing support for Entrepreneurial and Managerial Development of SMEs through Incubators	Director of Industries H.P., Shimla	23/02/2017
9.	To establish high altitude medicinal plants nursery at Centre of High Altitude Biology (CeHAB)	State Medicinal Plant Board, Shimla (H.P.)	28/02/2017

Participation in Exhibitions/ Technology Promotion Programmes

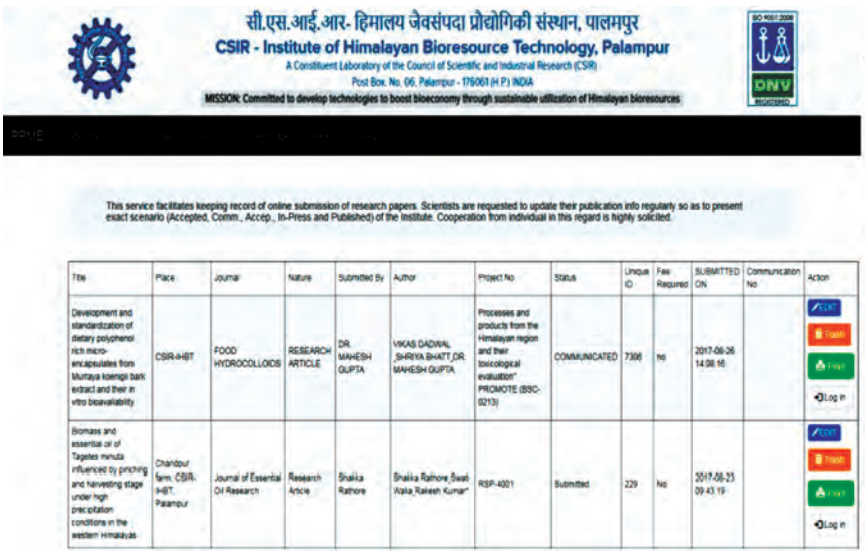
S. No.	Programme	Duration
1.	Workshop cum Exhibition on Popularizing CSIR Rural Technologies at CSIR-IMMT, Bhubaneswar	13-14/04/2016
2.	Kisan Mela by Himachal Government (H.P.) at Rakh, Chamba (H.P.)	3-5/07/2016
3.	Awareness Programme on Support for entrepreneurial and managerial development of SMEs through incubators, Shimla	22/08/2016
4.	Awareness programme on Food Processing organized by CSIR-IHBT, Palampur (H.P.) at Spiti, H.P.	22/08/2016
5.	Agri-Tech India-2016 International Exhibition Centre (BIEC) organized by Media Today Pvt. Ltd., Bangalore	21- 23/08/2016
6.	Agri- tech, India Exhibition - 2016 at BIEC, Bangalore	28-30/08/2016
7.	India International Innovation Fair- 2016 at BIEC, Bangalore	9-11/09/2016
8.	CSIR Foundation Day Programme at Vigyan Bhawan, New Delhi	26/09/2016
9.	CSIR-IHBT Exhibition during Annual Conference of Glaucoma Society of India, Palampur	4-6/11/2016
10.	CSIR Techno-fest 2016, New Delhi	14-27/11/2016
11.	Tea mechanization, Floriculture and Food products, India International Science Festival (IISF, 2016), CSIR-NPL, New Delhi,	7-11/12 2016
12.	National Vendor Development Programme-cum- Industrial Exhibition, Baddi	11- 12/12/2016
13.	Kisan Mela at CSIR- CIMAP, Lucknow	31/01/2017
14.	Review of Start Up Schemes, H.P. Secretariat, Shimla	24/01/2017
15.	Delegates in Bioasia, Hyderabad	6-8/02/2017
16.	Mahashivratri mela organized by Himachal Government (H.P.) at Baijnath (H.P.)	24/02/ 2017
17.	Destination North East - 2017 organized by Ministry of Development of North Eastern Region, Chandigarh	6-8/03/2017
18.	State level festival “Holi Mela”at Palampur and at Sujanpur organized by Himachal Government at Palampur and Sujanpur (H.P.)	9-13/03/ 2017
19.	Workshop on “Kangra tea geographical indications (GI)” in association with State Council for Science, Technology & Environment at Palampur, H.P.	24/03/2017

PLANNING PROJECT MONITORING & EVALUATION

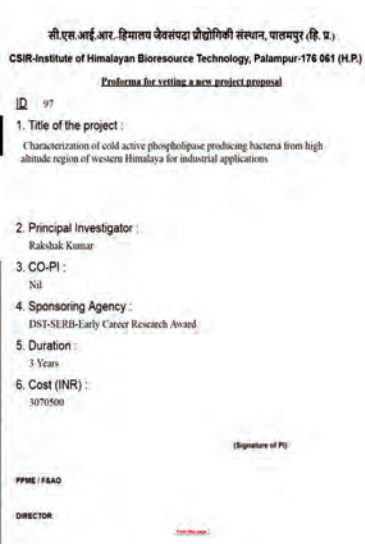
Research Planning: The division coordinated a series of meetings and facilitated the formulation of the document presented to Performance Appraisal Board. The strategic planning document "MANTHAN" was further strengthened and action taken towards achievement of goals were regularly furnished to the competent authority. Reports on significant achievements of the Institute were sent to CSIR HQ on monthly basis. As a statutory requirement, information on foreign visit of scientists were regularly furnished to CSIR HQ. The cell recorded initiation of 19 new projects funded by various agencies. As a part of routine activity, update and maintenance of databases pertaining to project, staff, papers, patents, ECF, royalty, MoU, resource management etc. was performed. To facilitate the process of decision making, monitoring of institutional performance w.r.t publication, ECF, patent and technology transfer was done. Institutional information for CSIR annual report was compiled. The 54th Meeting of Research Council of CSIR-IHBT was organized on July 13-14, 2016 at Palampur and follow-up actions were supported. To showcase technological strength of the Institute, participation at IISF-2016 was coordinated during December, 7-11, 2016 at CSIR-National Physical Laboratory. Information was disseminated regarding 33 Parliament questions received from CSIR.

Resource planning and monitoring: Fund allocation and expenditure as per the need and mandate of the institute was facilitated. Coordinated meetings to plan new infrastructures and

New website of the Institute



Publication format



Project format

equipments. Further appropriate steps were taken to seek approvals and induct new manpower to cater to the manpower requirement of the institute.

Right to Information: Information on 16 cases under RTI Act was filed quarterly report to RTI portalwww.rti.gov.in. No cases were received for appeal. Attended training for handling and furnishing RTI information online.

IT based activities: A new website of the institute was developed and launched. The updates were promptly posted in CSIR-IHBT facebook and tweeter accounts. Information were regularly updated and flashed on the intranet. CSIR-IHBT is moving towards implementation of integrated ERP system. To implement ERP successfully the R&D and store-purchase module was adopted at lab level and online indent process through OneCSIR portal was started w.e.f. August 16, 2016. As a result all indents pertaining to consumables are routed through ERP only. Through in house efforts, an online Web application for submitting research article (research paper/ review article/ book chapter/ popular article/ abstract) to the Review Committee was developed. Mechanism was put in place to log submission of new projects online.

ADMINISTRATION

The Administration provides a variety of support services for conducting R&D in the laboratory. The division has synchronized itself to realize the vision of CSIR-IHBT and facilitated the overall system to meet the set goals and targets. The division was significant roles in every phase of a staff's career development provides continued support from recruitment to superannuation. Administration connects all staff as a central unit and facilitate academic aspirations, career progression, housing and health care needs. The administration does the following:

- Formulates and implements policies concerning administrative procedures for smooth functioning of the institute.
- Provide advice to functional bodies (committees/functional groups) within the organization.
- Maintains liaison with CSIR Headquarters on matters related to administration.
- Provides healthy working conditions and environment in the laboratory through interpretation as well as implementation of governing rules and regulation.
- Assists the authorities of the laboratory, namely, the Director, the Head of Departments and the Principal Investigators on issues and decisions of administrative nature.

The division is headed by the Administrative Officer, who is the over all In-charge of the activities. He is supported by Section Officers, a group of assistants, and supporting staff including security services and Hindi cell. The security department which is headed by a security assistant is responsible for the safety and security of the institute.

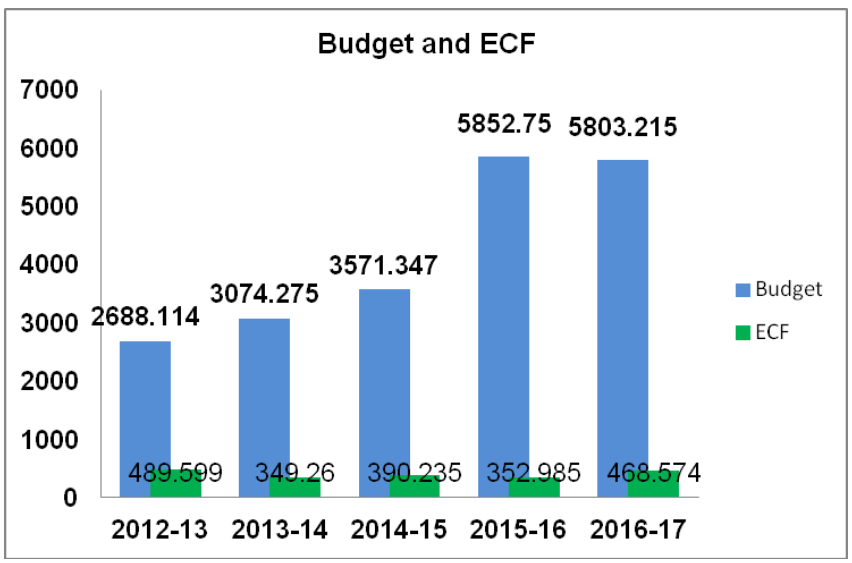
In recent past, the administration has undergone major transformation in terms of work culture and implementation of paperless processes. An improved work culture and decentralized leadership introduced at all levels to bring the desired changes. A trend of faster service delivery system has been inculcated in the staff to match the expectations of CSIR-Enterprise Transformation initiative.

FINANCE & ACCOUNTS

Finance & Account section is playing a vital role in the management of finances and providing support to scientific, technical as well as other administrative officials. The division manages the activities of budgetary control and adopts remedial measures for optimum utilization of allocation according to the guidelines of CSIR. In addition to this, it maintains accounts of the institute as per CSIR guidelines and also provides services for effective planning, utilization and post utilization of grants received for, grant-in-aid sponsored consultancy, collaborative projects and technical services aid.

Broad activities of Finance and Account section are:

- Assist and advise Director on financial, auditing and accounting related matters
- Preparation and compilation of revised estimate and budget estimate of the institute
- Management of financial resources received from CSIR, GAP, Sponsored, CNP & CLP projects
- Ensuring scrupulous implementation of financial directives of the Government of India
- Offering financial concurrence to the proposals developed in the institute
- Keeping liaison with CSIR HQ on financial, accounting and audit related matters
- Co-ordinating the duties related to CAG and CSIR internal audit and providing their replies
- Authorization of the payment to all suppliers, contractors and service providers
- Authorization of the payment to all employees for their official and personal claims
- Maintenance of various accounting records as per CSIR guideline
- Maintenance of various records of bank debits, credits, DD, NEFT, RTGS, etc
- Finalization of pension, family pension, timely issuance of PPOs and timely payment of pensionary benefits.
- Investment of resources from laboratory reserve funds.



STORE & PURCHASE

The Store & Purchase division is mainly responsible for the procurement of capital equipments from India and abroad, purchase of spares and consumable items, Annual Rate Contracts (AMCs) of equipments, annual rate contracts (ARCs) for chemicals, etc. The division also maintains a minimum inventory of routine consumable items such as office stationary, cleaning items, hardware, plumbing, etc. Technical & Purchase Committee, Equipment Prioritization Committee, Standing Disposal Committee etc. help the division take suitable decisions as per the CSIR procedures. The division also co-ordinates activities between indenting, planning, accounts, administration, vendor and various agencies like bank, customs, insurance, transportation, clearing and forwarding agents.

The major procurements made during 2016-17

- LIDAR System
- High Performance Computing Server System
- Novaseq Sequencing System
- Flash Chromatography System
- Environmental Test Chamber
- Hypoxia Chamber
- Biovia Discovery Studio Software
- Synergy Multimode Microplate Readers
- Large Scale Reactor System
- HPLC System
- Automated Media Preparator
- Automated Media Filling System
- Refrigerated Incubated Shaker
- Unmanned Aerial Vehicle (UAV)
- Gas Chromatograph,
- Acquity UPLC H-Class Core System

COMPUTER CELL

This section takes care of managing existing IT resources of the institute including a fleet of servers from HP, IBM, Supermicro, used for hosting website, DNS, centralized antivirus solution etc.

The institute is one of the nodal points of National Knowledge Network (NKN) connectivity as a part of CSIR programme under the Govt. of India's National Programme. As per the programme dedicated 1GBps WAN link is provided on optical fiber backbone through which internet facility on LAN and Wi-Fi has been provided to laboratory, hostel and faculty residences in the campus.

Network security hardware used for LAN & WAN comprises of almost 30 high speed switches, Unified Threat Management System (UTM/Firewall), wireless controller on high availability and their policies were deployed to protect CSIR-IHBT resources centrally.

Computer Section also facilitated cirtual classroom and video-conferencing facilities in the Institute.

As a routine job, this cell constantly extended services related to network, computers and peripherals over LAN in the campus. The cell also coordinates AMCs for computer and peripherals.

LIBRARY: IHBT-Knowledge Resource Centre (IHBT-KRC)

The library of the institute continues to procure and manage a range of knowledge resources including research journals in online & print mode, books, subject encyclopedias, research reports, online and CDs databases. Thesis in the field of science and technology. The library supports research and academic activities of the institute with a range of services including reference and consultation, circulation, document delivery, reprographic, resource sharing, information alert, user awareness using ICTs for web based library management and its services. This resulted in new knowledge generation by researchers of the institute. Assistance and information were provided 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.

The library has books in English as well as Hindi. The books include once on subjects such as biochemistry, genes, nanotechnology, floriculture, medicinal plants, bioinformatics, social science, science, religions, biographies, literature, etc. The library has bibliographic information in KOHA software on library management with hyper links of records available on internet and can be accessed over internet through- http://library.ihbt.res.in.

Library OPAC: The Online Public Access Catalogue (OPAC) is accessible on CSIR-IHBT website to search all the bibliographic records available in the library database through KOHA software. It allows on-line reservation, renewal and recommendation for new resources, besides indicating the status of a particular document. The user can check status of the issued books through KOHA software. It is searchable by keywords, author, title, publisher, accession number, subject etc. at http://14.139.59.218/ in addition to a link in library website.

National Knowledge Resource Centre (NKRC): NKRC is a national consortium of CSIR and DST libraries with an aim to provide a wide range of quality knowledge resources. The library has been the founder member of this consortium. Scientists and scholars of the institute are being facilitated to access to 2500+ e-journals of all major publishers, patents, standards, citation and bibliographic databases through this consortium. Apart from licensed resources, NKRC is also a single point entity that provides its users with access to a multitude of open access resources. The consortium envisions to emerge as a leader to serve the R&D sector with much needed information and strengthen the research and development system in the country (http://nkrc.niscair.res.in/ indexpage.php).

Citations: Citation reports were prepared for research articles and made available to scientists of the institute aiming to assess the impact of research done and published by them. This work was done by using the international resource like Web of Science, SciFinder and google scholar.

User orientation: Orientation of new users on accessing of online journal, OPAC and databases or learning how to find out a particular resource like bound journals, books etc. was provided for wide and effective use of resources.

Reference Service: Queries related to journal articles and specific topics are being attended to with print and online resources. Bibliographic as well as full text of reference is also being provided.

Photocopy and printing service: Printing requirements for relevant documents such as institute brochures official documents, project proposals and project reports by scientists, scholars and staff of the institute, binding of documents is also being facilitated .

Newspapers clipping service: Library is subscribing to 16 daily newspapers of Hindi and English languages. All the newspapers subscribed are scanned and marked important. News related to activities of the institute and scientific items are being disseminated to scientists for information. Library is managing of Newspaper Clippings Blog at- http://ihbtinnews.blogspot.in/.

During the year, the library was visited by 5065 visitors including scientists, students, research scholars and faculty members from several academic and R&D institutions to consult library resources and to access more than one lakh accesses from online resources. Library provided photocopying/ laser printing service to scientists, research scholars and staff of the institute. The books procured were 299 and 6 theses were added to the library collection.

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THESIS/DISSERTATIONS/REPORT/SUPERVISED

Ph.D.

Kumari Reenu (2016) Understanding molecular basis of cucumber mosaic virus movement in plants**.** Supervised by Dr. Vipin Hallan.

Chawla Vandna (2016) Computational Analysis of Next Generation Sequencing Data. GNDU, Amritsar, Punjab, Supervised by Dr. Ravi Shankar.

Walia Yashika (2016) Apple scar skin viroid*:* Infectivity and identification of interacting protein. Supervised by Dr. Vipin Hallan.

M.Sc./ M. Tech.

Gaurav (2016) Mapping of burnt areas due to forest fires in Dharamshala tehsil of Kangra district in Himachal Pradesh India using Remote sensing and GIS. Institute of Environmental Studies, Kurukshetra University, Kurukshetra Supervised by Amit Kumar.

Rakhi (2016) Geospatial mapping of forest fire affected areas in Palampur region of Kangra district in Himachal Pradesh. Institute of Environmental Studies, Kurukshetra University, Kurukshetra Supervised by Amit Kumar.

Yogesh Pant (2016) Morphological and Biochemical Studies on Chitinase expressing transgenic tea plants. CSK HP Krishi Vishwavidyalaya, Palampur Superised by Dr. Amita Bhattacharya.

Renu (2016) Studies on *in vitro* propagation and genetic transformation of important scion varieties of apple. CSK HP Krishi Vishwavidyalaya, Palampur Superised by Dr. Amita Bhattacharya.

B.Sc./ B. Tech.

Jaiswal Ananya (2017) Establishment of *in vitro* culture and aeroponic cultivation of *Rhodiola* species. Bundelkhand University, Jhansi, Supervised by Aashish Warghat.

Kumar Anil (2017) Comparative evaluation of major constituents in different soft drinks and tea Infusions. CSK Himachal Pradesh Agriculture, University, Palampur, (H.P.), Supervised by Ajay Rana.

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Singh Shiwangi (2017) Establishment of *in vitro* culture and aeroponic cultivation of Rhodiola species. Bundelkhand University, Jhansi, Supervised by Ashish Warghat.

TRAININGS IMPARTED

Ananya Jaiswal. (2017) Establishment of *in vitro* culture and aeroponic cultivation of *Rhodiola* species. Bundelkhand University, Jhansi, Supervised by Ashish Warghat.

Asifa Mumtaz. Comparative study of *Arabidopsis thaliana* and AtPSOD in response to metal stress, School of Biosciences and Biotechnology Baba Ghulam Shah Badshah University Rajouri (J&K, INDIA), CSIR-IHBT, February–June, 2017, under supervision of Dr. Rajiv Kumar.

Bazila Mustaq. Proteomic study of *Picrorhiza kurroa,* Baba Ghulam Shah Badshah University, Rajouri Jammu & Kashmir, CSIR -IHBT, February–June, 2017, under supervision of Dr. Rajiv Kumar.

Deepak Thakur. Analysis of plant functional traits in the temperate forest at Dhauladhar wildlife sanctuary, western Himalaya. Central University of South Bihar, Patna, 2016 under supervision of Dr. Manoj Kumar.

Devi Gopinath. ICAR-Indian Veterinary Research Institute, Bareilly was provided Professional Attachment Training (PAT), 15th November, 2016 to 14th February, 2017. Dr. Y.S. Padwad, Dr. Vikram Patial and Dr. Damanpreet Singh.

Himanshu Kaushik. Analysis of leaf litter nutrients and its effect on soil properties of temperate forests at Dhauladhar wildlife sanctuary, western Himalaya. Central University of South Bihar, Patna, 2016 under supervision of Dr. Manoj Kumar.

Kumari Anandita. Analysis of leaf traits of selected high altitude medicinal plants in different environmental conditions. Central University of Rajasthan, Ajmer, 2016 under supervision of Dr. Manoj Kumar.

Manpreet Kaur (2016) Basic *in vivo* and *in vitro* techniques. Department of Biotechnology, Guru Nanak Dev University, Amritsar completed her training for M.Sc. Biotechnology (01/06/16-30/06/16) Supervised by Dr. Damanpreet Singh.

Shivali Sharma. Ambala An exposure to basic in vivo and molecular techniques. College of Engineering and Applied Research, Haryana, 14 Juneto 28 July, 2016 under supervision of Dr. Vikram Patial.

Shiwangi Singh (2017) Micropropagation and hydroponic cultivation of *Stevia rebaudiana* (Bertoni). Bundelkhand University, Jhansi, Supervised by Ashish Warghat.

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CONFERENCE/TRAINING/WORKSHOP/SYMPOSIUM PRESENTATIONS

Kumar, A., Kumar, D., Padwad, Y.S. and Agnihotri, V.K. Phytochemical studies and value addition of *Saussurea lappa* from Western Himalaya, India. 4th International Congress of Society for Ethnopharmacology, (SFE-India) "Healthcare in 21st Century: Perspectives of Ethnopharmacology & Medicinal Plant Research", 2017, 310, held on Feb 23-25, at Uka Tarsadia University, Bardoli, Dist. Surat, Gujarat, India.

Kumar, R.,Sharma, S. and Walia, S. (2016) Conservation and cultivation of high altitude medicinal plants in cold desert region of the western Himalayas. Proceedings of workshop on High altitude Medicinal Plants held at ICFRE Dehradun, March 21-22.

Pal, P.K. (2016) Agrotechnology of Stevia: A Natural Sweetener. CSIR Platinum jubilee Technofest - 2016, November 14-27.

Sharma, M., and Pal, P.K. (2016) Difference between a world with and without stevia. International Symposium on Herbal Sweetener 'Stevia' - a Boon to Diabetics. Lovely Professional University, April 21.

Sharma, S., Singh, A., Sharma, M., Singh, B. and Kumar, R. (2016) Effect of harvesting time on essential oil content and composition of *Artemisia maritima* in the cold desert region of the western Himalayas. Extended summary 4th International Agronomy Congress held at IARI, New Delhi, pp 210-211, November 22-26.

Sharma, U. (2017) "Efforts towards characterization of bioactive molecules from medicinal plants" 4th International Congress of the society for Ethnopharmacology, India Healtcare in 21st century: Perspectives of Ethnopharmacology & Medicinal Plant Resarch, UKA Tassadia University, Bardoli, Surat, Gujrat, February, 23-25.

Thakur, M., Prasad, R., and Kumar, R. (2016) Crop weather interaction studies in damask rose (Rosa damascena Mill.) in the Western Himalaya. Extended summary 4th International Agronomy Congress held at IARI, New Delhi, pp 65-66, November 22-26.

Walia, S. and Kumar, R. (2016) Introduction and domestication of ginseng (*Panax ginseng*) in cold desert region of Western Himalayas. Extended summary 4th International Agronomy Congress held at IARI, New Delhi, pp 214-215, November 22-26.

Rana, R.K., Singh Ashok, Dhaliwal, Y.S. and Singh V. 2016. Selection of high yielding land races of Seabuckthorn from wild seedling population of Lahaul and Spiti District of Himachal Pradesh, India. Eds by: Virendra Singh et al. In: Proceedings of 7th Conference of International Seabuckthorn Association on *Seabuckthorn: Emerging Technologies for health protection & Environmental Conservation*, from November 24 - 26, 2015, NASC Complex, New Delhi, India. pp.108-111.

CONFERENCE/TRAINING/WORKSHOP/MEETING ATTENDED

Agnihotri, V.K. (2016) Asian Aroma Ingredients Congress & Expo 2016 on the topic "Asian Aroma Resources–glimpse into the future" organized by Essential Oil Association of India at Hotel Leela Ambience Hotel, Delhi, April 22-24.

Bhattacharya A (2017) Attended 28th Annual meeting of Plant Tissue Culture Association (India) at IICB, Kolkata, March 3-5.

Brij Lal (2016) Ayurvedic Pharmacopoeia Committee (APC)-Industry Interactive Workshop, CSIR-IHBT Palampur, August 29.

Chawla, A. (2016) Undertook 05 days Level 1 Infrared Training Centre (ITC) Thermography course at New Delhi, December 05-09.

Kumar, A. (2016) attended 45th PSC meeting of National Medicinal Plant Board (NMPB), Ministry of AYUSH, Govt. of India, New Delhi for the review of submitted project proposal entitled "Development of geo–tagged digital database and spectral library of medicinal and aromatic, AYUSH Bhawan, New Delhi, June 27.

Kumar, A. (2016) Attended task force review meeting of Network Programme on Convergence of Traditional Knowledge Systems for Integration to Sustainable Development in the Indian Himalayan Region under National Mission for Sustaining the Himalayan Ecosystem (NMSHE) Supported by Department of Science and Technology, Govt. of India, School of Environmental Sciences, Jawaharlal Nehru University, New Delhi, October 3.

Kumar, A. (2016) Attended training on Hyperspectral Imaging System at Norsk Elektro Optikk (NEO). Skedsmokorset, Oslo, Norway June 6-10.

Kumar, A. (2016) Attended Young Scientist Conclave in India International Science Festival (IISF) 2016. CSIR-National Physical Laboratory, New Delhi, December 7-11.

Kumar, A. (2017) Attended 1st PAMC meeting of Network Project on Imaging Spectroscopy & Applications (NISA), Department of Science & Technology, Govt. of India. Indian Institute of Space Science & Technology, Thiruananthpuram, Kerala. February 23-25.

Kumar, A. (2017) Attended project review meeting on "Alpine ecosystem dynamics and impact of climate change in Indian Himalaya" (PRACRITI-II) Space Applications Centre (ISRO), Ahmedabad, Gujarat, February 21–22.

Kumar, A. (2017) Attended project review meeting on "Alpine ecosystem dynamics and impact of climate change in Indian Himalaya" (PRACRITI-II). Space Applications Centre (ISRO), Ahmedabad, Gujarat, February 21–22.

Kumar, M. (2016) Attended and invited lecture in a national conference entitled "Prayavarn Pradooshan: Karan ewam Nivaran (पर्यावरण प्रदूषण : कारण एवं निवारण)" at CSIR- Indian Institute of Toxicology Research, Lucknow, October 20.

Kumar, M (2016) Attended and invited lecture in an international conference entitled "4th India Biodiversity Meet – 2106. ISI, Kolkata and Berhampore, October 24 – 27.

Kumar, M. (2016) Attended and oral presentation in an international Conference on "Mathematical Modeling and Simulation" B.H.U., Varanasi August 29-31.

Kumar, R. (2016) Attended meeting on the issues regarding landscaping, financing and development of herbal garden both for purpose of Ayurvedic medicinal plants demonstration and tourist destination. Principal secretary (Ayurveda), Armsdale Building, HP Secretariat Shimla, HP, August 5.

Kumar, R. (2016) Participated in Second Group monitoring Workshop & Third Meeting of the Programme Advisory Committee – Earth & Atmospheric Sciences (PAC-EAS). SERB at SMVD University, Katra, August 31, 2016.

Kumar, R. (2016) Workshop on medicinal plant. NMPB, Ayush Bhawan, GPO Complex, INA, New Delhi, May 6.

Kumar, R. and Bhargav, V. (2016) Training programme on science and technology for rural, Indian Institute of Public Administration, New Delhi, November 7-11.

Kumar, R. and Bhushan, S. (2017) Digital Exchange of Data and Information. CSK HP Krishi Vishvavidyala, March 9-10.

Kumar, S and Sud, R.K. (2016) Interactive Meet for Medicinal Plants, Chaired by Minister of Ayurveda, H.P. Sh. Karan Singh at Kullu, September 14.

Kumar, S., Lal, B., Sud, R.K., Vats, S.K., Sharma, R.K., Uniyal, S. and Gupta, M. (2017) Attended 11thUttrakhand State Science and Technology Congress 2016-17 as subject experts, Dehradun, March 02-04.

Meenakshi, Kumar, S. and Upadhyay, V. (2016) attended five days training program on "Imaging spectroscopy and its application, held National Agricultural Science Complex (NASC), New Delhi. Environmental Sciences, Jawaharlal Nehru University, New Delhi, December 20-24.

Nadda, G. (2016) Meeting of Management Committee for Implementation of Pilot Scheme for Revival of Kangra Tea in Himachal Pradesh at Tea Board of India office at Palampur, June 13.

Patial, V., Singh, D., and Padwad, Y.S. (2016) attended workshop on Agriculture Research and Technical Terminology. Commission for Scientific and Technical Terminology, Ministry of Human Resource Development at DGCN, COVAS, CSKHPKV Palampur, May 19-20.

Singh, B., Gulati A., Lal B., Sud, R.K., Vats, S.K., Sharma R.K., Agnihotri V.K., Sharma, U. (2016) APC-Industry Interactive Workshop at CSIR-IHBT Palampur organised By the Central Council for Research in Ayurvedic Sciences, Ministry of Ayush, August 29.

Singh, D., Patial, V. (2016) attended Ayurvedic Pharmacopia Committee (APC)-Industry Interactive Workshop for the classical Ayurvedic Drug Manufacturers of Northern Region organized by Ministry of AYUSH at CSIR-IHBT, Palampur (29/08/16).

Singh, S. (2016) Workshop on Socio-Economic Impact Assessment of R&D Outcomes at CSIR-HRDC, Ghaziabad, October 24 – 26.

Singh, S. (2017) Training program cum workshop on Science and Technology Policy at INSA, New Delhi by Zaheer Science Foundation, February 13-17.

Singh, S. (2017) Workshop on Sexual Harassment of Women at Workplace: Prevention, Redressal & Procedures at CSIR-HRDC, Ghaziabad, January 27 – 28.

Sud, R.K. (2016) Brainstorm-cum-Interactive Meet on Herbal Drug Pipeline Project, organized by DBT at New Delhi, May 18.

Sud, R.K. (2016) Meeting of Management Committee for Implementation of Pilot Scheme for Revival of Kangra Tea in Himachal Pradesh at Tea Board of India office, Palampur, May 13.

Sud, R.K. (2016) State Tea Development Board meeting chaired by Hon'ble Chief Minister of H.P. at Shimla, April, 08.

Sud, R.K. (2017) The Millennium Alliance by FICCI & USAID at Shimla, February 10.

Sud, R.K. (2017) SMC meeting of the network Project "Introduction, Domestication, Improvement and Cultivation of Economically Important Plants, AGTEC (BSC0110)" at Mysuru, January 23-

25.

Sud, R.K., Saini, K. and Dhadwal, V.S. (2017) Cultivation of medicinal crops in Paprola, January 13.

Uniyal, S.K. (2017) Attended the Indo Himalayan Climate Adaptation Programme meeting at the Swiss Embassy, New Delhi during January 17-18.

Uniyal, S.K. (2017) Attended the Indo-Swiss Joint Expert Group meeting on Joint collaboration held at Swiss Embassy, New Delhi during March 14-15.

Uniyal, S.K. (2017) Attended the National Mission on Sustaining the Himalayan Ecosystem meet held at Development Alternatives, New Delhi during January 30-31, 2017.

कुमार एम (2016) भारत सरकार वैज्ञानिक तथा शब्दावली आयोग द्वारा भारतीय चरागाह एवं अनुसंधान संस्थान, पालमपुर, हिमाचल प्रदेश में "कृषि अनुसंधान एवं तकनीकी शब्दावली" विषयक सेमिनार में भाग लिया.

INVITED LECTURES FROM CSIR-IHBT

Acharya, V. (2016) Functional Analysis of Pathogenicity genes of Plant Pathogens. ICAR, IARI, New Delhi, 6 January.

Acharya, V. (2016) Quandary in the distribution of defence signalling regulators in the genome of early green plants. Invited and presented talk on Biosciences Study Circle (BSC) seminar on faculty and PG students at Central University of Himachal Pradesh, Dharamshala, 27th April.

Agnihotri, V.K. (2017) Bioinspired Surfaces. A lecture was organized at institutional level entitled delivered by Professor Jaspal Badyal, FRS, Durham University, UK, March 28.

Brij Lal (2016) Combating desertification: land degradation and drought. Government Senior Secondary School, Khalet (Thakurdwara), Palampur, May 23.

Das, P. Frontiers in Chemistry 2017, Department of Chemistry, University of North Bengal, February 20-21, 2017.

Kumar, A. (2016) Basics of remote sensing, satellites and sensors. Institute of Science Education and Research (IISER), Mohali, Punjab, August 16, 2016.

Kumar, A. (2016) Remote sensing for vegetations. Institute of Science Education and Research (IISER), Mohali, Punjab, August 17.

Kumar, D. Metabolomics: Driving value with comprehensive solutions for chemical information and quality control of ethnomedicines. 4th International congress of the Society for Ethnopharmacology, India Healthcare in 21st Century: Prospective of Ethnopharmacology and Medicinal Plant Research dated, 23-02-2017 to 25-02-2017 Uka, Tarsadia University, Bardoli, Surat, Gujrat.

Nadda, G. (2016) Insect Pests of Tea and Their Management at TO Tea Office Palampur, August 12.

Nadda, G. (2016) Insect Pests of Tea with Special Reference to Mites and Their Management, during CSIR-Foundation day and Kisan Mela at CSIR-IHBT, Palampur, September 26.

Pal, P.K. (2016) Agrotechnology of Stevia: A Natural Sweetener in CSIR Platinum Jubilee Technofest-2016, during India International Trade Fair, New Delhi, November 23.

Sharma, M. "Difference between a World with and Without Stevia" at International Symposium on Sweet Revolution-Stevia organized by Green Valley Stevia in collaboration with Lovely Professional University, Phagwara on 21st April, 2016.

Singh, B. and Sur, R.K. (2016) Prospects of Medicinal and Aromatic Plants in HP, in Opportunities in Industrial Phytochemicals - Bridging the gap of Academia-Industry-Farmers of Himachal Pradesh at IIT Mandi, July 30.

Sud, R.K., (2016) Manufacturing methods and Pruning & Skiffing in Tea, in exposure visit of tea planters to CSIR-IHBT. State Agri Deptt., Palampur, December 03.

Sud, R.K., (2016) Marketing of Kangra tea in Workshop on Marketing of Tea, organised by State AgriDeptt., Palampur, June 28.

Sud, R.K., (2016) Production of Quality Tea, in Tea workshop-cum-Training Camp for Tea Growers, organised by State Agri. Deptt. Palampur, November 07.

Sud, R.K., (2016) Quality production of Green Tea and Plucking Management in Tea Workshop-cum-Training Camp on Tea, organised by State Agri Deptt., Palampur, May 24.

Sud, R.K., (2016) Role of CSIR-IHBT in Societal Development, in CSIR Platinum Jubilee Technofest-2016 during India International Trade Fair, New Delhi, November 23.

Sud, R.K., (2016) Tea Farm Mechanization during of CSIR-Foundation day and Kisan Mela at CSIR-IHBT, Palampur, September 26.

Sud, R.K., (2017) Lecture on Himalayan Medicinal and Aromatic Crops for Improving Farmers' Income, in Kisan Mela. CSIR-CIMAP, Lucknow, March 31.

Sud, R.K., (2017) Role of CSIR-IHBT in Development of Kangra Tea Industry in a Workshop on Kangra Tea Geographical Indications (GI). HP State Council for S&T, CSIR-IHBT, Palampur, March 24.

Sud, R.K., and Saini, K. (2016) Cultivation of promising aromatic crops in Chamba district. Sihunta, Chowari, Tissa, April 12-13.

Sud, R.K., and Saini, K. (2016) Cultivation of Tagetesminuta in Sihunta Chuwadi regions of Chamba regions: Practical demonstration and seed distribution, May 10.

Sud, R.K., Kumar, R. and Saini, K. (2016) Cultivation of promising aromatic crops in Mandi and Sundernagar regions, May 12.

Uniyal, S.K. (2016) Biodiversity loss and habitat degradation. Government Senior Secondary School, Khalet (Thakurdwara), Palampur, June 6.

VISITS ABROAD

Amit Kumar visited Norway to attend training on Hyperspectral Imaging System at Norsk Elektro Optikk (NEO), Skedsmokorset, Oslo, Norway, June 6-10, 2016.

DISTINGUISHED VISITORS

Shri Ambuj Sharma, IAS, additional Chief Secretary "I am very impressed with the facilities and technical expertise at IHBT, Palampur, especially the initiatives to preserve and augment the many dwindling plant species in upper reaches of HP. My best wishes to Dr. Sanjay Kumar, Director and his Team CSIR-IHBT", May 13, 2016.

Dr. Anil Kumar Tripathi, CSIR-CIMAP, Lucknow, "Delegated to visit CSIR-IHBT second time and to interact with the scientist and students of this unique institute located in the lap of picturesque Himalayan, was happy to feel the enthusiasm of student and all round development that have taken peace in CSIR-IHBT. I am confident that the work carried out here will soon start benefitting the society in a big way", My best wishes to Dr. Sanjay Kumar and his Team CSIR-IHBT", May 6, 2016.

Dr. KC Gupta, IIT Kanpur & IGIB Delhi, "It was indeed a great pleasure to visit CSIR-IHBT first time in my life. I was highly impressed to see all-round progress in the institute. I had an opportunity to interact with scientist & students. I am sure institute will make constant progress under the dynamic leadership of Dr. Sanjay Kumar. It has all the potential to meet the new challenges of present time" My best wishes to Dr. Sanjay Kumar and his Team CSIR-IHBT", May 13, 2016.

Dr. Harsh Vardhan, Minister of Science & Technology & Earth Sciences, Govt. of India, It was indeed a treat to spend a day at CSIR-IHBT, Palampur with the scientist and young researcher today. The Accomplishments of the institution till now are worth placing on record the young people appear very enthusiastic and energetic. We need to connect move and move with the people – there is the use potential & Capability to help the people and particularly the farmers of the country for this prestigious institutions all my good wishes and prayers all of you here" October 18, 2016.

Dr. Gurdev S. Khush, University of California (USA), "I am delighted to have the opportunity to visit CSIR-IHBT. I had the opportunity to see many labs, which are very well kept and have latest equipment. Staff is young and very enthusiastic and research program are well focused. Institute is not only studying the native plants but are preparing very useful products. These are useful for our people and the research results are being reported in outstanding scientific journals. I have great satisfaction with my visit" March 28, 2017.

POSTER PRESENTED

Kumar A, Kumar D, Padwad YS and Agnihotri VK (2017) Phytochemical studies and value addition of *Saussurea lappa* from Western Himalaya, India. 4th International Congress of Society for Ethnopharmacology, (SFE-India) "Healthcare in 21st Century: Perspectives of Ethnopharmacology & Medicinal Plant Research", 310, Uka Tarsadia University, Bardoli, Surat,

Gujarat, India, February 23-25.

Kumar M, Kumar N, Singh B and Sharma, U. (2016) Harnessing bio-based reagents for C-N bond formation reactions. 21st International Conference on Organic Chemistry, IIT Bombay, December 11-16.

Kumar R, Dhiman AK and Sharma U (2016) Catalyst and solvent free access to bioactive quinoline derivatives. 21st International Conference on Organic Chemistry, IIT Bombay, Bombay, December 11-16.

Nayal OS, Thakur MS, Kumar N, Sharma U and Singh B (2017) Novel approaches for the synthesis of tertiary amines via carbocationic pathway. VI National Symposium on Advances in Chemical Science at GNDU, Amritsar, Punjab, 5-6 March.

Sharma R, Kumar I and Sharma U (2016) Rhodium-catalyzed remote C-H activation using traceless directing group. 21st International Conference on Organic Chemistry, IIT Bombay, Bombay, December 11-16.

Sharma S, Kumar N, Singh B and U. Sharma (2016) Bioactivity to organocatalysis: Introduction of vasicine for C-C bond formation and reduction reaction. 21st International Conference on Organic Chemistry, IIT Bombay, Bombay, December 11-16.

Walia S and Acharya A (2016) Fluorescent nanoprobes for specific detection of organochlorine and organophosphate pesticides in aqueous medium. ICTAM-AMF10, jointly organized by STAMI and University of Delhi, Delhi, November 7-11.

PRIZES/AWARDS/RECOGNITIONS

Vishal Acharya received Bioclues Innovation, Research and Development (BIRD) Award for outstanding contributions in the area of Bioinformatics and Functional Genomics from Bioclues organization, an affiliate of International Society for Computational Biology and Asia-Pacific Bioinformatics Network, 2016.

Brij Lal, has been invited as a Judge to adjudge 3 best exhibits among the participants of the *'Inter School Science Exhibition 2016'* organized by Capt. Saurabh Kalia Welfare Foundation, Palampur at DAV Public School Palampur, June 29, 2016

Brij Lal, was recognized an expert member by State Medicinal Plant Board, H.P. Shimla regarding for 'Landscaping and Development of Herbal Gardens' at Regional Institute in ISM, Jogindernagar, Mandi, HP on August 17, 2016.

Vipin Hallan received Shri VP Gokhale award for significant contribution in the field of Phytopathology, administered by MACS ARI and Maharashtra Association for the Cultivation of Science. Maharashtra,2016.

Sushil Kumar Maurya received Early Career Research Award, SERB-DST, Govt of India (Ref: ECR/2016/000134); Project: "Adjuvants Based on Hybrid Antibiotics to Combat Resistance: Design, Synthesis, and Versatile Therapeutic Evaluation of Novel Fluoroquinolone-

Aminoglycoside Conjugates (FACs)". June 2016-2019.

Sanjay Kr. Uniyal selected as a Member of the Medicinal Plants Specialists Group (18/07/2016) of the International Union for Conservation of Nature (IUCN).

Sanjay Kr. Uniyal invited as an Expert in Botany to evaluate presentations and posters during the 11th Uttarakand State Science and Technology Congress held at Dehradun during March 2-4, 2017.

Sanjay Kr. Uniyal invited as an Expert member for assessment at CSIR-NBRI on March 23, 2017.

Upendra Sharma received Manjushree Pal Memorial Award for Best Oral Presentation from Ethanopharmacology Society of India. In a conference "4th International Congress of the Society for Ethnopharmacology, India Healthcare in 21st century: Perspectives of Ethnopharmacology & Medicinal Plant Research", Surat, Gujarat, February 23-25, 2017.

Upendra Sharma received Thieme Chemistry Journal Award: The Thieme Chemistry Journals Award, established in 1999 with the aim to encourage young scientists, is granted to prospective chemists, who have been recognized as high-potential researchers in the field of synthetic organic chemistry by the editorial board members of SYNTHESIS, SYNLETT and SYNFACTS, 2016.

Damanpreet Singh received Early Career Research Award, SERB-DST, Govt of India (Ref: ECR/2015/000257); Project: "Development and evaluation of the molecular mechanism of Ketogenic diet for comprehensive management of epilepsy associated central and peripheral comorbidities in experimental animal models. August 2016-2019.

MEMBERSHIP OF PROFESSIONAL BODIES/OGRATNIZATIONS

Reddy SGE received Pest Management in Horticultural Ecosystems, Division of Entomology, ICAR-IIHR, Hessaraghatta Lake post, Bangalore, Karnataka, 2000 to till date.

Manoj Kumar nominated a Member of Indian Academy for Mathematical Modeling and Simulation, Indian Institute of Kanpur, Kanpur, India.

Manoj Kumar nominated a Member of International Society for Tropical Ecology, Banaras Hindu University, Varanasi India.

STAFFS

Director
Dr. Sanjay Kumar

Chief Scientist
Dr. Bikram Singh

Sr. Principal Scientist
Dr. Ashu Gulati
Dr. Brij Lal
Dr. R.K. Sud
Sh. K.K. Singh
Dr. Aparna Maitra
Dr. Amita Bhattacharya
Dr. Gopi Chand

Principal Scientist
Dr. S.K. Vats
Dr. Vipin Hallan
Dr. Sanjay Kuma Uniyal
Dr. Ram Kumar Sharma
Er. Amit Kumar
Dr. Sanat Sujat Singh
Dr. Rakesh Kumar

Senior Scientist
Dr. Shashi Bhushan
Dr. Pralay Das
Dr. Gireesh Nadda
Dr. Vijay Kant Agnihotri
Dr. Ravi Shankar
Dr. Probir Kumar Pal
Dr. Rituraj Purohit
Dr. Sushil Kumar Maurya
Dr. Dharam Singh

Scientist
Er. Mohit Sharma
Dr. Amit Chawla
Dr. Ashok Kumar
Dr. S.G.E. Reddy
Dr. Mahesh Gupta
Dr. Y.S. Padwad
Dr. Amitabha Acharya
Dr. Dinesh Kumar
Dr. Vikram Patial
Dr. Manoj Kumar
Dr. Damanpreet Singh
Dr. Vishal Acharya
Dr. Ashok Singh
Dr. Upendra Sharma
Dr. Bhavya Bhargava
Dr. Kunal Singh
Dr. Ashish Rambhau Warghat
Dr. Rajeev Kumar
Dr. Narender Vijay Tirpude

Principal Technical Officer
Sh. Mukhtiar Singh
Sh. Om Prakash

Senior Technical Officer (3)
Sh. R.S. Shekhawat

Senior Technical Officer (2)
Sh. Sukhjinder Singh
Dr. Robin Joshi
Dr. (Smt.) Kiran Devi

Senior Technical Officer (1)
Sh. Vikrant Gautam
Dr. Avnesh Kumari
Sh. Ramdeen Prasad
Sh. Jitender Bisht
Sh. Jai Prakash Dwivedi
Dr. Kiran Singh Saini
Sh. Shiv Kumar
Dr. Rajneesh
Dr. Pankaj K Markand
Sh. Bijan Bihari Garnayak
Sh. Ashok Gehlot

Sh. Kunjan Saxena

AEE (Civil)
Sh. Rakesh Verma
Sh. Anil Kumar

Technical Officer
Sh. Vivesh Sood
Sh. Mahesh S.
Sh. Mohit Kumar Swarankar
Sh. Ramjee Lal Meena
Sh. Jasbeer Singh
Sh. Mukesh Gautam
Sh. Om Prakash
Smt. Vijaylaya Pathania
Sh. Pabitra Gain
Sh. Aman Kumar

Technical Assistant
Smt. Meenakshi
Sh. Arvind Kumar Verma
Sh. Dharmesh Kumar
Sh. Anil Chaudhary
Sh. Pawan Kumar
Smt. Rimpy Dhiman
Sh. Virat Abhishek
Sh. Saurabh Sharma

Sr. Technician (2)
Sh. V.S. Dhadwal
Sh. Ajay Parmar
Sh. Dharuv Kumar
Sh. Karandeep Sood

Sr. Technician (1)
Sh. Parveen Kumar
Sh. Ramesh Kumar
Sh. Kuldeep Singh

Technician (2)
Sh. Sanjay Kumar
Sh. Avinash Chander Rana
Sh. Sandeep Sood
Sh. Ranjeet Singh
Sh. Ajay Kumar

Technician (1)
Sh. Arvind Kant
Sh. Surjeet Singh
Smt. Jasveer Kaur
Sh. Vikas Kumar

Lab. Assistant
Sh. Amar Singh

Lab Attendent (1)
Sh. Girjanand
Sh. Baldev Singh
Sh. Balak Ram
Sh. Uttam Chand
Sh. Kuldeep Singh
Sh. Balwant Raj
Sh. Rakesh Chand
Sh. Deepak Sood

Lab Attendent (2)
Smt. Rajni Devi Chetri
Mrs. Anupama Saini
Sh. Shamsher Singh

Administrative Officer
Sh. Alok Sharma

Controller of Store and Purchase
Sh. Suresh Pant

Section Officer (Gen.)
Sh. S.D. Rishi
Sh. Amar Jeet

Section Officer (F&A)
Sh. Darshan Singh

Sr. Steno
Sh. Didar Singh Patial

Hindi Translator
Sh. Sanjay Kumar

Assistant (Gen.) Gr. I
Sh. Raj Kumar

Assistant (F&A) Gr. I
Sh. Manoj Kumar

Assistant (Gen.) Gr. I
Sh. Parveen Singh
Sh. Devraj Nagina
Sh. Ved Prakash
Sh. Kirti Raj
Smt. Santosh Kumari

Assistant (F&A) Gr. I
Sh. Vipan Kumar

Assistant (S&P) Gr. I
Sh. Rajeev Sood

Assistant (F&A) Gr. II
Smt. Aruna Kumari

Assistant (Gen.) Gr. II
Sh. Baldev
Sh. Kiran Kumar
Smt. Pooja Awasthi

Assistant (Gen.) Gr. III
Sh. Praveen Kumar
Sh. Sandeep Kumar
Sh. Ajay Singh Kaundal
Sh. Mukul Sharma

Assistant (S&P) Gr. III
Sh. Rajender Singh

Security Assistant
Sh. Trilok Nath

Coupon Clerk
Sh. Anand Sharma

Driver
Sh. Partap Chand
Sh. Braham Dass
Sh. Lakhvinder Singh
Sh. Nitesh Bhardwaj

Cook
Sh. Oman Singh
Sh. Karan Singh

Waiter
Sh. Vipan Kumar

Wash Boy
Sh. Shankar

Gr. 'C' (Non- Technical)
Sh. Thaman Bahadur

Chowkidar
Sh. Baleshwar Prasad
Sh. Kuldeep Singh
Sh. Devender Kumar

Tea Maker
Sh. Vipan Gurang

Frash
Smt. Rujala Devi

Staff Joined CSIR IHBT between 01.04.2016-31.03.2017

Sr. No.	Name	Designation	Date of joining
1.	Sh. Suresh Pant	Controller of Store & Purchase	11.04.2016
2.	Sh. Aman Kumar	Technical Officer	01.08.2016
3.	Sh. Ashok Gehlot	STO (I)	26.08.2016
4.	Sh. Rajender Singh	Assistant (S&P)Gr. III	03.10.2016
5.	Sh. Praveen Kumar	Assistant (Gen.) Gr. III	03.10.2016
6.	Sh. Sandeep Kumar	Assistant (Gen.) Gr. III	04.10.2016
7.	Sh. Mukul Sharma	Assistant (Gen.) Gr. III	05.10.2016
8.	Sh. Ajay Singh Kaundal	Assistant (Gen.) Gr. III	06.10.2016
9.	Sh. Kunjan Saxena	STO (I)	05.12.2016

Staff transferred/ left CSIR- IHBT between 01.04.2016-31.03.2017

Sr. No.	Name	Designation	Date	Reason
1.	Dr. G.D. Kiran Babu	Sr. Principal Scientist	27.05.2016	Transferred to CSIR–CIMAP Research Centre, Hyderabad
2.	Dr. Y. Sreenivasulu	Principal Scientist	10.06.2016	Transferred to CSIR-CCMB, Hyderabad
3.	Dr. Sudesh Kumar	Principal Scientist	11.04.2016	Resigned
4.	Sh. Parag Patar	F&AO	02.12.2016	Transferred to CSIR-CGCRI, Kolkata
5.	Dr. Partha Ghosh	Scientist	03.02.2017	Resigned

Expired

1.	Sh. Bhawani Ram	MTS, Gr.'C'	11.01.2017

EMERITUS SCIENTISTS/SCIENTIST FELLOWS/RESEARCH SCHOLARS

Name	Designation
Emeritus Scientists	
Dr. S.K. Sharma	CSIR-Emru. Scientist
Dr. Arvind Gulati	Emeritus Scientist
Scientist Fellows	
Dr. Ugir Hossain SK	Scientist Fellow
Dr. Tanuja Rana	Scientist Fellow
Dr. Ajay Rana	Scientist Fellow
Mr. Pierre Nobosse	TWAS - Fellow
Dr. Rakshak Kumar	DST INSPIRE Faculty
Dr. Rakesh Kumar	DST Young Scientist
Dr. Rohit Sharma	DST-Young Scientist (PI)
Dr. Promik Bhattacharya	NPDF
Mr. Praveen Dhyani	NPDF
Mr. Vijay Kumar	NPDF
Dr. Ashun Chaudhary	NPDF (PI)
Dr. Jyoti Bhardwaj	Project Investigator
Ms. Nidhi Sharma	Project Investigator
Ms. Reenu Kumari	Research Associate
Mr. Vinay Randhawa	Research Associate
Dr. Swati Verma	Research Associate
Ms. Priyanka Sati	Research Associate
Dr. Dipika Rana	Research Associate
Dr. (Ms.) Ruchi	Research Associate
Ms. Pallavi Sharma	Research Associate
Dr. Virender Kumar	Research Associate
Dr. Rachit R Kashyap	Research Associate
Ms. Isha Sharma	SRF
Ms. Shashi Kiran	SRF
Ms. Madhu Kumari	SRF
Ms. Shikha	SRF (INSPIRE)

Name	Designation
Research Scholars	
Mr. Bhuvnesh Sareen	Project Assistant Level-II / SRF ICMR
Ms. Monika Bhuria	JRF(NET) / SRF (NET)
Mr. Ajay Kumar	JRF(DBT) / SRF
Mr. Ashish Kumar	JRF(UGC) / SRF (UGC)
Ms. Poonam Roshan	JRF(NET) / SRF (NET)
Ms. Indu Gangwar	JRF(NET) / SRF (NET)
Ms. Kiran Mansingh Rawat	JRF(INSPIRE) / SRF(INSPIRE)
Mr. Rakesh Kumar	JRF(UGC) / SRF (UGC)
Mr. Inder Kumar	JRF(UGC) / SRF (UGC)
Ms. Bharti Lalhan	JRF(NET CSIR) / SRF (NET CSIR)
Mr. Ganesh Prabhakar Panjade	Project Fellow / SRF
Ms. Vandna Thakur	JRF / SRF
Mr. Abhishek Bhandawat	JRF
Mr. Pradeep Singh	JRF(Project) / Project Assistant - III
Ms. Poonam Bharti	JRF / Project Fellow
Mr. Gagandeep Singh	JRF
Ms. Shweta Guleria	Project Fellow/JRF
Mr. Dinesh Thakur	JRF / SRF
Mr. Dhananjay Bhattacharjee	JRF / SRF

Name	Designation
Mr. Saurabh Sharma	JRF (NET) / SRF
Mr. Vinod Bhatt	JRF (NET) / SRF
Mr. Sourabh Soni	JRF (NET) / SRF
Ms. Rubal Singla	JRF (UGC) / SRF
Mr. Roushan Kumar	JRF-NET / SRF
Mr. Maheshwar Thakur	JRF-UGC / SRF
Ms. Tanvi Sharma	JRF-ICMR / SRF
Ms. Nisha Dhiman	JRF-UGC / SRF
Mr. Arindam G. Majumdar	JRF-INSPIRE / SRF
Ms. Sunil Kumar	SRF-CSIR
Ms. Jyoti Chhimwal	SRF-CSIR
Ms. Shanka Walia	SRF-CSIR
Ms. Himankshi	SRF-CSIR
Ms. Ritika Sharma	SRF-CSIR
Mr. Archit Sood	SRF
Mr. Gopal Singh	JRF(UGC)
Ms. Shaifali	JRF(UGC)

Name	Designation
Ms. Namo dube	JRF(UGC)
Mr. Lakhbeer Singh	JRF(UGC)
Ms. Nikita Rathore	JRF
Ms. Meenakshi Thakur	JRF-Project
Mr.Rohit Rana	JRF (CSIR-NET)
Mr. Subhash Kumar	JRF-ICMR
Mr. Sachin Kumar	JRF-CSIR (NET)
Ms. Jyoti Devi	JRF-CSIR (NET)
Mr. Shiv Rattan	JRF-CSIR (NET)
Mr. Vipin Upadhayay	JRF
Mr. Shankar Ram	CSIR-JRF
Ms. Srishti Jaiswal	JRF
Mr. Upendra Pradhan	ISWP
Ms. Priyanka Dhaka	UGC-CSIR (NET)
Mr. Rohit	JRF
Ms. Syunkta Dharnal	JRF (NET)
Mr. Romit Seth	Research Fellow
Mr. Sourav Kumar	Research Fellow

OBITUARY

20/12/1933 -22/07/2016
Prof. N.K. Jain
Coordinating Director, CSIR Complex Palampur
(20/02/1984 to 31/12/1990)

OBITUARY

Dr. Paramvir Singh Ahuja
(19/12/1952 - 21/01/2017)
Director
(13/04/1998 to 07/05/2014)

Director General CSIR and Director CSIR-IHBT, Palampur
(08/05/2014 to 31/12/2014)

OBITUARY

Sh. Bhawani Ram
(15/03/1961 to 11/01/2017)
(Service :12-01-1994 TSW; 17-02-14 Regular)

NEWS CLIPPINGS OF IHBT

Develop industries around bio-resources: Dr Vardhan

RAVINDER SOOD

PALAMPUR OCTOBER 15

Union Minister for Science and Technology and Earth Sciences Dr Harsh Vardhan has urged local entrepreneurs to develop industries around local bio-resources of high commercial values.

The Union Minister, who visited CSIR-Institute of Himalayan Bio-resource Technology, here, last evening, stressed bio-resources in Himalayas should be used for identification of new bio-molecules of therapeutic importance, and developing crop varieties to withstand increasing biotic and abiotic stress in face of changing climate conditions. He exhorted young scientists and research scholars to play a great role in this area.

Dr Vardhan, who's also Vice-President of Council of Scientific and Industrial Research (CSIR), said

Himalayas are highly suitable for cultivation of high-value medicinal, aromatic and other crops of commerce. CSIR should develop a network of entrepreneurs for cultivation, processing and marketing of the produce. Dr Harsh Vardhan, union minister

since land holdings in the state were small, farmers could form societies and approach the institute for technical know-how to improve production.

Climatic diversity in the Himalayan region, he said, offered unique opportunities to develop range of products and technologies such as low calorie sweeteners, enzymes and microbial based products of societal and industrial significance. He advised the adoption of green technology and application of nanotechnology.

He noted that the Himalayan region had a vast bamboo resource which should be exploited for the development of various industrial products such as wooden board, textile yarn and activated charcoal.

Observing that Himalayas are highly suitable for cultivation of high-value medicinal, aromatic and other crops of commerce, he suggested that CSIR should develop a network of entrepreneurs for cultivation, processing and marketing of the produce in an organised manner.

IHBT Director Sanjay Kumar apprised the Union Minister of technologies given to various entrepreneurs and industrial partners and sign-

ing of the pact with Mozaffarpur's tea industry for transfer of tea wine technology.

The minister inaugurated the pilot plant facility/ instrumentals, Academy of Technology Extension, Bio and hydroponic and aeroponic facility. He interacted with institute's scientists and students, and entrepreneurs, farmers, who benefited from the institute in the area of floriculture, tea, medicinal and aromatic plants, fruits, sweeteners and enzymes.

Appreciating the technical support given to floriculturists that has boosted the income threefold, he asked the institute to ensure support of quality planting materials to farmers and provide services in back-up for the success of the industry. He was happy to note that the institute has promoted the ready-to-eat local cuisine 'Kangri Dham' which is preservative free with longer shelf life and wider marketability.

Scientists to explore commercial values of Himalayan crops

TIMES NEWS NETWORK

Dharamshala: Union minister for science & technology and earth science Harsh Vardhan, and vice-president of Council of Scientific and Industrial Research (CSIR) during his visit to CSIR-Institute of Himalayan Bioresource Technology located at Palampur has asked scientists and entrepreneurs to develop industries around local bioresources of high commercial values.

Minister said that since land holding size in Himachal Pradesh is small, farmers could form societies and approach the institute for technical know-how and improved cultivars. Information technology should be used for marketing of their produce. "Himalayan region offers unique opportunities to develop range of products and technologies such as low calorie sweeteners, enzymes and microbial based products of societal and industrial significance," he said.

He advised that adoption of green technology should be preferred and application of nanotechnology for enhancing efficacy of bioactive compound and metabolites for effective utilization should be rewarding.

Himalayan region has a vast bamboo resource which should be exploited for the development of various industrial products such as wooden board, textile yarn, activated charcoal and other industrial products, he added.

"Region is highly suitable for cultivation of high value medicinal, aromatic and other crops of commerce, the institute should develop a network of entrepreneurs for cultivation, processing and marketing of the produce in an organized manner. It will not only address the issue of increasing menace due to rising populations of monkeys, wild boar and ungulates in Himachal Pradesh, but will provide higher returns to the farmers as well," said minister.

For tackling the current issues of labor shortage and rising cost of tea production, promotion of tea farm mechanization, and development of value added product from tea, is a welcome step since its global market is expected to grow from current value of 4400 tonnes to 9200 tonnes by 2020. Similarly, tea based wines and ready-to-serve teas also have global demand, he added.

कांगड़ी धाम के संरक्षण से मंत्री खुश

पालमपुर - पालमपुर स्थित सीएसआईआर संस्थान द्वारा पोषक खाद्य

कृषि व विपणन को नैटवर्क हो तैयार

हरित प्रौद्योगिकी को अपनाने का करें प्रयास : डॉ. हर्षवर्धन

Now, tech for growing plants with roots in air

TIMES NEWS NETWORK

The plants at IHBT in Palampur, Kangra

aramshala: The Institute of Himalayan Bio-urce Technology at Palampur unveiled a nology to grow plants with their roots remain-g in air without having to plant them into the th.

This technology was originally developed by US space agency, NASA, for developing nts in space. The technology has been import-to IHBT with an idea to help develop exotic nts as saffron and medicinal plants nearing inction. Union minister for science and tech-nev Harsh Vardhan, who was on a short visit inaugurated this Aerophonic e plant development facility. He ct the ongoing projects at IHBT. id that Aerophonic technology f the plants are treated with nut-prays of water at periodic inter-onic technology, the roots of the pped in water and are provided

nutrients. The nutrients that are provided to develop the plants under the said technologies are also imported.

"IHBT has been working on a project to introduce saffron plantation in the cold deserts of Himachal. Since the plants yield very high value in market, we would try to see the results of producing the saffron crop under the controlled condition using Aerophonic and Hydrophonic technologies." said a scientist at the institute, R K Sud.

कैंसर, लिवर की बीमारियां ठीक करेगा कप

सीएसआईआर पालमपुर में शोध, देसी जड़ी-बूटी से बनाया कैप्सूल • मार्केट में जल्द आएगी दवाई

चंबा, भरमौर, रोहतांग उत्तराखंड में उगती हैं यह जड़ी-बूटी, कैप्सूल मार्केट में उतारने को कंपनियों से साधा जा रहा संपर्क

सीएसआईआर ने भी तैयार की पौध

कई गंभीर बीमारियों से बचाती हैं यह जड़ी-बूटी

लोगों तक पहुंचे प्रयोगशाला की खोज

समस्या का हल ढूंढें वैज्ञानिक

विदेशों से लौट रहे हैं हमारे वैज्ञानिक

अब ब्रेन गेन हो रहा है, 250 वैज्ञानिक लौटे हैं देश

हर खोज देश के लिए हो: हर्षवर्धन

हिमाचल दस्तक। पालमपुर

केंद्रीय विज्ञान एवं प्रौद्योगिकी और पृथ्वी विज्ञान मंत्री डॉ. हर्षवर्धन ने कहा कि अब देश में ब्रेन ड्रेन की समस्या नहीं है, बल्कि ब्रेन गेन हो रहा है। विदेशों से अढ़ाई सौ के करीब वैज्ञानिक लौटे हैं और वे अब देश में कार्य करना चाहते हैं। उन्होंने ये उद्गार पत्रकारों से बातचीत करते हुए व्यक्त किए। उन्होंने देश के वैज्ञानिकों से भी आह्वान किया कि वे भी अपनी खोजों को शोध पत्रों और पेटेंट तक सीमित नहीं रखें, बल्कि उसका लाभ आम जनता के साथ किसानों को भी मिले। उन्होंने कहा कि वैज्ञानिकों की हर खोज देश की जनता के लिए होनी चाहिए। इससे पहले सीएसआईआर पालमपुर संस्थान के निदेशक डॉ. संजय कुमार ने उनका स्वागत किया और संस्थान की प्रमुख अनुसंधान गतिविधियों के बारे में बताया। अभी हाल ही में विभिन्न उद्यमियों और औद्योगिक भागीदारों को हस्तांतरित की गई प्रौद्योगिकियों के बारे में अवगत कराया। साथ ही मोजाम्बिक में चाय उद्योग के प्रतिनिधियों के साथ टी-वाइन की प्रौद्योगिकी के हस्तांतरण के लिए समझौता ज्ञापन पर हस्ताक्षर किए जाने की भी मंत्री को जानकारी दी गई। कार्यक्रम के दौरान डॉ. हर्षवर्धन ने संस्थान के प्यूटास्यूटिकल पायलट प्लांट सुविधाएं अकादमी एवं प्रौद्योगिकी प्रसार ब्लॉक और हाइड्रोपोनिक और एयरोपोनिक सुविधा परिसर का उद्घाटन भी किया। उन्होंने कहा कि हिमालय क्षेत्र की व्यापक जलवायु विविधता सामाजिक और औद्योगिक महत्व के कम कैलोरी आधारित उत्पादों और प्रौद्योगिकियों को विकसित करने के लिए अवसर प्रदान करता है।

किसान हरित प्रौद्योगिकी अपनाने के लिए करें प्रयास : डॉ. हर्षवर्धन

सिटी रिपोर्टर | पालमपुर

हिमालय क्षेत्र की व्यापक जलवायु, विविधता, सामाजिक और औद्योगिक महत्व के कम कैलोरी मिठास, और प्रौद्योगिकी को विकसित करने के लिए अद्वितीय अवसर प्रदान करता है। यह बात केंद्रीय विज्ञान एवं प्रौद्योगिकी और पृथ्वी विज्ञान मंत्री डॉ. हर्षवर्धन ने सीएसआईआर पालमपुर का दौरा करने के उपरांत वैज्ञानिकों को संबोधित करते हुए कही।

उन्होंने कहा कि हिमाचल में भूमि जोत का आकार छोटा है, इसलिए किसान सहकारी संस्थाएं बना कर संस्थान से तकनीकी जानकारी प्राप्त करके नई किस्मों को उगा सकते हैं। उन्होंने किसानों को अपने उत्पादों के विपणन के लिए सूचना प्रौद्योगिकी का प्रयोग करने पर बल दिया। उन्होंने किसानों को सलाह दी कि जहां तक संभव हो हरित प्रौद्योगिकी को ही अपनाने का प्रयत्न करें। उन्होंने संस्थान के शोध द्वारा विकसित प्रौद्योगिकियों को अपनाने के लिए उद्यमियों और किसानों के प्रयासों की प्रशंसा की। उन्होंने स्थानीय जैव संसाधानों पर आधारित उद्यमियों को उच्च वाणिज्यक मूल्यों के उद्यमों को लगाने का आह्वान किया। हिमालय क्षेत्र में बांस में एक व्यापक संसाधन है जिसका इस्तेमाल लकड़ी के बोर्ड, कपड़ा यार्न, कोयला और अन्य उत्पादों के रूप में किया जा रहा है। उन्होंने कहा कि जंगली गेंदा, गुलाब, बेलीरियाना, बड़ी इलायची की फसल को बढ़ावा देकर किसानों की आय को बढ़ाया जा सकता है।

हरित प्रौद्योगिकी अपनाएं किसान

केंद्रीय विज्ञान एवं प्रौद्योगिकी मंत्री हर्षवर्धन ने पालमपुर में किया आह्वान

अमर उजाला ब्यूरो

पालमपुर (कांगड़ा)।

सीएसआईआर में प्रदर्शनी का अवलोकन करते केंद्रीय मंत्री हर्षवर्धन।

केंद्रीय विज्ञान एवं प्रौद्योगिकी मंत्री डॉ. हर्षवर्धन ने कहा कि एक ऑस्ट्रेलियन रिपोर्ट के मुताबिक प्रधानमंत्री नरेंद्र मोदी के नेतृत्व में भारत विश्व में विज्ञान के क्षेत्र में दूसरे नंबर पर है।

अब भारत को प्रथम श्रेणी नंबर बन पर लाना होगा।विज्ञान को लेकर मोदी सरकार बेहतर कार्य कर रही है। सीएसआईआर-आईएचबीटी पालमपुर का दौरा करने पहुंचे डॉ. हर्षवर्धन ने किसानों व उद्यमियों से जैव संसाधनों पर आधारित उच्च वाणिज्यिक मूल्यों के उद्यमों को लगाने का आह्वान किया। उन्होंने कहा कि किसान सहकारी संस्थाएं बनाकर संस्थान से तकनीकी जानकारी प्राप्त कर नई किस्मों को उगा सकते हैं। उन्हें अपने उत्पादों के विपणन के लिए सूचना प्रौद्योगिकी का प्रयोग भी करना चाहिए। उन्होंने किसानों व उद्यमियों को सलाह दी है कि जहां तक हो सके हरित प्रौद्योगिकी को अपनाने का प्रयास करें।

कागजों तक सीमित न रहें कार्य : हर्षवर्धन

विनोद राणा

पालमपुर (कांगड़ा)।

केंद्रीय विज्ञान एवं प्रौद्योगिकी मंत्री डॉ. हर्षवर्धन ने देश को विज्ञान के क्षेत्र में आगे ले जाने के लिए साथ संदेश दिया है।

उन्होंने कहा कि देश के अलग-अलग सेक्टर में कार्य कर रहे वैज्ञानिकों को एकजुट होकर काम करना होगा। सीएसआईआर पालमपुर में उन्होंने वैज्ञानिकों से साथ कहा कि कार्य अब कागजों तक ही सीमित न रहें और न ही यह कार्य सिर्फ इसका पेटेंट लेने के लिए हो। इसके लिए जरूरी है कि अब धरातल में और काम करना होगा। इसलिए सभी वैज्ञानिक इस दिशा में कार्य करें।

विज्ञान की खोज का सरोकार है कि इसका फायदा सीधे लोगों तक पहुंचे। उन्होंने यह भी कहा कि देश को आजाद हुए 70 साल हो गए लेकिन लोगों की जो समस्या थी वह नहीं मिटा। अब मोदी सरकार ने इसके लिए कदम उठाए हैं जिनका लाभ लोगों का मिलना शुरू हुआ है।

किसानों को फूल उत्पादन के दिए टिप्स

पालमपुर : फूलों की व्यावसायिक खेती की तकनीक हेतु प्रशिक्षण प्रदान करते वैज्ञानिक।

पालमपुर, 13 फरवरी (स.ह.): हिमालय जैव संपदा प्रौद्योगिकी संस्थान पालमपुर ने राज्य विज्ञान, प्रौद्योगिकी एवं पर्यावरण परिषद हिमला के सौजन्य से फूलों की व्यावसायिक खेती की तकनीक हेतु प्रशिक्षण कार्यक्रम सक्रड़ें में आयोजित किया गया। संस्थान निदेशक डा. संजय कुमार के प्रयासों से अनुसूचित जाति के किसान के समूह के फूलों की खेती पर एक्सटिंक्टिव प्रशिक्षण कार्यक्रम का आयोजन किया गया, जिसमें लगभग 90 किसानों ने प्रतिभागिता की। इस कार्यक्रम में ग्राम पंचायत की प्रधान मीना देवी, उपप्रधान शिवदेव गुलेरिया व अन्य सदस्यों का पूर्ण सहयोग रहा। प्रशिक्षण के संयोजक डॉ. भव्य भार्गव ने गुलाब एवं गुलदाउदी आदि फूलों पर जानकारी दी। डॉ. अशोक कुमार ने गेंदे की खेती के लाभ के बारे में बताया। इस क्षेत्र में पानी व बंदरों की समस्या को ध्यान में रखते हुए डा. अरविंद

फूलों की खेती का दिया प्रशिक्षण

हरिपुर : देहरा की सकरी ग्राम पंचायत में हिमालयन जैवसंपदा प्रौद्योगिकी संस्थान पालमपुर ने फूलों की व्यावसायिक खेती की तकनीक के लिए प्रशिक्षण कार्यशाला का आयोजन किया। यह कार्यशाला राज्य विज्ञान प्रौद्योगिकी एवं पर्यावरण परिषद शिमला के सौजन्य से लगाई गई कार्यशाला में अनुसूचित जाति के किसा के समूह को फूलों की खेती के का प्रशि दिया गया। इसमें लगभग 90 लोगों ने भाग लिया। इस कार्यक्रम में सकरी ग्रा पंचायत की प्रधान मीना देवी, उपप्रधान शिवदेव गुलेरिया एवं अन्य सदस्यों का सहयोग रहा। प्रशिक्षण के संयोजक डॉ भव्य भार्गव ने गुलाब एवं गुलदाउदी आ फूलों पर जानकारी दी। डॉ. अशोक कु ने गेंदे के बारे में बताया।

फूलों की खेती करने की तकनीकें समझाईं

हरिपुर (कांगड़ा)। सकरी ग्राम पंचायत में वैज्ञानिक और औद्योगिक अनुसंधान परिषद हिमालयन जैवसंपदा प्रौद्योगिकी संस्थान पालमपुर ने राज्य विज्ञान प्रौद्योगिकी एवं पर्यावरण परिषद शिमला के सौजन्य से फूलों की व्यावसायिक खेती की तकनीक के लिए प्रशिक्षण कार्यशाला का आयोजन किया गया। यह संस्थान दो दशकों से ज्यादा समय से व्यावसायिक फूलों की खेती करने की वैज्ञानिक तकनीकों को विकसित करने पर शोध कार्य कर रहा है। यहां व्यावसायिक फूलों जैसे लिलियम, गुलदाऊदी, कार्नेशन, बर्ड ऑफ पैराडाइस, एलस्ट्रोमेरिया, ग्लैडीलियस एवं गेंदा की खेती की तकनीकों को लगातार प्रशिक्षण एवं प्रदर्शन के माध्यम से किसानों तक पहुंचाने का कार्य किया जा रहा है। ब्यूरो

डॉ. विशाल आचार्य को मिला बीआइआरडी-2016 पुरस्कार

सीएसआइआर आइएचबीटी के वैज्ञानिक विशाल आचार्य।

किसानों को किया जागरूक

आईएचबीटी पालमपुर के वैज्ञानिक को मिला अवॉर्ड

CSIR showcases products at open day

OUR CORRESPONDENT

PALAMPUR, NOVEMBER 23

As a prelude to "India International Science Festival", CSIR-Institute of Himalayan Bioresource Technology organised an open day today to showcase various scientific activities.

The institute remained open to welcome common men who were apprised of the role played by the institute in societal uplift, education and industrial research. Special scientific exhibits were displayed to showcase products and technologies developed by the institute. About 500 children from various schools of Palampur, Nagrota Bagwan, Baijnath and Dharamsala participated in the programme.

Addressing students in the auditorium, Dr Bikram Singh, seniormost scientist, apprised about the CSIR achievements and further highlighted the progress made by the institute under the leadership of the Director, Dr Sanjay Kumar.

A lecture on the topic, "Cultivation of Passion for Science and Innovation" for schoolchildren was delivered by Dr OP Sharma, former Head, Indian Veterinary Research Institute (IVRI), at Palampur. The meritorious students were also honoured by the keynote speaker.

The students were also shown short documentaries on technologies developed by the institute. The visitors and students were taken to various labs to apprise them of recent research and development activities and to interact with scientists.

Representatives from various Gram Panchayats of the adjoining areas expressed to have been greatly benefited by the visit and lauded the work being carried out by the institute.

शोध कार्यों पर किया जागरूक

पालमपुर। अंतरराष्ट्रीय विज्ञान महोत्सव के अंतर्गत सीएसआईआर-हिमालय जैवसंपदा प्रौद्योगिकी संस्थान पालमपुर में बुधवार को समाज के लिए उपयोगी विविध वैज्ञानिक गतिविधियों/उपलब्धियों के प्रदर्शन के लिए 'जन दिवस' के रूप में मनाया गया। पालमपुर, नगरोटा बगवां, बैजनाथ एवं धर्मशाला के विभिन्न स्कूलों के लगभग 500 छात्रों तथा अध्यापकों ने इसमें भाग लिया। विद्यार्थियों को वैज्ञानिक उपलब्धियों, जनसाधारण के सामाजिक-आर्थिक उत्थान तथा शोध के क्षेत्र में किए जा रहे कार्यों के बारे में जागरूक किया गया। संस्थान द्वारा विकसित उत्पादों और प्रौद्योगिकी को प्रदर्शनी के माध्यम से प्रदर्शित किया गया। इस मौके पर प्रतिभावान छात्रों

सी.एस.आई.आर. में प्रतिभावान छात्र सम्मानित

छात्र विज्ञान को कॅरिअर के रूप में अपनाएं : ओपी शर्मा

सी.एस.आई.आर. प्लैटिनम जुबली वर्ष का शुभारंभ

पालमपुर, 21 नवम्बर (स्पूतने): सी.एस.आई.आर. हिमालय जैवसंपदा प्रौद्योगिकी संस्थान पालमपुर 23 को प्लैटिनम जुबली वर्ष के अंतर्गत खुला दिवस के रूप में मना रहा है। सी.एस.आई.आर. प्लैटिनम जुबली वर्ष का शुभारंभ 27 सितम्बर, 2016 को प्रधानमंत्री नरेंद्र मोदी ने किया था। संस्थान ने निदेशक डा. संजय कुमार के नेतृत्व में विज्ञान के विभिन्न क्षेत्रों में अभूतपूर्व प्रगति की है तथा इस दिवस पर इसे सभी को प्रदर्शित किया जाएगा। संस्थान इस अवसर पर सामान्यजन, महिलाओं, स्वयंसेवी संस्थाओं के लिए खुला रहेगा तथा संस्थान की वैज्ञानिक उपलब्धियों, सामान्यजन के सामाजिक-आर्थिक उत्थान तथा शोध के क्षेत्र में किए जा रहे कार्यों को एक प्रदर्शनी के माध्यम से प्रदर्शित किया जाएगा तथा इच्छुक लोगों को प्रयोगशाला तथा फार्म में जा के जाकर शोध एवं विकास कार्यों की जानकारी दी जाएगी। इसमें स्कूलों के 400 से अधिक छात्र इसमें भाग लेंगे। इस अवसर पर संस्थान के वैज्ञानिक तथा पूर्व प्रभारी वैज्ञानिक, आई.वी.आर.आई. पालमपुर विज्ञान एवं नवोन्मेष के लिए उत्साह विषय पर संभाषण भी देंगे।

ज्ञान जन दिवस पर छात्रों-जनप्रतिनिधियों व एनजीओ की टीमों ने किया दौरा

छात्रों ने जानीं सीएसआईआर की गतिविधियां

• दिव्य हिमावत टीम, पालमपुर

हिमालय जैवसंपदा प्रौद्योगिकी संस्थान में बुधवार को जन दिवस का आयोजन किया गया। इस अवसर पर क्षेत्र के स्कूली बच्चों, जनप्रतिनिधियों और एनजीओ की टीमों ने स्थान का दौरा कर सीएसआईआर की तविधियों को जाना।

केंद्रीय विद्यालय पालमपुर से अध्यापकों शल राज, योगिता गुरंग और कुशल कपूर साथ पहुंची रिया, पूर्वा, खुशबू व स्मृति दि ने बताया कि सीएसआईआर में पहुंच र उनको अनेक जानकारियां मिली हैं। बच्चों ने कहा कि संस्थान के वैज्ञानिकों का अनुभव विशेषकर विज्ञान को शिक्षा ग्रहण कर रहे बच्चों के लिए काफी लाभप्रद हो सकता है।

इसलिए ऐसे आयोजन समय-समय पर किए जाने चाहिएं। डा. ओपी शर्मा पूर्व प्रभारी वैज्ञानिक आईवीआरआई पालमपुर ने 'विज्ञान एवं नवोन्मेष के लिए उत्साह जगाना' विषय पर संभाषण दिया।

छात्रों को संस्थान द्वारा विकसित प्रौद्योगिकी पर तैयार लघु वृत्तचित्र भी दिखाया गया। इस अवसर पर शिक्षा के क्षेत्र में उत्कृष्ट प्रदर्शन करने वाले विभिन्न स्कूलों के बच्चों को पुरस्कृत भी किया गया।

विज्ञान क

आइएचबीटी पालमपुर में लोग वी जानकारी लेते स्कूली बच्चे।

कार्यक्रम

• आइएचबीटी में 'भारतीय अंतरराष्ट्रीय विज्ञान महोत्सव' दिवस मनाया

मंगल पर उगेंगे सीएसआइआर पालमपुर के पौधे

रविवार विशेष

• बिना मिट्टी, कम ऑक्सीजन और पानी में तैयार किए जा रहे पौधे

• मंगल ग्रह पर ऑक्सीजन की कमी दूर करने में होंगे मददगार

प्रयोग सफल होने में लगेगा अभी समय

दो तरीकों से हो रहे तैयार

अभी शुरुआती दौर में हैं पौधे

जड़ी-बूटियों से अर्जित करें आय

पालमपुर : सीएसआइआर हिमालय जैवसंपदा प्रौद्योगिकी संस्थान पालमपुर के वैज्ञानिकों ने लाहुल घाटी में स्थित अति दुर्गम जैव विज्ञान केंद्र में प्रशिक्षण शिविर का आयोजन किया। इसमें औषधीय एवं सगंध पौधों का उत्पादन बारे बताया गया। शिविर में घाटी की लगभग 22 कृषकों ने भाग लिया। इसका मुख्य उद्देश्य लाहुल घाटी में पैदा होने वाली जड़ी-बूटियों व सगंध पौधों के बारे में विस्तृत जानकारी देना, खेती करना और उनका मूल्य वर्धन कर अधिक आय अर्जित करना था। वरिष्ठ वैज्ञानिक डॉ. राकेश कुमार ने बताया कि औषधीय एवं संगध पौधे विभिन्न उद्योगों में पूरे संसार में उपयोग में लाए जाते हैं। ऐसी फसलों की पैदावार कर किसान अच्छी आमदनी अर्जित कर सकते हैं। केंद्र के वैज्ञानिक डॉ. अशोक सिंह ने भी महत्वपूर्ण जानकारी दी। उन्होंने लाहुल घाटी में विलुप्त होते औषधीय पौधों के संरक्षण के बारे में बताया। इंजीनियर मोहित शर्मा ने किसानों को तेल निकासी यंत्र द्वारा सगंधित पौधों से तेल निकालने की विधि का प्रशिक्षण दिया। शिविर में उपस्थित तांडी पंचायत प्रधान विजेंद्र तथा मुलिंग पंचायत प्रधान दिनेश भी मौजूद रहे।

लाहौल में औषधीय खेती की अपार संभावना

हिमालय जैवसंपदा प्रौद्योगिकी संस्थान पालमपुर द्वारा औषधीय पौधों की खेती के लिए प्रशिक्षण शिविर का आयोजन

चाय से बनेगी शराब, होगी पौष्टिक

नई दिल्ली, 16 सितम्बर (वार्ता): वैज्ञानिक एवं औद्योगिक अनुसंधान परिषद (सी.एस.आई.आर.) से संबद्ध ईस्टीच्यूट ऑफ हिमालय बायोरिसर्च टैक्नोलॉजी (आई.एच. बी.टी.) ने ऐसी तकनीक विकसित की है जिससे चाय से शराब बनाई जा सकती है। इस तकनीक के हस्तांतरण के लिए मोजाम्बिक की एक कंपनी के साथ करार किया गया है जिसके तहत उत्पादन जल्द शुरू होने की उम्मीद है।

आई.एच.बी.टी. के निदेशक डा. संजय कुमार ने आज यहां पत्रकारों के साथ अपने संस्थान की उपलब्धियों सांझा करते हुए बताया कि चाय आधारित यह शराब रैड वाइन की श्रेणी की है। इसकी खासियत यह है कि इसमें कैटशिन होता है जो एंटी-ऑक्सीडैंट है। इससे थकान दूर होती है, उम्र का असर कम होता है तथा ताजगी बनी रहती है। रैड वाइन में भी कैफीन होता है जो एंटी-ऑक्सीडैंट है लेकिन कैटशिन बेहतर एंटी-ऑक्सीडैंट है।

नींद का गांव, बिन कांटों का गुलाब

सीएसआइआर के स्थापना दिवस पर विशेष

पीएम मोदी ने की कैला लिली की किस्मों पर चर्चा

पालमपुर, 26 सितंबर। सोग्रवार को सीएसआईआर स्थापना दिवस के अवसर पर पालमपरी नेट मोदी देश के पीले रंगों के किसानों से सीधे प्रसारण के माध्यम से चर्चा की। इस अवसर पर विज्ञान भवन, नई दिल्ली से प्रधानमंत्री ने सीएसआईआर-आईएचबीटी, पालमपुर द्वारा विकसित 'कैला लिली' की दो किस्मों 1) हिम सूरज (रेगुलर) एवं 2) हिम परिमा (सफेद) और उनके की 5 किस्मों (हिम रश्मि, हिम शिखर, हिम अरुणा, हिम अरुणी एवं हिम कांति) को विमोचित किया। कैला लिली लोकप्रिय पुष्प है जो कि मौसम आधारित फसली वर्ग में आती है।

आपकी सुबह में सुगंध बिखेरेंगी फूलों की नई किस्में

मोदी ने पूछा, आपके इलाके में बंदरों की समस्या तो नहीं

प्रधानमंत्री ने हिमाचल के दो किसानों से की वीडियो कांफ्रेंसिंग से सीधी बात

पालमपुर में फूल की दो प्रजातियां कीं तैयार

पालमपुर ने ईजाद की फूलों की नई किस्में

प्रधानमंत्री नरेंद्र मोदी ने दिल्ली में लांच की जरबेरा की पांचों वैरायटी

हिमाचल में बंदरों के उत्पात से पीएम भी बाखबर

आईएचबीटी के स्थापना दिवस पर पालमपुर के किसानों से सीधे संवाद में नरेंद्र मोदी ने जताया सरोकार

बंदरों की समस्याओं से कैसे निपटें, पीएम ने ली जानकारी

प्रधानमंत्री नरेंद्र मोदी ने सीधे संवाद में पालमपुर के दो प्रगतिशील किसानों से ली जानकारी

मोदी ने किया 2 नई पुष्प प्रजातियों का विमोचन

आई.एच.बी.टी. पालमपुर द्वारा विकसित कैलेंडिलिफ की 2 किस्मों व जरबेरा की 5 किस्मों को पीएमडी कार्यालिस द्वारा जारी किया

देश को वैज्ञानिक जगत से आशाएं, हल तलाशें

■ कार्यालय संवाददाता, पालमपुर

हिमालय जैव संपदा प्रौद्योगिकी संस्थान के महानिदेशक डा.गिरीश ...ानिकों से शोध को ...समस्याओं के हल पर ...का आह्वान किया है। ...अपने दौरे के दौरान ...लय का शिलान्यास ...संस्थान के विभिन्न

विभागों का दौरा किया। सीएसआईआर में आयोजित कार्यक्रम में डा. साहनी ने कहा कि देश को वैज्ञानिक जगत से बहुत आशाएं हैं, जिसके लिए वैज्ञानिकों को किसानों, ग्रामीणों एवं आम जनता के बीच जाकर समस्याओं और चुनौतियों को समझकर उनका वैज्ञानिक हल तलाशना होगा। देश ने विश्व में अलग पहचान बनाई है पर अभी भी इस विशाल देश में बहुत सी चुनौतियां व समस्याएं हैं, जिनका हल खोजना वैज्ञानिक जगत का दायित्व है। इस अवसर पर संस्थान के निदेशक डा. संजय कुमार और सीएसआईआर लखनऊ के निदेशक डा .अनिल कुमार त्रिपाठी सहित

वैज्ञानिकों को समस्याओं व चुनौतियों को समझना होगा : महानिदेशक

पालमपुर, 7 मई (ब्यूरो): माध्यम से इन्हें ज्यादा से ज्यादा सर्वोदिकल निलय का शिलान्यास भी महानिदेशक सी.एस.आई.आर. एवं सचिव भारत सरकार डा. गिरीश साहनी ने हिमालय जैव संपदा प्रौद्योगिकी संस्थान पालमपुर यात्रा के दौरान वैज्ञानिकों एवं स्टाफ को संबोधित करते हुए उनका आह्वान किया कि वे अपने शोध को देश के जनसाधारण एवं किसानों के जीवन स्तर को बेहतर बनाने के लिए केंद्रित करें।

उन्होंने कहा कि देश को वैज्ञानिक जगत से बहुत आशाएं हैं, जिसके लिए वैज्ञानिकों को किसानों, ग्रामीणों एवं आम जनता के बीच जाकर समस्याओं और चुनौतियों को समझना होगा और वैज्ञानिक हल प्रस्तुत करना होगा। महानिदेशक ने संस्थान के चाय,

किया, जिसमें संस्थान में शोध करने के लिए आने वाले विज्ञान वैज्ञानिकों के लिए ठहरने की सुविधा होगी।

डा. साहनी ने इस अवसर पर

देश को वैज्ञानिक जगत से बहुत-सी आशाएं : साहनी

सी.एस.आई.आर. के महानिदेशक ने किया हिमालय जैव संपदा प्रौद्योगिकी संस्थान का दौरा

पालमपुर, 6 मई (ब्यूरो): सी.एस.आई.आर. के महानिदेशक एवं सचिव भारत सरकार डा. गिरीश साहनी ने कहा कि देश ने अनेक क्षेत्रों में अलग पहचान स्थापित की है परंतु फिर भी अनेक चुनौतियां व समस्याएं हैं, जिनका समाधान किया जाना है। डा. गिरीश साहनी सी.एस.आई.आर. की पालमपुर स्थित प्रयोगशाला हिमालय जैव संपदा प्रौद्योगिकी संस्थान पहुंचे थे। उन्होंने कहा कि वैज्ञानिक अपने शोध को देश के जनसाधारण व किसानों के जीवन स्तर को सुधारने के लिए केंद्रित करें। उन्होंने कहा कि देश को वैज्ञानिक जगत से बहुत-सी अपेक्षाएं हैं, जिस हेतु वैज्ञानिकों को किसानों, ग्रामीणों व आम जनमानस के बीच जाकर समस्याओं व चुनौतियों को समझना होगा तथा इसका वैज्ञानिक समाधान निकालना होगा। इस अवसर पर हिमालय जैव संपदा प्रौद्योगिकी संस्थान के निदेशक डा. संजय कुमार ने संस्थान की गतिविधियों से सी.एस.आई.आर. के महानिदेशक डा. गिरीश साहनी व से भी मैप के निदेशक प्रो. अनिल त्रिपाठी को अवगत करवाया। इससे पूर्व सी.एस.आई.आर. के महानिदेशक डा. गिरीश साहनी ने हिमालय जैव संपदा प्रौद्योगिकी संस्थान द्वारा चाय, पुष्प विज्ञान और औषधीय पौधों के क्षेत्र में किए जा रहे शोध का फर्म में जाकर निरीक्षण किया।

उन्होंने इस अवसर पर संबोधित विलय का शिलान्यास भी किया।इस विलय में संस्थान में शोधरत्नु आने वाले शोधित वैज्ञानिकों के ठहरने की व्यवस्था होगी।

जनमानस की समस्याओं को निपटाएगी सीएसआईआर

■ कार्यालय संवाददाता, पालमपुर

पालमपुर स्थित हिमालय जैव संपदा प्रौद्योगिकी संस्थान में को ...य प्रौद्योगिकी दिवस मनाया ...। समारोह के मुख्य वक्ता ...एसआईआर - भारतीय विज्ञान अनुसंधान संस्थान ...नऊ के पूर्व निदेशक एवं ...टस साइंटिस्ट, आईजीआईबी ...के वरिष्ठ वैज्ञानिक डा. केसी ने 'नेचुरल पोलीसेकराइड्स ऐफिसिएंट कैरियर फॉर मॉलिक्यूल्स' विषय पर ...गिकी दिवस संभाषण दिया। ...ने अपने संबोधन में उन्होंने ...मॉलिक्यूल्स को निरंतर ...ज और उसके अल्ताइमर व कैंसर आदि कई रोगों के प्रबंधन में प्रभाव पर अनुसंधान की जानकारी दी। समारोह की अध्यक्षता करते हुए योजना आयोग के पूर्व सदस्य डा. वीएल चोपड़ा ने वैज्ञानिकों से आह्वान किया कि वे देश की जरूरतों को ध्यान में रखते हुए शोध कार्य करें, ताकि उस शोध का उपयोग सही प्रकार से हो सके। संस्थान के निदेशक डा. संजय कुमार ने बताया कि प्रधानमंत्री ने वैज्ञानिकों के सामने जनसामान्य की आवश्यकताओं, समस्याओं का हल प्रस्तुत करने की चुनौती दी है। सीएसआईआर इन समस्याओं व चुनौतियों के समाधान से समाज एवं देश के विकास में योगदान कर सकती है।

आइएचबीटी में मनाया राष्ट्रीय प्रौद्योगिकी दिवस

हिमालय जैव संपदा प्रौद्योगिकी संस्थान पालमपुर में राष्ट्रीय प्रौद्योगिकी दिवस मनाया

देश की जरूरत के हिसाब से करें शोध

मीठे पत्तों वाले स्टीविया की खोज

इसकी खूबियों से पंजाब भी हैरान

बाल झड़ने से बचाएगा एसओडी

एंटी इन्फ्लेमेशन के लिए खास

डिब्बाबंद कांगड़ी धाम का लीजिये मजा

खुशखबरी

- जैवसंपदा प्रौद्योगिकी संस्थान पालमपुर करवाएगा उपलब्ध
- जल्द बाजार में उपलब्ध होंगे मदरा व अन्य व्यंजन

कांगड़ी धाम का क्रम

1. कुछ मदरे जिनमें आलू और सफेद चने का, पालक पनीर का, राजमाह का और मुकुन्दबड़ी का मदरा प्रमुख है
2. चने की दाल
3. छुहारे का दमपुख्त
4. कढ़ी (पलदा)
5. खूब तेल में बनी माह की दाल
6. काले चनों का खट्टा
7. मीठे चावल

कैप्सूल में चाय का जायका

आयुर्वेद और हर्बल बिजनैस पर बायर और सैलर मीट कुल्लू में होगी

कर्ण सिंह करेंगे उद्घाटन

शिमला, 8 अगस्त (जय): प्रदेश में आयुर्वेद और हर्बल को बढ़ावा देने के लिए बायर और सैलर मीट

अब प्रदेश में उपलब्ध होगा जड़ी-बूटियों का कच्चा माल

प्रदेशभर में मौजूदा समय में करीब 180 आयुर्वेद फार्मेसियां कार्य कर रही हैं जिन्हें जड़ी-बूटियों के लिए खारी बावली मार्कीट दिल्ली या अमृतसर पर निर्भर रहना पड़ता है। इस आयोजन में किसानों को प्रोत्साहन देने पर इन फार्मेसियों को भी

शेष पृष्ठ 7 पर

Now, relish ready-to-eat 'Kangri Dham'

RAVINDER SOOD

PALAMPUR, AUGUST 9

Food lovers will now be able to relish ready-to-eat 'Kangri Dham'. The packaging and processing technology of the most famous ethnic cuisine of Kangra region has been developed by the CSIR-IHBT.

MLA Kishori Lal appreciated the efforts of the CSIR-IHBT and Sai Foods for launching the product saying the initiative would empower several youths and create new jobs.

Dr Sanjay Kumar, director, CSIR-Institute of Himalayan Bioresource Technology, Palampur, said the packaged food was preservative free with beneficial pre-biotic effect, cholesterol-lowering activity and retention of typical aroma characteristic of this onion and garlic-free cuisine.

The canned food has a shelf life of six months. He said the technology met the aim of International Year of Pulses – 2016, declared by the UN General Assembly, to heighten public awareness about the nutritional benefits of pulses as part of sustainable food production.

'Kangri Dham' is prepared in curd by special cooks in special containers. It comprises a combination of lentil dominant dishes. Rajma, retta, mash dal topped by khatta are served first and then ther[e] is mitha (sweet rice) t[o] satiate the sweet toot[h]. The technology will no[t] only popularise the cu[isine] to newer areas, bu[t] will also help conserv[e] art that has devel[oped] over a long traditional [his]tory of Kangra region.

अब बंद डिब्बे में लें कांगड़ी धाम

जड़ी-बूटियों से अर्जित करें आय

पालमपुर : सीएसआइआर हिमालय जैवसंपदा प्रौद्योगिकी संस्थान पालमपुर के वैज्ञानिकों ने लाहुल घाटी में स्थित अति दुर्गम जैव विज्ञान केंद्र में प्रशिक्षण शिविर का आयोजन किया। इसमें औषधीय एवं सगंध पौधों का उत्पादन बारे बताया गया। शिविर में घाटी की लगभग 22 कृषकों ने भाग लिया। इसका मुख्य उद्देश्य लाहुल घाटी में पैदा होने वाली जड़ी-बूटियों व सगंध पौधों के बारे में विस्तृत जानकारी देना, खेती करना और उनका मूल्य वर्धन कर अधिक आय अर्जित करना था। वरिष्ठ वैज्ञानिक डॉ. राकेश कुमार ने बताया कि औषधीय एवं संगध पौधे विभिन्न उद्योगों में पूरे संसार में उपयोग में लाए जाते हैं। ऐसी फसलों की पैदावार कर किसान अच्छी आमदनी अर्जित कर सकते हैं। केंद्र के वैज्ञानिक डॉ. अशोक सिंह ने भी महत्वपूर्ण जानकार दी। उन्होंने लाहुल घाटी में विलुप्त होते औषधीय पौधों के संरक्षण के बारे में बताया। इंजीनियर मोहित शर्मा ने किसानों को तेल निकासी यंत्र द्वारा सगंधित पौधों से तेल निकालने की विधि का प्रशिक्षण दिया। शिविर में उपस्थित तांडी पंचायत प्रधान विजेंद्र तथा मुलिंग पंचायत प्रधान दिनेश भी मौजूद रहे।

सुलझ गया सबसे पुराना रहस्य! आखिर सूरजमुखी का फूल सूर्य की दिशा में ही क्यों रखता है मुंह

आयुर्वेद और हर्बल बिजनैस पर बायर और सैलर मीट कुल्लू में होगी

कर्ण सिंह करेंगे उद्घाटन

अब प्रदेश में उपलब्ध होगा जड़ी-बूटियों का कच्चा माल

डिब्बा बंद कांगड़ी धाम लांच, कहीं भी कभी भी उठाएं लुत्फ

औषधीय पौधों की खेती को दिया जाएगा बढ़ावा

अमर उजाला ब्यूरो

पालमपुर (कांगड़ा)। हिमालय ज़ैव संपदा प्रौद्योगिकी संस्थान पालमपुर अब प्रदेश में संभावित औषधीय और सुगंधित फसलों की खेती को बढ़ावा देगा।

इससे जहां किसान लावारिस पशुओं और बंदरों के डर से खेती करना छोड़ चुके है वहां औषधीय और सुगंधित फसलों की खेती की जा सकेगी। इसे लेकर आईआईटी मंडी में एक संयुक्त बैठक की गई। इसमें डॉ. विक्रम सिंह ने कहा इससे किसानों को लाभ होगा।

सीएसआईआर ने पहले ही जंगली गेंदा समेत पहाड़ी क्षेत्र में सुगंधित फसलों को पैदा करने की पहल की है। राज्य में चार विभिन्न जलवायु क्षेत्रों में सुगंधित खेती को बढ़ावा देने की पहल की है। डॉ. आरके सूद ने कहा कि इससे खेतों में फिर से हरियाली होगी और जमीन उपयोग के लिए काम आएगी।

जब चाहें तब खाएं ...

* 95 रुपये में मिलेगा 425 ग्राम का डिब्बा

कांगड़ी धाम का क्रम

डिब्बाबंद कांगड़ा धाम दुनिया के कोने-कोने में बिखेरेगी अपनी खुशबू

सीएसआईआर ने पेटेंट प्रोडक्ट किया लॉन्च, छह महीने तक व्यंजन रहेंगे शुद्ध

बैजनाथ | कांगड़ी धाम का आनंद अब दुनिया के किसी भी कोने में घर बैठे उठा सकते हैं। इसके लिए हिमालय जैव संपदा प्रौद्योगिकी संस्थान पालमपुर (सीएसआईआर) ने कांगड़ा धाम को पेटेंट करवाने के बाद साईं फूड बैजनाथ के साथ एमओयू हस्ताक्षरित करने के बाद इन्हें डिब्बा बंद प्रोडक्ट के रूप में बाजार में उतारा है। सीएसआईआर द्वारा धीरे-धीरे विलुप्त हो रहे परंपरागत व्यंजनों को सहेजने की दिशा में यह कदम सराहनीय है। सोमवार को बैजनाथ में आयोजित समारोह में सीएसआईआर के निदेशक डॉ. संजय कुमार ने डिब्बा बंद कांगड़ा धाम को लॉन्च किया उन्होंने बताया कि संस्थान द्वारा तैयार किए गए इस प्रोड्क्ट को उपभोक्ता छह माह तक इस्तेमाल कर सकते हैं।

डिब्बाबंद प्रोडक्ट लॉन्च करते हुए सीएसआईआर के अधिकारी व अन्य।

धाम में नहीं किया है प्याज-लहसुन का इस्तेमाल

सीएसआईआर संस्थान के वैज्ञानिकों ने राजमाह का मदरा, चने का खट्टा, छुआरे का रैंठा और तेलीय माह को लेकर काफी शोध और खास परीक्षण किए। इससे कि यह डिब्बाबंद व्यंजन लंबे समय तक सुरक्षित रह सकें। व्यंजनों की इस विधि में प्याज व लहसुन का प्रयोग नहीं किया गया है। वैज्ञानिकों के अनुसार इन डिब्बाबंद व्यंजनों का स्वाद छह माह तक बरकरार रहता है।

अब घर पर लें कांगड़ी धाम का स्वाद

■ बैजनाथ में सीएसआईआर के निदेशक डॉ. संजय कुमार ने की कांगड़ी धाम की प्री लांचिंग

आम से बनाई वाइन, सेहत के लिए बताया टॉनिक

इसमें सिर्फ 8 से 9 % है अल्कोहल

अब जब दिल चाहे खाओ कांगड़ी धाम

जल्द ही बंद डिब्बे में मिलेंगे मदरा-रायता-तैलीय माह और चणेयां दा खट्टा

हिमाचल रिपोर्टर टीम, पालमपुर

यह है खासियत

- व्यंजन-लहसुन एवं प्रयोग नहीं होगा
- डिब्बे में राजमाह एवं मदरा डाई फ्रूट रायता, तैलीय माह तथा चनेरा दा खट्टा होगा
- डिब्बाबंद धाम सात महीने से ज्यादा समय तक सुरक्षित रहेगी

डिब्बाबंद धाम के व्यंजनों को बनाने के लिए वैज्ञानाथ की फर्म को तकनीक हस्तांतरित कर दी गई है। अगले माह तक यह स्टाप्रिंट व्यंजन बाजार में प्रवेश हो जाएंगे

डा.संजय कुमार
निदेशक, सीएसआईआर

औषधीय पौधों की खेती को दिया जाएगा बढ़ावा

अमर उजाला ब्यूरो

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इससे जहां किसान लावारिस पशुओं और बंदरों के डर से खेती करना छोड़ चुके है वहां औषधीय और सुगंधित फसलों की खेती की जा सकेगी। इसे लेकर आईआईटी मंडी में एक संयुक्त बैठक की गई। इसमें डॉ. विक्रम सिंह ने कहा इससे किसानों को लाभ होगा।

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सीएसआईआर-आई.एच.बी.टी. में अन्तर्राष्ट्रीय योग दिवस

हिमाचल रिपोर्टर न्यूज़
पालमपुर : रमेश माऊ

योग के महत्व और भारत सरकार के प्रयासों के फलस्वरूप संयुक्त राष्ट्र ने 21 जून को अन्तर्राष्ट्रीय योग दिवस घोषित किया।

संयुक्त राष्ट्र महासभा में 177 देशों से भी अधिक ने अन्तर्राष्ट्रीय योग दिवस घोषित करने के लिए अपना समर्थन दिया। सीएसआईआर-आई.एच.बी.टी. के निदेशक डा. संजय कुमार के व्यक्तिगत रुचि अनुसार संस्थान में कायाकल्प-हिमालय योग एवं प्राकृतिक शोध संस्थान, पालमपुर के सहयोग से अन्तर्राष्ट्रीय योग दिवस का आयोजन किया गया। संस्थान में अन्तर्राष्ट्रीय

योग दिवस दिनांक 21 जून 2016 को बड़े उत्साह से कर्मचारियों की भरपूर भागीदारी के साथ मनाया गया। योग दिवस का शुभारम्भ संस्थान के वरिष्ठतम वैज्ञानिक डा. विक्रम सिंह ने किया। कायाकल्प-हिमालय योग एवं प्राकृतिक शोध संस्थान, पालमपुर के योगशिक्षिका सुश्री रुचिता चौहान ने विभिन्न प्रकार के योगासनों का महत्व एवं लाभ के बारे में बताया तथा योगाभ्यास भी करवाया। संस्थान के कर्मचारियों ने इस योग कार्यक्रम को सराहा और योग चिकित्सा से कायाकल्प में चल रहे विभिन्न योग कार्यक्रमों के बारे में जानकारी प्राप्त की तथा भविष्य में भी इस प्रकार के योग कार्यक्रम संस्थान में करवाने के लिए आग्रह किया।

Ready-to-eat Kangri Dham

OUR CORRESPONDENT

PALAMPUR, JULY 2

CSIR — Institute of Himalayan Bio-Technology (IHBT) has developed an indigenous technology for the production of ready-to-eat foods served during Kangri Dham (traditional lunch).

The IHBT has transferred the technology to Sai Food, a Baijnath-based company, which is likely to launch the food products in the country within a month.

Kangri Dham is cooked by Botis. Madra is made of raajma. The typical menu for dham starts with madra specifically of rajma, which is cooked in yoghurt and is prepared in a unique style. This is followed by retta, mash dal and topped by khatta.

The dham ends with the ha (sweet rice). Raajma ka dra is delicately prepared n handpicked red kidney ns cooked in curd gravy of ected vegetables and hew nut paste.

डॉ. संजय कुमार के कुशल नेतृत्व में IHBT छू रहा सफलता की नई मंजिलें: डॉ. डी.पी. भंगालिया

हिमाचल रिपोर्टर न्यूज़ टीम
राजेश सूर्यवंशी

फ़ीजिबल सल्यूशन एंड टेक्नोलॉजी हब बनने हेतु सराहनीय कदम

CSIR (IHBT) के बारे में क्या कहते हैं डॉ. डी.पी. भंगालिया, निदेशक :

IHBT से तब आपका मित्र तक का सफ़रीय चल रहा है ?

श में बंदरों की समस्या से मोदी भी चिंतित

पालमपुर : आई.एच.बी.टी. में आयोजित किसान मेले में भाग लेते कृषक।

टच स्कूल

जब चाहो तब खाओ कांगड़ी धाम

हिमालय जैव संपदा प्रौद्योगिकी संस्थान ने पैक्ड धाम के व्यंजन किए तैयार

पालमपुर, 30 जून (ब्यूरो): अब कांगड़ी धाम का मजा वर्ष भर ले सकते हैं। इसके लिए किसी शुभ मुहूर्त की प्रतीक्षा नहीं करनी पड़ेगी। हिमालय जैव संपदा प्रौद्योगिकी संस्थान पालमपुर (सी. एस. आई.आर.) पैक्ड रेडी टू ईट कांगड़ी धाम उपलब्ध करवाने जा रहा है। संस्थान ने कांगड़ी धाम के 4 प्रमुख व्यंजनों को पैक बंद उपलब्ध करवाने की तकनीक को विकसित किया है। डिब्बा बंद ये उत्पाद 7 माह से ज्यादा समय तक सुरक्षित रहेंगे।

संस्थान ने इसकी प्रोसेस का पेटेंट भी प्राप्त कर लिया है। ऐसे में अब आप किसी भी समय राजमाह का मदरा, ड्राई फ्रूट रैटा, तैलीय माह तथा चने के खट्टे का स्वाद ले पाएंगे। हिमालय जैव संपदा प्रौद्योगिकी संस्थान पालमपुर ने इस तकनीक का हस्तांतरण साई फूड बैजनाथ को किया है। पैकबंद धाम की बाजार

पालमपुर : हिमालय जैव संपदा प्रौद्योगिकी संस्थान के निदेशक साई फूड बैजनाथ से हस्ताक्षरित समझौता पत्र का आदान-प्रदान करते हुए। (भूरी)

में उतारने के लिए हिमालय जैव संपदा प्रौद्योगिकी संस्थान ने साई फूड बैजनाथ से समझौता पत्र हस्ताक्षरित किया है।

इन व्यंजनों में प्याज-लहसुन का उपयोग नहीं किया जाएगा। वहीं पैकबंद डिब्बे में 4 प्रकार के व्यंजन राजमाह का मदरा, ड्राई फ्रूट रैटा, तैलीय माह तथा चने का खट्टा उपलब्ध होंगे। संस्थान के अनुसंधान में पाया गया कि यह डिब्बाबंद खाना 7 माह से ज्यादा समय तक सुरक्षित रहेगा।

जब चाहो तब खाओ 'कांगड़ी धाम'

सीएसआईआर (आईएचबीटी) पालमपुर की विशेष पहल

हिमाचल रिपोर्टर न्यूज़
पालमपुर : रमेश माऊ

कांगड़ा घाटी में होने वाले शादी, जन्मदिवस जैसे विशिष्ट समारोह या आयोजन का मुख्य आकर्षण वहां पर परोसे जाने वाले खास भोजन का होता है जिसे 'धाम' कहा जाता है। खाने में 3-4 किस्म के मुख्य व्यंजन जैसे मदरा, रैटा, दाल, खट्टा आदि होते हैं। स्वाद में लजीज यह व्यंजन विशेष समुदाय के रसोइए द्वारा बनाए जाते हैं।

रेडी टू ईट कांगड़ी धाम

क्त व्यंजन बिना प्याज-लहसुन व कम से कम तेल तथा मसालों द्वारा तैयार किए जाते हैं। लेकिन अब आपको कांगड़ी धाम खाने के लिए किसी आयोजन या समारोह का इंतजार नहीं करना पड़ेगा क्योंकि *सीएसआईआर-हिमालय जैवसंपदा प्रौद्योगिकी संस्थान, पालमपुर* के प्रयासों से अब यह खाना आपको 'रेडी टू ईट' के रूप में बन्द डिब्बों में शीघ्र उपलब्ध होने जा रहा है। संस्थान ने इस तकनीक

को विकसित करके धाम के चार प्रमुख व्यंजनों राजमाह का मदरा, ड्राय फ्रूट रैटा, तैलीय माह तथा रतदा चना का खट्टा प्राप्त कर लिया है। इस तकनीक का हस्तांतरण मैं. साई फूड, बैजनाथ को कर दिया है तथा उक्त कम्पनी एक माह की अवधि में उक्त उत्पाद बाजार में उतारने वाली है।

क्या खास है रेडी टू ईट कांगड़ी धाम में

1 यह व्यंजन बिना किसी प्याज लहसुन के बनाए जाते हैं।

हिमालयी जैवसंपदा के सतत् सदुपयोग द्वारा सामाजिक, औद्योगिक और पर्यावरणीय हितार्थ जैवआर्थिकी उन्नयन हेतु प्रौद्योगिकी विकास की दिशा में अग्रसर

Developing technologies to boost bioeconomy through sustainable utilization of Himalayan bioresources for societal, industrial and environment benefits