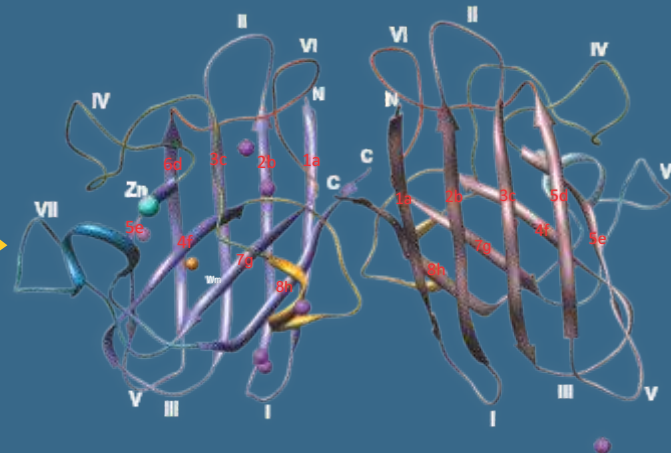


वार्षिक प्रतिवेदन Annual Report 2013 - 14



Superoxide Dismutase

A Journey from Discovery to Market



CSIR-IHBT

CSIR-Institute of Himalayan Bioresource Technology
Palampur, Himachal Pradesh, India

ISSN - 0971 - 8842

Annual Report 2013-14

With

Best Compliments from

Dr. Paramvir Singh Ahuja
Director



CSIR - Institute of Himalayan Bioresource Technology
Palampur, Himachal Pradesh, India

© **DIRECTOR, CSIR-IHBT, PALAMPUR**

Published by:

Dr. Paramvir Singh Ahuja

Director

CSIR-Institute of Himalayan Bioresource Technology,
Palampur, Himachal Pradesh-176 061 INDIA

Phone: +91- 1894-230411, Fax: +91- 1894-230433

Email: director@ihbt.res.in

Web: <http://www.ihbt.res.in>

Concept & Editorial Advisor:

Dr. Paramvir Singh Ahuja

Editorial Board:

Dr. Amita Bhattacharya

Dr. Vipin Hallan

Dr. Sanjay K Uniyal

Dr. Shashi Bhushan

Dr. Gireesh Nadda

Dr. Neeraj Kumar

Dr. Pralay Das

Dr. Yogendra S Padwad

Dr. Amitabha Acharya

Mr. Sanjay Kumar

Mr. Prashanta Kumar Behera

Convener: Mr. Mukhtiar Singh

Photography and cover design: Mr. Pabitra Gain

MISSION

Committed to provide R&D services on economic bioresources in western Himalayan region leading to value added plants, products and processes for industrial, societal and environmental benefits.

Thrust Areas

- Biodiversity mapping and conservation
- Bioprospection of Himalayan bioresources
- Genomics, proteomics and metabolomics
- Adaptation biology
- Natural products chemistry
- Plant health management
- Nanobiology
- Bioinformatics
- Regulatory research

From the Director's Desk.....



CSIR-IHBT continued to forge ahead with a mission to conserve, sustainably manage and valorize the vast bioresources of the Himalayan region. Our R&D activities catalyzed the translation of lab outputs into an array of industrial products and processes.

On a happy note, the institute successfully transferred the technology for the production of Superoxide Dismutase (SOD) to M/s Phyto Biotech, Kolkata. The journey of deciphering the adaptive behaviour of cold desert plant 'Potentilla' led to the discovery of the unique Pa-SOD enzyme. Owing to its autoclavable property and activity at temperature ranging from sub-zero to >50 °C, the enzyme has industrial applications in cosmetics, pharmaceuticals, food processing, preservations etc. The influence of this enzyme in combination with Ascorbate peroxidase from *Rheum australe* was studied at the genome wide expression level in *Arabidopsis thaliana*. The finding revealed that, besides the lignin synthesis pathway, which was activated by low concentration of H_2O_2 , the cellulose synthesis and plant growth promoting pathways were also upregulated. This led to early cell wall synthesis and plant regeneration responses in cultures. Furthermore, transcriptomes of *Picrorhiza kurroa*, *Sinopodophyllum hexandrum* and *Camellia sinensis* were studied with a perspective of adaptation of these species under varying environmental cues with respect to quality and secondary metabolite production.

The year also saw a significant improvement in the green process for extracting total steviol glycosides (SGs) with a purity of $\geq 95\%$ from the leaves of *Stevia rebaudiana*, thereby, placing us at a globally competitive platform in this important technology. The SGs were also used to formulate valuable products such as 'HIM Stevia', a table top sweetener, and 'Tea Fizz', a ready to drink tea.

An array of tea, buckwheat, apple and bamboo based food and nutraceuticals were also developed. The green process for extraction of natural colours from black carrot is under scale-up at pilot plant facility of the institute.

Our initiative in plant breeding led to development of new hybrids of gerbera, stevia and tea.

In the field of nanotechnology, hybrid nanocomposite materials are being investigated for imaging diagnosis. Nano-catalysts have been developed for atom-economy and low-cost organic synthesis.

The Centre for High Altitude Biology (CeHAB) was strengthened with plant tissue culture, chemistry and biochemistry labs in a pre-fabricated double storied building. Establishment of

small scale food processing unit is underway for post harvest management of perishables. The germplasm repository for seabuckthorn was enriched with accessions from other Himalayan regions of the country. Demonstration plots for buckwheat, black carrot, clary sage, saffron, picrorhiza and liliium were laid out.

Establishment of third generation PacBio facility in the current year brought the institute at the forefront of sequencing technology. It will enhance the quality of genome sequencing to unravel information on Himalayan bioresources.

Under CSIR-800 mission, the technologies of the institute are being showcased using the TIM/TEPP facilities. Research scholars enrolled with AcSIR are contributing immensely towards meeting the CSIR-800 goals. The AcSIR was further strengthened with a state of the art virtual classroom in the newly developing Academy Block of the institute.

Our pursuits in innovation resulted in the filing of nine patents. Significantly, 109 research articles and two folders on 'Ginseng (*Panax ginseng*) cultivation and agrotechnology' and 'Ornamental rose (*Rosa hybrida*) cultivars' were published.

The year witnessed unprecedented challenges of attrition due to non-parity of pay scales and superannuation age between CSIR, and particularly, ICAR. The institute also had to perform within a difficult financial outlay, nevertheless performing at par.

I thank the previous Research Council (RC) for contributing immensely for bringing this institute to its present level. I also take this opportunity to welcome the new RC of the institute.



Paramvir Singh Ahuja

निदेशकीय प्रतिवेदन.....

सीएसआईआर-आईएचबीटी हिमालय क्षेत्र की अपार जैवसंपदा के संरक्षण, सतत प्रबन्धन और मूल्यवर्धन के अपने लक्ष्य की ओर सतत प्रगतिशील है। हमारी शोध एवं विकास गतिविधियों ने हमारे संस्थान से औद्योगिक उत्पाद और प्रक्रम के विकास को प्रेरित किया है।

यह हर्ष का विषय है कि संस्थान ने सुपर ऑक्साइड डिस्म्यूटेज (एस.ओ.डी.) के उत्पादन की प्रौद्योगिकी को मै. फाइटो बायोटेक, कोलकाता को हस्तांतरित किया है। शुष्क मरुस्थलीय पोटेंटिला पौधे की अनुकूलता के गूढ़ रहस्य की परिणति पीए-एस.ओ.डी. एन्जाइम की खोज के रूप में हुई। शून्य से कम और 50 डिग्री से. से अधिक तापमान में क्रियाशीलता और आटोकलेवेबल विशेषता के कारण इस एन्जाइम का सौंदर्य प्रसाधन/कांतिवर्धक, भेषज, खाद्य प्रसंस्करण, परिरक्षण आदि उद्योगों में उपयोग है। इस एन्जाइम व *रूह्यूम ऑस्ट्रेल* के एस्कोरबेट पेरोक्साईड का संयुक्त रूप से प्रभाव का अध्ययन *एरोबिडॉप्सिस थालियाना* में जिनोम वाइड एक्सप्रेशन स्तर पर किया गया। इस खोज से पता चला है कि इस एन्जाइम के प्रभाव से लिग्निन संश्लेषण मार्ग, जो H_2O_2 की सूक्ष्म मात्रा से क्रियाशील होता है, सेल्यूलोज संश्लेषण और पादप वृद्धि को प्रेरित करने वाले मार्ग विनियमित हो गये हैं। इससे संवर्धनों में पूर्व कोशिकीय भित्ति व पादप पुनर्जनन में अनुक्रमिता पाई गई। इसके साथ ही *पिक्रोराइज़ा कुरुआ*, *पोडोफिलम हैक्सेन्ड्रम* और *कैमेलिया साइनेंसिस* का ट्रांसक्रिप्टोम्स अध्ययन विविध वातावरण संकेतों में इन प्रजातियों के अनुकूलन तथा गुणवत्ता और सेकेन्डरी मेटाबोलाइट उत्पादन जांचने के लिए किया गया।

इस वर्ष एक ग्रीन प्रोसेस में एक सार्थक सुधार द्वारा स्टीविया की पत्तियों से स्टीवियोल ग्लाइकोसाइड का ³ 95 प्रतिशत तक निष्कर्षण किया गया। जिससे इस महत्वपूर्ण प्रौद्योगिकी के साथ हम वैश्विक प्रतिस्पर्धा में अपना एक स्थान बनाने में सफल हुए हैं। स्टीवियोल ग्लाइकोसाइड से 'हिम स्टीविया' एक मीठाकारक और 'टी फिज' शीतल पेय जैसे मूल्यवान उत्पाद बनाए गए हैं।

चाय, बक व्हीट, सेब और बाँस आधारित खाद्य एवं न्यूट्रास्यूटिकल को विकसित किया जा रहा है। काली गाजर से प्राकृतिक रंगों के निष्कर्षण के लिए हरित प्रक्रम को संस्थान के पायलट प्लांट सुविधा द्वारा बड़े पैमाने पर मानकीकृत किया जा रहा है।

पादप प्रजनन के क्षेत्र में हमारी पहल से जरबेरा, स्टीविया और चाय की नई संकर किस्मों को विकसित किया गया है।

नैनोतकनीक के क्षेत्र में इमेजिंग निदान के लिए संकर नैनोकम्पोजिट सामग्री को खोजा गया है। नैनो कॅटालिस्ट को एटम इकोनोमी और कम मूल्य के जैव संश्लेषण में प्रयुक्त किया गया।

उच्च जलवायु जीवविज्ञान केन्द्र, रिबलिंग में दो मंजिला पूर्व निर्मित सामग्री से तैयार भवन में पादप टिशु कल्चर, रसायन और जैवरसायन प्रयोशालाओं को स्थापित किया गया है। जल्द खराब होने वाली चीजों के प्रबन्धन के लिए लघु खाद्य प्रक्रमण इकाई की स्थापना भी की जा रही है। छरमा (सीबकथोर्न) के जर्मप्लाज़म संग्रहण केन्द्र में देश के

विभिन्न हिमालयी क्षेत्रों से संग्रहित जर्मप्लाज़म को इसमें जोड़ा गया है। बक व्हीट, काली गाजर, क्लेरी सेज, केसर, पिक्रोराइजा और लिलियम के प्रदर्शन प्लॉट को विकसित किया जा रहा है।

अत्याधुनिक पैकबायो सुविधा ने इस संस्थान को स्ट्रिक्चरल तकनीक के क्षेत्र में अग्रणी में कर दिया है। इससे हिमालयी जैवसंपदा की जिनोम सिक्वेन्स की गुणवत्ता बढ़ जाएगी।

सीएसआईआर-800 मिशन के अन्तर्गत टिम/टेप सुविधाओं का उपयोग करते हुए संस्थान की प्रौद्योगिकी को उजागर किया गया है। वैज्ञानिक नवीकृत अनुसंधान अकादमी में कार्यरत रिसर्च स्कॉलर सीएसआईआर-800 के लक्ष्यों को पूरा करने में अहम भूमिका निभा रहे हैं। अकादमी ब्लाक में अत्याधुनिक क्लासरूम को स्थापित किया गया है। हमारे नवोन्मेष के प्रयासों से हमें 9 पेटेंट प्राप्त हुए। 109 शोध पत्र और जिनसेंग और सजावटी गुलाब पर दो फोल्डर भी प्रकाशित किए गए।

इस वर्ष सीएसआईआर में वेतनमान तथा अधिवर्षिता आयु संबन्धी विसंगताओं से बहुत सी चुनौतियों का सामना करना पड़ा, विशेषकर आईसीएआर की तुलना में। संस्थान ने कड़े वित्तीय संकट में भी अच्छे परिणाम दिए हैं।

मैं संस्थान को इस स्तर पर लाने के लिए पुरानी अनुसंधान परिषद के योगदान के लिए आभारी हूँ तथा नई अनुसंधान परिषद का स्वागत करता हूँ।

परमवीर सिंह अहूजा
परमवीर सिंह अहूजा

CONTENTS

From the Director's Desk	v
Characterization and Management of Himalayan Bioresources	1
High Altitude Biology	13
CSIR-Centre for High Altitude Biology (CeHAB)	20
Genomics and Proteomics	27
Nanotechnology	31
Nanobiology	31
Nanochemistry	33
Computational Biology and Bioinformatics	35
Natural Products Chemistry	38
Synthetic Chemistry	41
Multidisciplinary Approaches to Crop Improvement	46
Kutki (<i>Picrorhiza kurrooa</i>)	46
Himalayan May Apple (<i>Sinopodophyllum hexandrum</i>)	48
Wild Turmeric (<i>Curcuma aromatica</i>)	49
Coleus (<i>Coleus forskohlii</i>)	50
Stevia (<i>Stevia rebaudiana</i>)	51
Ginkgo (<i>Ginkgo biloba</i>)	57
Tea (<i>Camellia sinensis</i>)	57
Bamboo (<i>Dendrocalamus</i> and <i>Bambusa</i> spp.)	63
Apple (<i>Malus</i> sp.)	66
Ornamental Rose (<i>Rosa</i> spp.)	70
Gerbera (<i>Gerbera jamesonii</i>)	72
Incarvillea (<i>Incarvillea emodi</i>)	73
Microbiology and Plant Protection	75
Regulatory Research	85
Industrial Dimensions of CSIR-IHBT	88
Business Outreach of CSIR-IHBT	88
Pa-Superoxide Dismutase (SOD) from <i>Potentilla atosanguinea</i>	88
Other Technologies / Products Ready for Transfer	90
Steviol glycosides (SGs)	90
Tea products	91
Dietary fibres/products from apple	93
Value added products from buckwheat and mango	95
Natural colours using green technology	95
Essential oils, perfumes and flavouring compounds	96
Viral diagnostics	97
Plant growth promoting microbial inoculants	98

CSIR 800 Programme for Rural Development	99
Facilities and S & T Services	109
राजभाषा गतिविधियाँ	111
Support Services	113
Project Planning, Monitoring & Evaluation Cell	113
Computer Cell	114
IHBT-Knowledge Resource Centre (IHBT-KRC)	114
Photography Unit	115
Patents, Publications, Human Resources and Publicity	116
Patents Filed and Granted	116
Publications	117
टेलीविजन द्वारा प्रसारित कार्यक्रम	127
Awards/Honours/Recognitions	128
Ph.D. Awarded	129
M.Sc./M. Pharma/M.Tech./B.Tech./B.E/ Thesis/Project supervised	130
Foreign Research Training Fellow	132
Lectures Delivered	133
Guest Lectures Delivered at CSIR-IHBT	133
Visit Abroad	136
Memorandum of Understanding (MoU)	136
Participation in Exhibition	138
Visitors	139
Important Events	140
Research Council	143
Management Council	144
Staff	145
सीएसआईआर-हिमालय जैवसंपदा प्रौद्योगिकी संस्थान, पालमपुर-हि.प्र. शोध एवं विकास गतिविधियाँ तथा प्रमुख उपलब्धियाँ	148
Obituary	162



CHARACTERIZATION AND MANAGEMENT OF HIMALAYAN BIORESOURCES

FIELD SURVEY

Field surveys were conducted in the interior areas of Himachal Pradesh (HP) for various R & D activities (**Table 1**).

Table 1 Field surveys conducted during 2013-2014

Area	Purpose	Outcome(s)	Month
Kumhari	Floristic and ethnobotanical documentation	Herbarium enrichment, Folk knowledge information	May 2013
Suraj Taal, Baralacha, Udaipur, Trilokinath, Sissoo, Koksar	Ground truthing, Plant collection, Identification of unique niches	Training sets for satellite image classification, Herbarium enrichment	June 2013
Udaipur, Myad valley, Hinsal, Trilokinath	Ground truthing, Identification of sites for Permanent Monitoring Plot (PMP), Collection of plants	Study site selection, Herbarium enrichment	June 2013
Khala-Bagnala area	Collection of pteridophytes	Enrichment of fernery	July 2013
Hinsal (Trilokinath) Reserve Forest	Laying of PMP #1	Establishment of PMP of 1ha size	July 2013
Gondhla area	Ground truthing, Plant collection	Herbarium enrichment	July 2013
Mulling Reserve Forest	Laying of PMP #2, Plant collection	Establishment of PMP of 1ha size Herbarium enrichment	July 2013
Jispa Darcha area	Ground truthing,	Training sets for satellite image classification	July 2013
Mulling Reserve Forest	Sampling and Plant collection	Phytosociological characteristics, Herbarium enrichment	July 2013
Gaggal and Shahpur area	Collection and distributional studies on <i>Diplazium esculentum</i>	Co-ordinates of species occurrence	August 2013



Khanjar Reserve Forest, Myad valley	Laying of PMP # 3, Plant collection	Establishment of PMP of 1ha size Herbarium enrichment	August 2013
Banikhhet, Dalhousie hills and Kalatop wildlife sanctuary	Survey and sampling of target pteridophytic plants for molecular studies	Information on species population and diversity	August 2013
Rohtang pass area, Naingarh and Neelkanth area	Collection of plants, Ground truthing; Identification of future PMP sites	Training sets for satellite image classification, Herbarium enrichment	August 2013
Chhota Bhangal areas of HP	Survey and sampling of target pteridophytic plants for molecular studies	Information on species population and diversity	August 2013
Peukar, Darcha	Field survey, Ground truthing	Training sets for satellite image classification	September 2013
Mulling	Field studies in PMP #2	Study of vegetation structure and phytosociology, Litter fall experiment, Recording of temperature variable, Herbarium enrichment	September 2013
Rohtang	Collection of plants, Ground truthing	Training sets for satellite image classification, Herbarium enrichment	September 2013
Khanjar	Field studies in PMP #3	Study of phytosociology and vegetation structure, Litter fall experiment, Recording of temperature variable, Herbarium enrichment	September 2013
Gwaltikar, Kangra district	Survey and mapping of ferns and fern allies	Distribution of ferns	October 2013
Trilokinath, Khanjar	Field studies in PMP #1 & 3	Study of phytosociology and vegetation structure, Recording of temperature variable, Litterfall experiment, Herbarium enrichment	October 2013
Mulling	Field studies in PMP #2	Study of phytosociology and vegetation structure, Recording of temperature variable, Litterfall experiment, Herbarium enrichment	October 2013
Jaisinghpur	Reconnaissance survey	Training sets for satellite image classification	December 2013
Thural area	Survey and collection of a target plants for biochemical screening	Chemical evaluation	February 2014

Herb, shrub and tree density in the campus of CSIR-IHBT

Four plantations in the campus of CSIR-IHBT i.e. short rotation high density fuel-woods (SRHD), *Eucalyptus* spp., damask rose and tea were studied (Fig. 1). A total of 96 plant species belonging to 52 families were recorded from these plantations. Poaceae, Asteraceae and Rosaceae were the dominant families. Maximum tree density was recorded in SRHD plantation ($36.63 \pm 28.10/100 \text{ m}^2$), while maximum shrub and herb density was in tea plantation ($20.50 - 2.10/25 \text{ m}^2$). Rose plantation had the highest herb density ($210.83 \pm 57.30/\text{m}^2$) but tree ($H' = 2.547$) and shrub diversity ($H' = 2.382$) was highest in SRHD. Amongst the four plantations, SRHD and eucalyptus plantations showed maximum similarity '(22 %)'.



Fig. 1 Studies on plantations of CSIR-IHBT campus (A) SRHD fuel-wood (B) *Eucalyptus* (C) damask rose (D) tea

Plant invasion studies

Studies on alien species of HP revealed that ~15 % of the state flora comprises of aliens. Majority of the alien species are herbs (73 %) and belong to the family Asteraceae (60 taxa) followed by Poaceae (48 taxa) and Leguminosae (43 taxa) (Fig. 2). Most of these species are of American origin (29.37 %). Amongst the genera, *Eucalyptus*, *Ipomoea* (9 each) and *Euphorbia* (8) are the most predominant. Apart from the human disturbed landscapes, these species can also be seen inside deep forests while a few on alpine meadows.

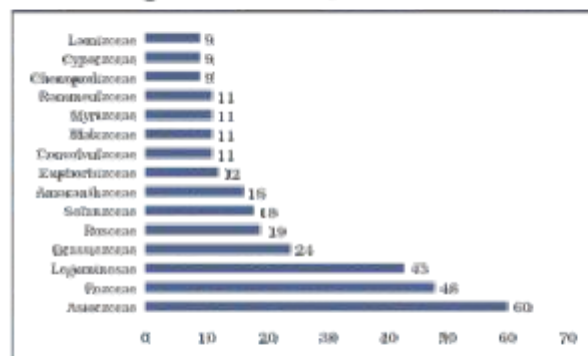


Fig. 2 Top 15 families in terms of richness of alien species (Source: Environmental Monitoring and Assessment 185: 6129-6153)

Modelling *Sapium sebiferum* distribution

Sapium sebiferum is amongst the highly invasive species of the world and its spread in western Himalaya is a serious conservation issue. Maxent- a maximum entropy based program was used to predict potential distribution of the plant in western Himalaya.

Field collected co-ordinates of 177 presence locations of the species and environmental data downloaded from the worldclim data portal were used for the same under default setting. Area under curve for the receiving operator analyses, an accuracy at all possible threshold in training (0.993) and test (0.993) close to 1 were recorded. The total predicted area for *S. sebiferum* is 11920 km². This area lies between 30° 14' 43" to 32° 50' 40" N and 74° 52' 25" to 79° 23' 28" E over an altitudinal range of 349 m to 2390 m (Fig. 3). The species had a high probability of occurrence in 15 % of the total area.

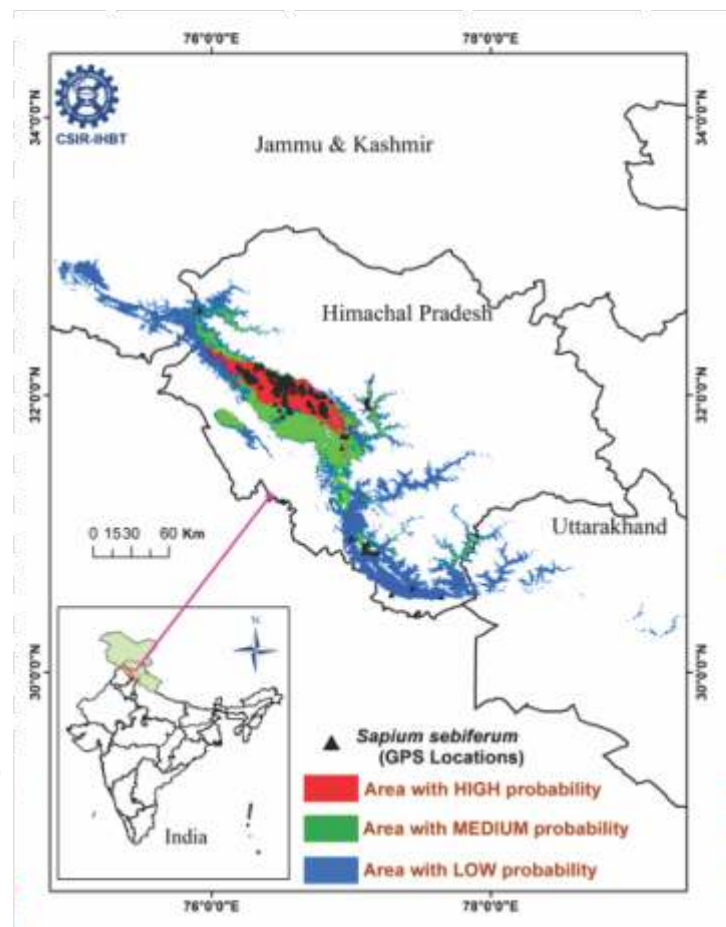


Fig. 3 Probability distribution of *Sapium sebiferum* in western Himalaya (Source: Current Science 105: 1282-1288)

Studies on umbellifers of western Himalaya

In order to understand the current distribution status of the members of the family Apiaceae (Umbelliferae) in Indian western Himalayan region particularly in HP, an updated list of about 100 species was prepared. Different sources such as published literature, internet and the specimens available in the herbarium (PLP) were used. The list contains latest nomenclature, distribution and altitudes.

Ethnobotanical studies

While conducting plant surveys in different locations of Chamba and Kangra districts, HE Gaddis were interviewed and ethnobotanical information associated with the plants used by these folks was recorded. Information on 25 plants was gathered. The plants used for treating different diseases are *Ainsliaea* (boils and blisters), *Ajuga* (wound healing), *Asplenium* (itching), *Bergenia* (wound healing), *Geranium* (toothache), *Hedychium* (urinary trouble in cattle), *Sorbaria* (dysentery), etc.

Enrichment of herbarium

In order to enrich the existing herbarium of the institute, several floristic surveys were carried out in different parts of the state of HP. Approximately 1000 voucher specimens including gymnosperms, angiosperms, ferns and fern allies (pteridophytes) were collected from different localities and about 200 specimens were processed and deposited in the herbarium (PLP) of the institute for reference. Fifteen species, new to the herbarium were added. *Sanicula elata*, *Torilis japonica*, *Onychium siliculosum*, *Polypodiastrum argutum*, *Salvinia molesta*, *Selaginella adunca* etc. are among the new additions.

Authentication of plants

Authenticity of 50 plant species, including 15 species of ferns and fern allies, was established. The authenticated specimens were processed and deposited in the herbarium of the institute.

Soil analysis

Composite soil samples from 125 localities of HP were collected from a depth of 15 cm and analyzed for physico-chemical properties. Soil pH ranged from 3.41 to 8.10, while the saturation percentage ranged from 17.1 to 74.0 %. The organic matter and total nitrogen in these sites ranged from 0 to 4.5 % and 0 to 0.20 %, respectively. Available phosphorous ranged between 1.1 and 813.6 $\mu\text{g g}^{-1}$, and available potassium between 18.99 and 649.2 $\mu\text{g g}^{-1}$.

Land use land cover mapping

The land use land cover (LULC) mapping of Chamba district of HP was conducted using remote sensing techniques. The classification of LANDSAT satellite image resulted in nine broad LULC classes in the region (Fig. 4). The result showed that 54.20 % of Chamba district is under forest cover and alpine pastures. The grass/scrub land and barren land constitute 9.65 % area. Its 9.71 % region is occupied by agricultural and built-up areas and 26.42 % region is under snow, scree slopes and water bodies.

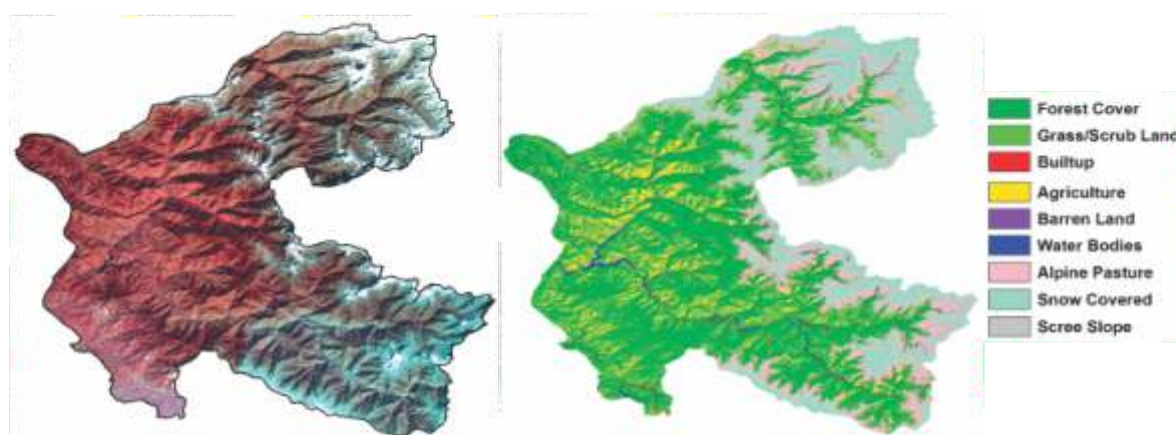


Fig. 4 Satellite image and land use land cover map of Chamba district (HP)

Estimation of net primary productivity of Great Himalayan National Park (GHNP)

The net primary productivity (NPP) of GHNP was estimated using MODIS satellite data of 2013. The average annual NPP of GHNP was 523.81 $\text{g C/m}^2/\text{year}$ and ranged from 0 to 1557.90 $\text{g C/m}^2/\text{day}$ (Fig. 5).

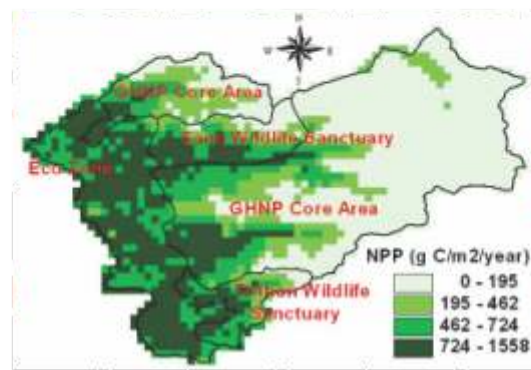


Fig. 5 Net primary productivity of GHNP in 2013

Assessment of watersheds in Kangra region for fluvial erosion susceptibility

The fluvial erosion susceptibility of watersheds in Kangra region (HP) was assessed through drainage morphometric analysis in Geographic Information System (GIS) environment and 10 watersheds were identified. These were namely, 1B1A1, 1B1A2, 1B1B3, 1B1B4, 1B1B5, 1B1B6, 1B1B7, 1B1C8, 1B1C9 and 1B1C10. The watersheds 1B1A2 and 1B1B5 were identified as most susceptible to stream erosion followed by 1B1A1, 1B1B3, 1B1B7, 1B1B4-1B1B6-1B1C10, 1B1C9 and 1B1C8 (Fig. 6).



Fig. 6 Watersheds susceptible to stream erosion (Source: Him. Geology 35(1): 47-55)

Development of Kangra Spatial Information System (KSIS)

The Kangra Spatial Information System (KSIS) is a web application developed at the institute for Kangra district of HP (Fig. 7). It is hosted by ArcGIS Server 9.3 and can be accessed through local area network. The multilayered spatial and non-spatial information provided in the KSIS can be retrieved to know about the availability and distribution pattern of bioresources in the region.

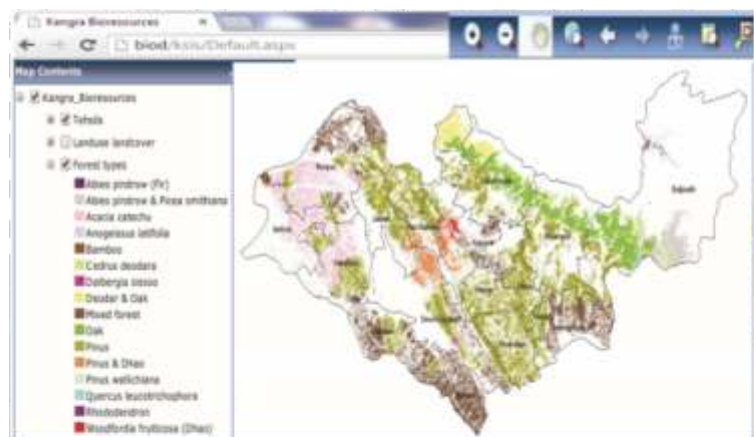


Fig. 7 Graphic user interface of KSIS (Source: ASRS 13: 1-6)

Bioresource inventorization with a focus on bioprospection of pteridophytes of western Himalaya (Sponsored by Department of Biotechnology, Govt. of India)

In order to inventorize and map the pteridophytes of HP, botanical surveys were conducted in different localities. Two fern species-rich pockets viz. Shikari Devi Wildlife Sanctuary (SDWLS) and Barot area of Mandi district were identified. SDWLS is one of the diverse evergreen protected forest area situated in Mandi district. A total of 105 species (100 ferns and 5 fern allies) belonging to 33 genera and 15 families were recorded from the area. Ninety species of pteridophytes with 85 ferns and fern-allies belonging to 31 genera and 14 families were recorded. These represent about 95 % of the pteridophytic flora of Mandi district. Thirty five percent of fern and fern-allies of HP were recorded from Barot in the Uhl Valley of Mandi district. Live collections of 80 species of ferns and fern-allies were also introduced in the fernery of CSIR-IHBT for conservation and multiplication purposes.

Maintenance and upkeep of fernery

Recording of periodic phenological data of ferns growing in fernery were continued. Multiplication of ornamental ferns was initiated and currently 200 plants are ready for sale. Five species, new to the fernery, were successfully introduced during this period (Table 2).

Table 2 Fern species new to IHBT fernery

Species	Collection Site	Native place
<i>Selaginella moelondorffii</i>	Taiwan	Taiwan, Southeast Asia and South China
<i>Selaginella adunca</i>	Garhwal Himalaya	Western Himalaya
<i>Onychium siliculosum</i>	Garhwal Himalaya	Western Himalaya
<i>Salvinia molesta</i>	Fern house of Panjab University, Chandigarh	All warm places including low altitude areas of HP
<i>Polypodiastrium argutum</i>	Dalhousie hills, Chamba	Western Himalaya

A first report on aphid pest infestation on fern

The aphid, *Amphorophora ampullata* (Homoptera: Aphididae) was found to be a pest of the fern, *Hypolepis polypodioides* (Hypolepidaceae) from western Himalayas. Although the pest was first observed during the last week of August, 2012, its infestation increased gradually from last week of September to October, and peaked during the last week of November. This was attributed to high temperature (28–30°C) and humidity (65-75 %). The infestation decreased during December and January 2013 when temperatures were low (4-10°C). Nymphs and adults stages of *A. ampullata* that were congregating on the ventral surface of the fronds and injured the *H. polypodioides* plants by piercing and sucking the sap. This led to yellowing, loss of vigour, drying, and dropping of fronds (Fig. 8A). In severe infestations, the entire plants showed wilting and drying (Fig. 8B).



Fig. 8 A. ampullata infestation on (A) fronds of *H. polypodioides* (B) damaged fronds

Development of plant based pesticides

In continuation to previous work on the development of plant based pesticides, ten fern extracts were screened for pesticidal activities against insect pests viz. diamondback moth (*Plutella xylostella*) and aphids (*Aphis craccivora*). One sample, IHBPEAL 00VI showed larvicidal activity against *P. xylostella* after 48 and 72 h of treatment. It resulted in 53, 23 and 7 % mortality after 48 h, and 67, 40 and 33 % mortality after 72 h of treatment at 2.0, 1.5 and 1.0 % concentrations, respectively.

Website on pteridophytes

In order to popularize R&D activities on pteridophytes across the world, a website was developed. This website will be useful for researchers, scientists, academicians and all who are interested in pteridophyte biology. One can access it either by opening IHBT website or directly by clicking <http://www.ihbt.res.in/IFS/index.html>. This website contains detailed information on the history and biology of pteridophytes, and also about the activities of Indian Fern Society.

Creation of bioresource information centre for floral resources of Himachal Pradesh, western Himalaya (Sponsored by Department of Biotechnology, Govt. of India)

Development of a website for Bioresource Information Centre was initiated. HyperText Markup Language (HTML), Cascading Style Sheets (CSS), JavaScript, PHP, and Word press are being used for designing the front end. The back end of the same constitutes MySql (a relational database management system) and XAMPP (server).

Preventing extinction and improving conservation status of the threatened plants through application of biotechnological tools (Sponsored by Department of Biotechnology, Govt. of India)

In a new activity, pods of the endangered medicinal orchid, *Dactylorhiza hatagirea* were collected during June to September. Seeds extracted from these pods were germinated on culture medium supplemented with different additives and plant growth regulators (PGRs). Germination followed by subsequent development into protocorm-like-bodies (PLB) was achieved. The PLBs developed into shoots after 6 months of inoculation (Fig. 9).



Fig. 9 Germination of *D. hatagirea* (A) pods (B) seed with embryo (C) protocorm-like-body (D) development of shoots and rhizoids from seeds

LONG TERM ECOLOGICAL MONITORING STUDIES

Three 1ha PMPs in the tree line zone were established in the Lahaul forest division (Table 3, Figs. 10-12).

Table 3 Establishment of three PMPs

Plot	Locality	Dominant species	Coordinates	Altitude	Aspect
PMP#1	Hinsa, Trilokinath	<i>Abies pindrow</i> <i>Betula utilis</i>	N32 40 07.9 E76 41 36.1	3587 m	N
PMP#2	Mulling, Chandra valley	<i>Betula utilis</i>	N32 29 54.7 E76 59 30.7	3750 m	N
PMP#3	Khanjar, Myad valley	<i>Betula utilis</i>	N32 52 06.1 E76 51 31.0	3661 m	N



Fig. 10 Tree line forest dominated by *Abies pindrow* and *Betula utilis* at Hinsa, Trilokinath (PMP#1)



Fig. 11 Tree line forest dominated by *Betula utilis* at Khanjar, Myad valley (PMP#3)



Fig. 12 A tree line where *Betula utilis* was found dominating in two different seasons. Also shown is the position of 1ha PMP (#2)

Revegetation of dumping sites of NHPC (Sponsored by the National Hydroelectric Power Corporation, Faridabad, Haryana)

The 10 dumping sites (DS) of NHPC which were revegetated two years back and are located in Manikaran, Garsa, and Sainj valleys of Kullu district of Himachal Pradesh were revisited. *Robinia pseudoacacia* followed by *Ailanthus excelsa* showed faster vertical growth as compared to other target tree plants (Fig. 13). Variation in plant height within a target tree species was also recorded.

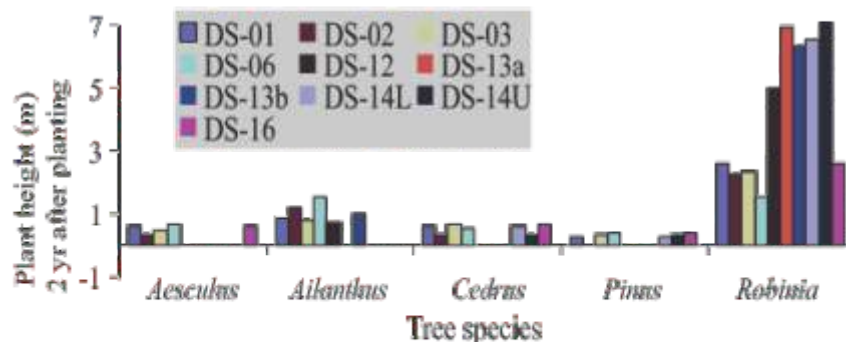


Fig. 13 Height of tree species used for revegetation of the dumping sites (DS) of NHPC in Kullu district, HP

Seed germination and phenological responses of altitudinal ecotypes of *Rumex nepalensis*

The adaptive plasticity of *Rumex nepalensis* was studied using seeds of four altitudinal populations collected from 800 to 4000 m amsl and grown in pots under green house conditions in the institute. The seed weight of the four populations at 15, 25 and 35 °C increased with altitude. About 80% increase was recorded in the alpine population (AP). Seeds of AP germinated faster at 15 °C compared to that at 25 °C (Fig. 14).

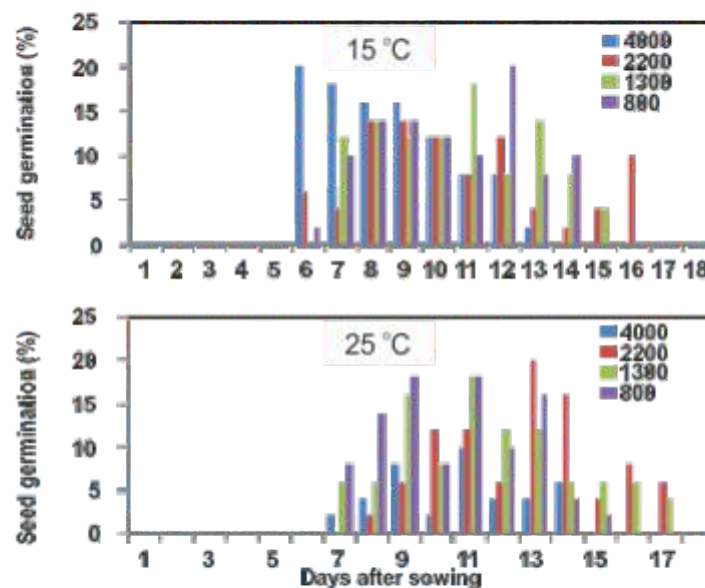


Fig. 14 Seed germination in four altitudinal populations of under polyhouse conditions

Under green house conditions, delayed response for emergence, first leaf formation, bud formation, initiation of flowering but relatively an early (50% and 100%) flowering, seed setting, seed maturity and senescence was observed in AP (Fig. 15).

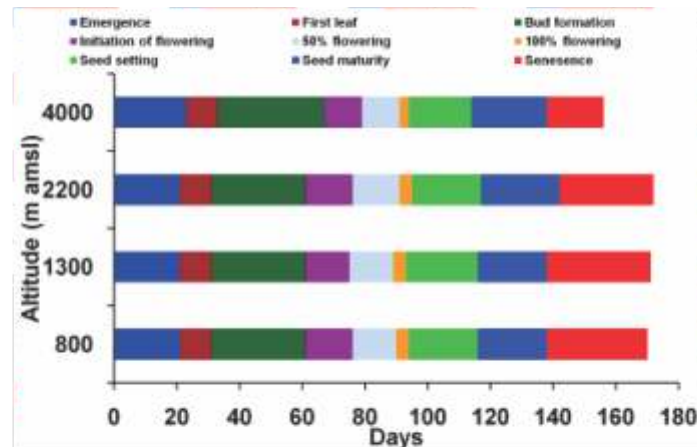


Fig. 15 Phenological stages of altitudinal populations of *R. nepalensis* under polyhouse conditions

Gas exchange parameters

Photosynthetic characteristics of the four altitudinal populations of *R. nepalensis* were also found to vary (Fig. 16)

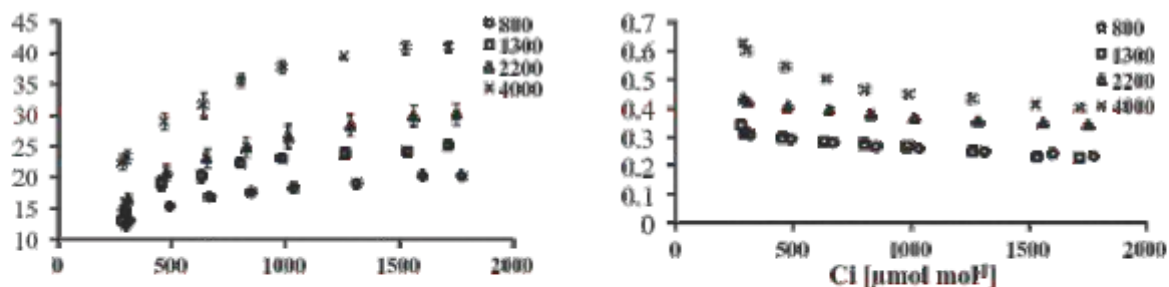


Fig. 16 Response of net photosynthetic rate (P_n) and stomatal conductance (g_s) *R. nepalensis* populations collected from different altitudinal zones at different levels of intercellular CO_2 concentration (C_i) at common polyhouse conditions

Photosynthetic response of *Taraxacum officinale* and *Valeriana jatamansii* to Free Air CO_2 Enrichment (FACE) and Free Air Temperature Increase (FATI)

P_n always increased at elevated CO_2 compared to ambient (control) CO_2 levels, showing an average increase of about 26 % and 18 % for *T. officinale* and *V. jatamansii*, respectively. Season-wise, the greater percent increase in P_n under elevated CO_2 was recorded during autumn (35 %) and winter (32 %) months for *T. officinale*. For *V. jatamansii*, the higher values of similar increase were observed during autumn (26 %) and spring (21 %) seasons. Under FATI, P_n increased by 22 % during winter months for *T. officinale* and by 28 and 29 % during autumn and winter months respectively. P_n decreased during summer, in case of *V. jatamansii*. g_s invariably decreased under FACE for both the plant species, with highest reduction during

winter (36 %) and autumn (29 %) months for *T. officinale*, and during autumn (26 %) and spring (21 %) seasons for *V. jatamansii*. Under FATI conditions, g_s reduced during autumn (5 %) and winter (2 %) for *T. officinale* but showed an increase during winter (5 %) months in case of *V. jatamansii* (Fig. 17).

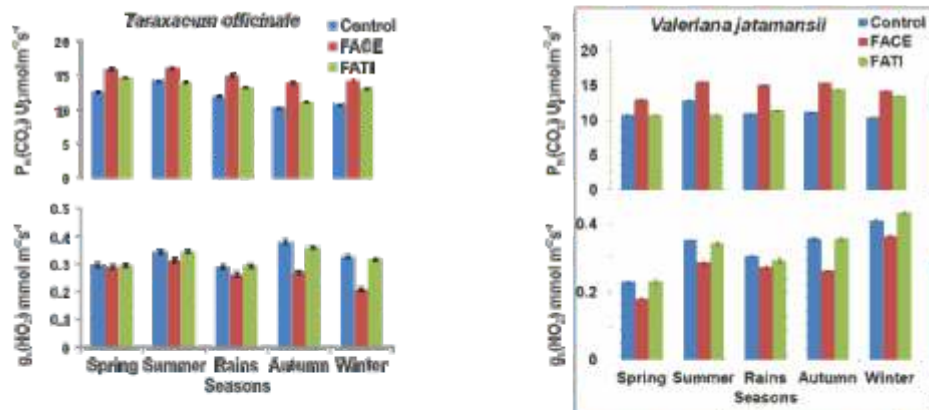


Fig. 17 Net photosynthetic rate (P_n) and stomatal conductance (g_s) of *Taraxacum officinale* and *Valeriana jatamansii* under FACE (550-650 ppm CO_2) and FATI (2-3° C higher than ambient) facilities at CSIR-IHBT for one year and analysed for five major seasons. Ambient CO_2 at 380 ppm served as control

HIGH ALTITUDE BIOLOGY

Decipherance of the molecular mechanism of survival in *Caragana jubata* in the harsh climate of high altitude

In continuation to previous work, a 2-Cys peroxiredoxin cDNA (*CjPrx*) was isolated and characterized from *C. jubata*. The cDNA was 1,064 bp long and consisted of an ORF of 789 bp encoding 262 amino acids (MW 28.9 kDa and pI 5.84). The deduced amino acid sequence shared a high degree of homology with similar proteins from other plants. It had both PRX_type 2-Cys and thioredoxin-like superfamily domains. It contained 26.7 % α -helices, 6.9 % β -turns, 20.6 % extended strands and 45.8 % random coils. The protein was hydrophilic and its expression was modulated by low temperature (LT), methyl jasmonate (MJ), salicylic acid (SA) and drought stress (DS). However, no significant changes in response to abscisic acid (ABA) treatment were observed. Among all the treatments, a strong up-regulation of *CjPrx* was observed in response to MJ treatment (Fig. 18).

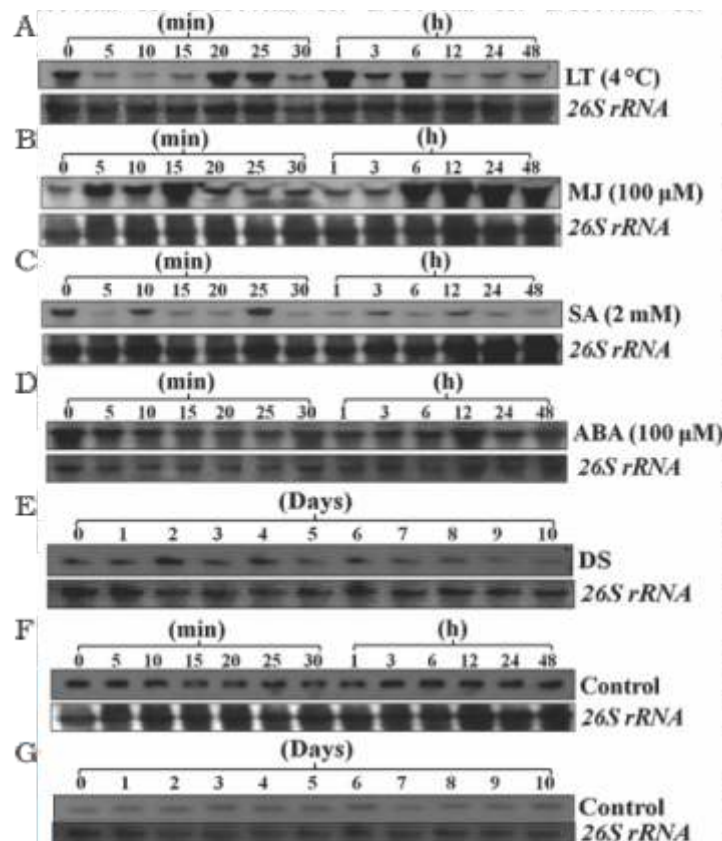


Fig. 18 Expression analysis of *CjPrx* in response to (A) low temperature (LT) (B) methyl jasmonate (MJ) (C) salicylic acid (SA) (D) abscisic acid (ABA) (E) drought stress (DS) (F) control where water was sprayed) (G) control where plants were irrigated regularly

Bioprospecting microbial endophytes and their natural products from some medicinal plants of Indian Trans-Himalayas (PMSI, WP-12)

Isolation and characterization

A total of 980 endophytes including 701 bacteria, 209 fungi and 72 actinomycetes were isolated from *Camellia sinensis*, *Cedrus deodara*, *Dactylorhiza hatagirea*, *Ephedra gerardiana*, *Ginkgo biloba*, *Hippophae rhamnoides*, *Juniperus communis*, *Picrorhiza kurroa*, *Pinus roxburghii*, *Populus alba*, *Potentilla anserina*, *Taxus baccata* and *Salix salicifolia*.

Antimicrobial activity

Among 607 endophytic isolates screened against a panel of test organisms, antimicrobial activity was recorded in 39 isolates against *B. subtilis* (MTCC 121), 26 against *M. luteus* (MTCC 2470), 29 against *S. aureus* MLS16 (MTCC 2940), 28 against *S. aureus* (MTCC 96), 10 against *C. albicans* (MTCC 3017), 25 against *R. planticola* (MTCC 530), and 15 against *E. coli* (MTCC 739). Fifty-three bacterial and 7 fungal-isolates showed broad spectrum activity against two or more test organisms. The isolates showing relatively high broad spectrum activity belonged to genus *Bacillus*, *Paenibacillus*, *Micromonospora*, *Nigrospora*, *Nocardia*, *Serratia*, *Streptomyces* and *Variovorax*.

ACC-deaminase producing bacteria

Soil samples collected from rhizospheres of *Hippophae rhamnoides*, *Populus alba*, *Pisum sativum*, *Salix salicifolia*, *Solanum tuberosum* and *Taraxacum officinale* growing in the trans-Himalayan region of Lahual and Spiti in HP were screened for ACC deaminase producing bacteria. A total of 238 bacteria exhibited ACC-deaminase activity where the activity of 69 isolates ranged between 0.23-405470 nM α -ketobutyrate h⁻¹ mg protein⁻¹. An increase in root elongation from 1.3 to 120 % in maize and 0.7 to 165 % in pea were recorded (Fig. 19). The evolutionary relationships of the isolates based on 16s rRNA gene sequencing showed their affiliation to *Acinetobacter*, *Arthrobacter*, *Bacillus*, *Cellulomonas*, *Enterobacter*, *Flavimonas*, *Microbacterium*, *Pantoea*, *Pseudomonas*, *Rhizobium*, *Stenotrophomonas* and *Zhihengliuella* (Fig. 20).

The identified 238 ACC-deaminase producing bacteria were further screened for phosphate solubilization and auxin production. While 82 isolates showed phosphate-solubilization on modified Pikovskaya agar, 69 showed tricalcium phosphate solubilization ranging between 0.8-851 μ g/ml at 28 °C after 5 days of incubation in NBRIP broth (Fig. 21). The isolates also produced IAA-like auxins (0.9-88 μ g/ml) after 48 h incubation at 28 °C in tryptophan-supplemented nutrient broth.

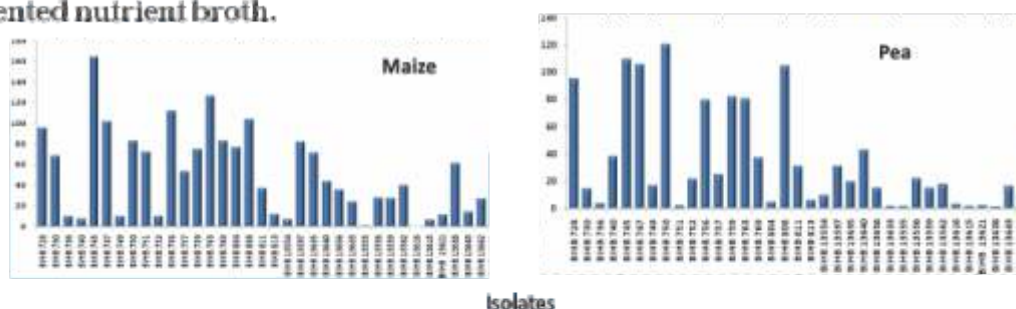


Fig. 19 Root elongation by ACC-deaminase producing bacteria

Fig. 20 Evolutionary relationship of ACC-deaminase producing bacterial strains and related taxa constructed using the neighbor-joining method. The percentage of replicated trees with associated taxa clustered together in bootstrap test (1000 replicates) are shown next to the branches. The evolutionary distances were computed using the Kimura 2-parameter method in units of number of base substitutions per site. Evolutionary analysis were conducted in MEGA5.

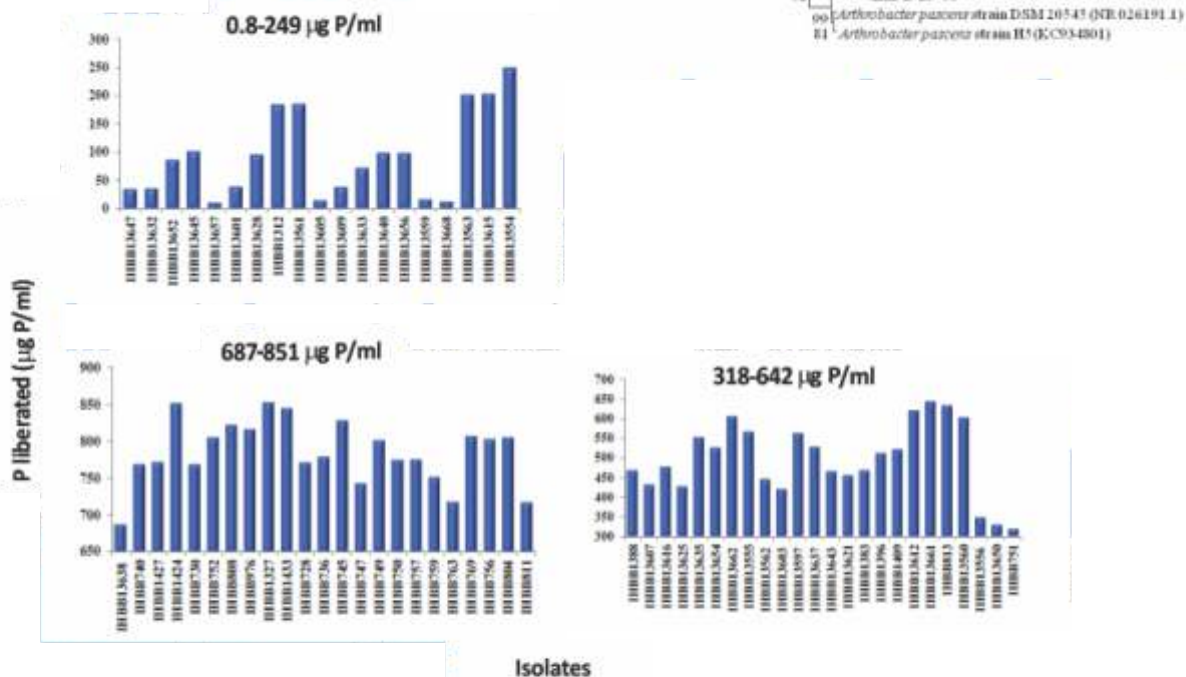
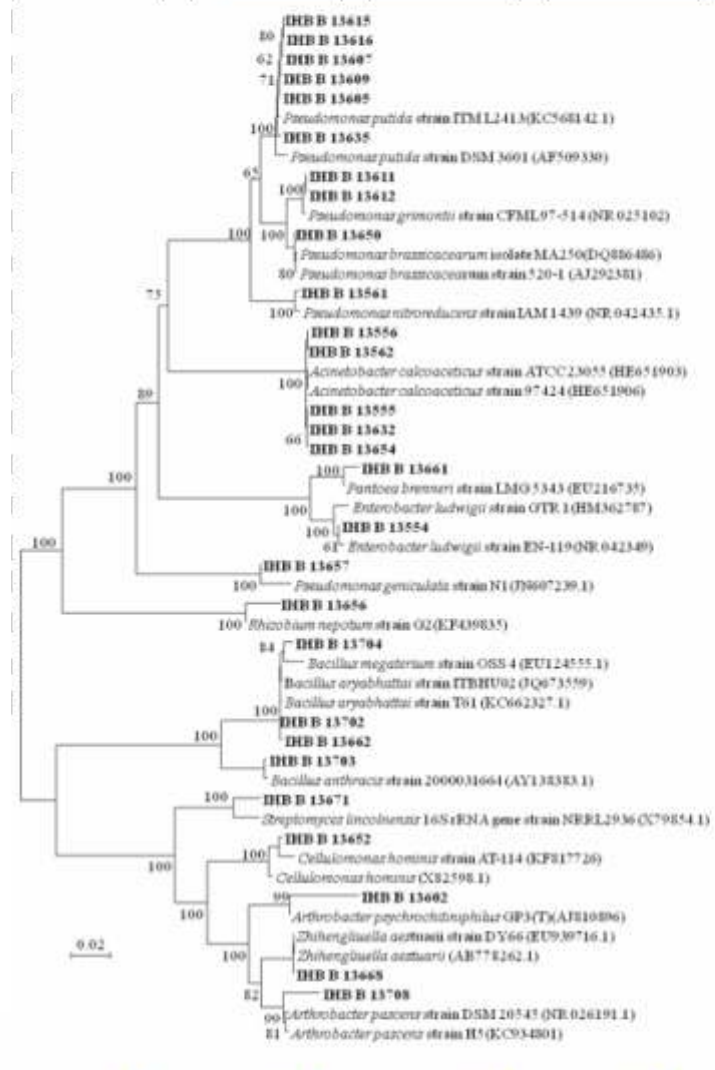


Fig. 21 Solubilization of tricalcium phosphate by ACC-deaminase producing bacteria at 28 °C in NBRIP broth

Isolation and characterization of microorganisms from the Indian trans-Himalayas

In continuation to earlier work on Indian trans Himalayas, diversity analysis and characterization of microorganisms from novel niches including high altitude lakes and glaciers was carried out. Assessment of the genetic variability of bacterial isolates from Suraj Tal and Chandra Tal lakes using ERIC-PCR fingerprints showed a high level of polymorphism in their banding patterns (Fig. 22). Based on 16S rRNA gene sequencing, the ERIC types showed relatedness with *Arthrobacter agilis*, *A. flavus*, *A. nitroguajacolicus*, *A. oxydans*, *A. psychrochitiniphilus*, *A. scleromae*, *Bacillus clausii*, *B. pumilus*, *B. stratosphericus*, *Bosea lathyri*, *Brevundimonas bullata*, *Flavobacterium oceanosedimentum*, *Janibacter melonis*, *Kocuria gwangalliensis*, *Kocuria palustris*, *K. rosea*, *Methylobacterium tardum*, *Microbacterium oxydans*, *M. phyllosphaerae*, *Paenibacillus cineris*, *Pedobacter steynii*, *Pseudomonas cedrina* subsp. *cedrina*, *P. jessenii*, *P. mandelli*, *P. poae*, *Rhodococcus cerastii*, *R. cercidiphylli*, *R. fascians*, *R. jialingiae*, *R. qingshengii*, *Salinibacterium xinjiangense*, *Sanguibacter antarcticus*, *Sphingomonas aerolata*, *S. faeni* and *Staphylococcus hominis* subsp. *hominis*.

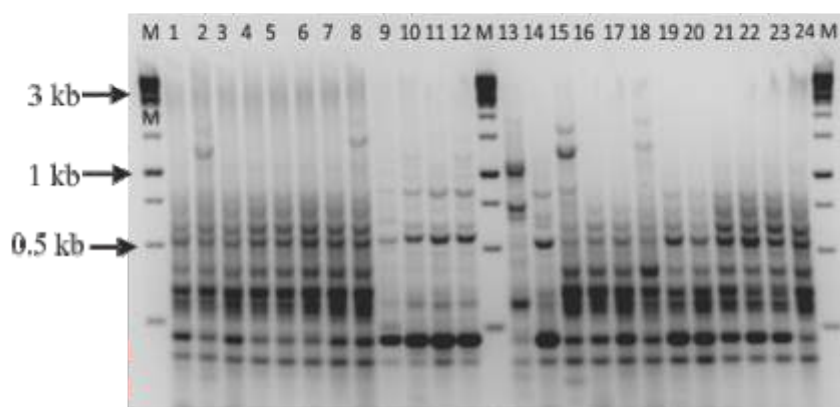


Fig. 22 ERIC fingerprints of bacterial cultures isolated from water samples of Suraj Tal and Chandra Tal lakes. Lane 1-24: IHBB 1112-11136

Low temperature active and alkaline-stable protease from psychrotrophic bacteria from Indian trans- Himalayas.

Psychrotrophic bacterial diversity of the trans-Himalayas in Lahaul and Spiti were screened, isolated and purified for protease production at low temperature and alkaline pH. In 16S rRNA gene sequencing, the potential isolates showed affiliation with diverse genera such as *Acinetobacter*, *Arthrobacter*, *Bacillus*, *Chryseobacterium*, *Exiguobacterium*, *Flavobacterium*, *Mycoplana*, *Paenibacillus*, *Planomicroblum*, *Pseudomonas*, *Serratia* and *Stenotrophomonas*. The representative isolates showed subtle differences in their carbon source utilization pattern. One 35 kDa protease from *Acinetobacter* sp. IHBB 5011 was active over broad range of temperature and pH. It was strongly inhibited by serine protease inhibitor, PMSF. On purification to homogeneity, it exhibited nearly 10 fold increase in specific activity and its kinetics using different substrates showed high substrate specificity towards casein followed by BSA, azocasein, skimmed milk and gelatin. It was stable in the presence of oxidants, surfactants and commercial detergents. It acted synergistically with detergents in removing blood stains from cotton fabrics. The enzyme has potential for detergent industry.

The *Alp* gene corresponding to the purified serine protease from *Acinetobacter* sp IHB B 5011 was also amplified, cloned and sequenced. Its sequence analysis showed a conserved catalytic domain of peptidase S8 family and presence of pre- and pro-sequences in the protein. The initial 1-21 amino acids encoded a putative N-terminal extracellular signal sequence followed by a prepeptide sequence of 22-143 residues, a mature peptidase of 144-434 residues and small propeptide of 435-441 residues at C-terminal region (Fig. 23). The cleavage site was located between Ala21 and Leu22 residues and contained a catalytic triad centre containing Asp169, His209 and Ser348, a characteristic feature of subtilisin-like serine proteases.



Fig. 23 A physical map representing the different domains of the protease. Deduced amino acid sequence representing the entire ORF was used for the analysis

In a further study, the *Alp* gene was expressed in pET-28(a)+ expression vector, and three constructs were generated. The construct pET-AP included both the signal sequence and the prepropeptide sequence (Fig. 24), whereas, the signal sequence was not included in the construct pET-APxip. The pET-APxip and pre-propeptide constructs represented only the mature domain without signal peptide and pre-propeptide sequences. Protein expression as induced by IPTG was maximum after 5 h. In agreement with the predicted molecular mass of the cloned *Alp*-protease, over-expression of 46 and 35 kDa proteins from recombinant cell extracts of the two constructs was recorded (Fig. 25).

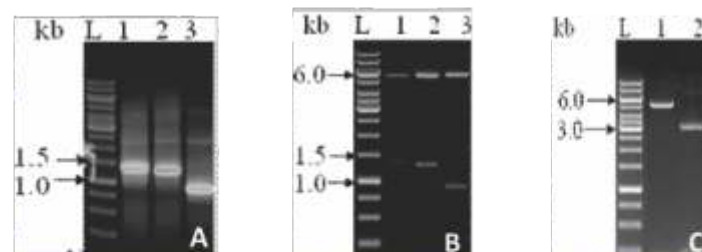


Fig. 24 (A) PCR amplification of *Alp* protease (B) Restriction analysis of recombinant plasmids where lane L: 1 kb marker, lane 1: complete 1323 bp protease gene, lane 2: 1261 bp protease gene without signal IP, lane 3: 870 bp protease gene without signal peptide and prepropeptide sequence (C) Restriction analysis of pET-28(a)+ expression vector where lane L: 1 kb marker, lane 1: vector digested with *Bam*HI and *Sal*I 2: insert digested with these enzymes

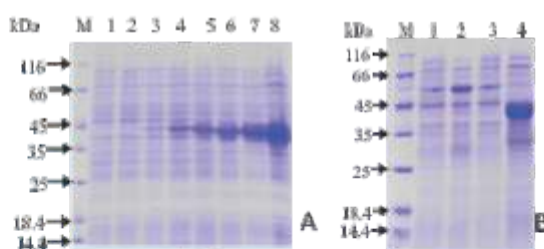


Fig. 25 (A) Time course analysis of recombinant protease from *E. coli* BL21 where lane M: protein marker, lane 1: un-induced protease pET-APxip and pre-propeptide, lane 2: IPTG induced protease pET-APxip and pre-propeptide after 0h, lanes 3-8: IPTG induced protease after 0.5, 1, 2, 3, 4 and 5h; (B) lane M- Protein marker, lane 1: un-induced protease from pET-APxip, lane 2: IPTG induced protease from pET-APxip, lane 3: uninduced proteases from pET-APxip and pre-propeptide, lane 4: IPTG induced protease from pET-APxip and pre-propeptide

Exploring endoglucanase-producing bacteria from cold environments and molecular characterization of extracellular endoglucanases

Psychrotrophic bacteria from Lahaul and Spiti were isolated and screened for cold active endoglucanase activity. The genetic diversity of such bacteria by ARDRA and 16S rRNA gene sequencing showed similarity with different species of *Bacillus*, *Flavobacterium*, *Paenibacillus*, and *Pseudomonas*. *Paenibacillus* sp. IHB B 3084 showed the highest enzyme activity and displayed stability over a broad range of temperature and pH with more than 50 % activity at 10°C and pH 9. The genes encoding endoglucanases were amplified, cloned using T&A cloning vector into *E. coli* DH5 α and sequenced. The domain analysis of the sequence revealed the presence of glycosyl hydrolase family 5 (GH5) catalytic domain. Finally, the genes EG5B and EG5C were cloned into expression vector pET-28a(+) and expressed in *E. coli* BL21(DE3). The molecular mass was estimated to be ~59 kDa for EG5B and ~63 kDa for EG5C. The active recombinant enzymes were purified from culture supernatant using Ni-NTA affinity chromatography, and the activity detected by zymogram (Fig. 26).

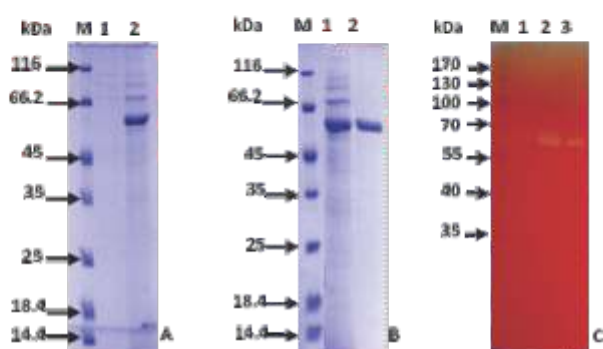


Fig. 26 SDS-PAGE of endoglucanase secreted into the culture medium by the recombinant *E. coli* BL21 (DE3) (A) Lane M: unstained protein marker, lanes 1-2 : un-induced and induced cells transformed with pET-EG5C (B) Lane M: unstained protein marker; lane 1: ammonium sulphate precipitate; lane 2: purified EG5C enzyme (C) Zymogram analysis of extracellular fractions from recombinant *E. coli* where lane M: prestained protein marker, lane 1: cell-free supernatant, lane 2: ammonium sulphate precipitate, lane 3: purified EG5C enzyme

Characterization of purified EG5B enzymes revealed stable endoglucanases activity between pH 4-9 and temperature 5-50 °C, with pH and temperature optima at 7.0 and 50 °C, respectively. Metal ions Cd²⁺ and Hg²⁺ strongly inhibited its activity. On the other hand, EG5C was stable over pH ranging between 4-10 and temperature up to 40 °C with maximum activity at pH 5.0 and 40 °C. The presence of Co²⁺ increased the endoglucanase activity of EG5C by 50 % and was compatible with Triton X-100, Tween 80, Tween 20 and urea. SDS and H₂O₂ completely inhibited its activity. The endoglucanase, EG5B was stable in the presence of commercially available detergents tested for compatibility. The enzymes hydrolyzed Avicel PH-101 and CMC but no activity was detected against filter paper, microcrystalline cellulose, p-nitrophenyl β -D-glucoside and salicin. *K_m* and *V_{max}* values of EG5B were higher in comparison to EG5C with CMC as the substrate.

First draft genome sequence of *Planomicrobium glaciei* isolated from the Chandra river

The psychrotolerant bacterium, *Planomicrobium glaciei* CHR43 was isolated from a soil sample of Chandra river located in the cold desert area of Lahaul and Spiti district, HP. *P. glaciei* CHR43 was found to grow and produce protease enzyme over a wide range of temperatures (5 to 42°C). When the whole-genome shotgun sequencing was performed using the Illumina Genome Analyzer Iix in 76-bp paired-read format, a total of 73,533,050 raw reads were obtained with

5,588,511,800 bp of raw sequence. The final assembly contained 103 contigs with a total size of 3,900,800 bp, an N_{50} contig length of 66,943 nucleotides (nt), the longest contig length of 442,487 nt, and a G+C content of 46.97 %. The annotation performed with the help of the RAST server using the Glimmer 3 option predicted 3,934 coding genes, 76 RNA genes and 406 predicted SEED subsystem features (Fig. 27).

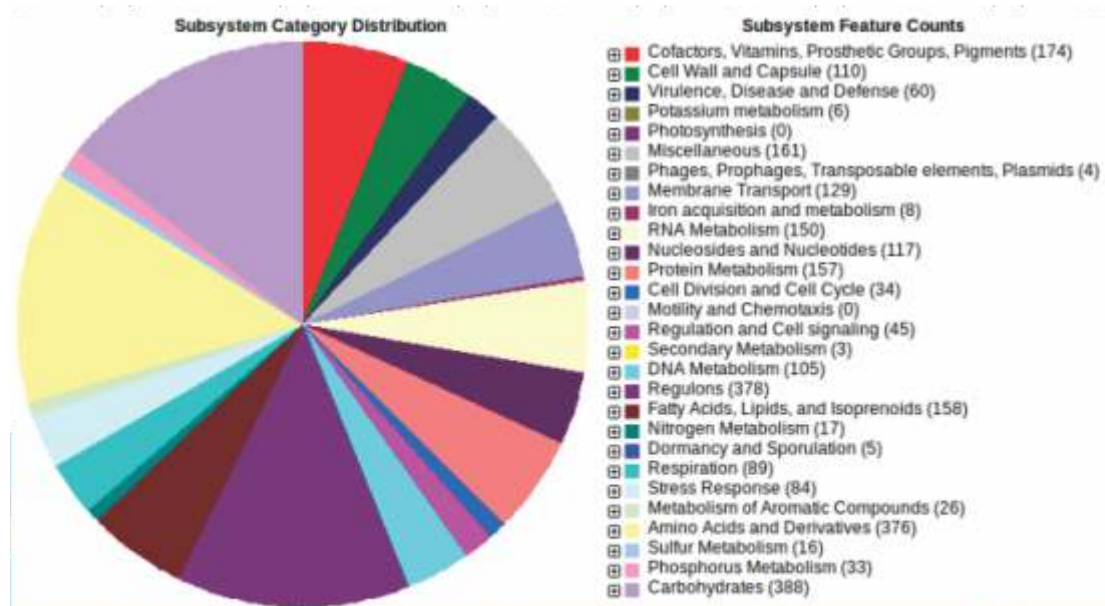


Fig. 27 Gene ontology analysis of the identified genes of *P. glaci*



CSIR-CENTRE FOR HIGH ALTITUDE BIOLOGY (CeHAB)

Infrastructure development

In order to set up chemistry, bio-chemistry as well as a plant tissue culture laboratory, pre-fabricated double storied structures were built at Tandi in Lahaul Valley, Lahaul and Spiti district of HP Work was also initiated on the chemical characterization of the bioresources of that region.



Laboratory set up at CSIR-CeHAB, Tandi

Research and Development Activities

Establishment of aseptic cultures of saffron (*Crocus sativus* L.)

The plant tissue culture facility was used to successfully establish aseptic cultures of saffron. The aseptic cultures of saffron were raised during the first week of October. The explants comprised of apical and axillary buds and parts of corm. Multiple shoot cultures were also raised.



Multiple shoot cultures of saffron at CSIR-CeHAB, Tandi

Saffron cultivation in Lahaul Valley

To assess the suitability of growing saffron, the most expensive spice crop of the world in the region, an experiment was initiated during July 2013 at the CeHAB farm. Three categories of corms [S1 (10-15g), S2 (5-9g) and S3 (small corms)] were planted for three consecutive months i.e., last week of July, August and September (D1, D2 and D3 respectively). A total of 50 corms were planted in a bed of one square meter and two planting depths i.e., 10 cm (P1) and 15 cm

(P2) with plant to plant distance of 10 cm and row to row distance of 20 cm were employed. A saffron demonstration plot was also laid in the farmer's field (**Fig. 28**).



Fig. 28 Saffron production (A) at field site and (B) spice produced at CSIR-CeHAB, Lahaul and Spiti, HP

Growth performance of planted crops was also evaluated w.r.t number of flowers, percent flowering, stigma length, fresh and dry weight, number of leaves, plant height and leaf length up to the month of October. Data for percent flowering, stigma length, fresh wt. and dry wt. is compiled in **Table 4**.

Table 4 Saffron yield at CSIR-CeHAB, Tandi, Lahaul and Spiti, HP in terms of flowering and stigma production

Plantation parameters		Fresh wt. flower	Fresh wt. stigma	Dry wt. stigma	Length of stigma	No. of flowers per bed	Percent flowering
July	D1P1S1	206.68	16.42	5.42	2.31	18.67	37.33
	S2	286.08	19.6	5.22	2.51	8.67	17.33
	S3	166.24	12.34	5.76	2.3	8.67	17.33
	D1P2S1	291.24	23.2	5.66	2.55	26.33	52.67
	S2	317.38	22.72	5.04	2.5	14.67	29.33
	S3	173.8	13.67	3.86	2.31	6.33	12.67
August	D2P1S1	259.74	22.5	5.16	2.34	10.67	21.33
	S2	151.34	12.6	5.06	2.11	9.67	19.33
	S3	279.64	19.12	3.54	2.59	4.0	8.00
	D2P2S1	208.02	18.32	4.36	2.25	6.33	12.67
	S2	160.66	12.5	4.56	2.15	6.0	12.00
	S3	221.28	13.88	5.72	2.47	2.67	5.33
September	D3P1S1	280.56	22.56	5.44	2.56	16.67	33.33
	S2	268.14	22.22	5.68	2.63	7.67	15.33
	S3	214.02	23.04	6.74	2.21	3.33	6.67
	D3P2S1	278.02	23.08	4.9	2.91	9.33	18.67
	S2	365.82	31.36	7.5	2.8	10.33	20.67
	S3	133.52	14.02	5.66	2.13	2.0	4.00

D1, D2 and D3: last week of July, August and September, respectively; P1 and P2: planting depths of 10 and 15 cm, respectively; S1, S2 and S3: corm sizes of 10-15 g, 5-9 g and small, respectively



***Hippophae* germplasm resource centre**

In continuation to previous activity, on *Hippophae* germplasm, 143 accessions from HP, 60 accessions from Leh region of Jammu and Kashmir (J&K), and one accession each from Russia and China are being maintained at seabuckthorn germplasm resource centre in collaboration with the Forest Department of HP at Lahaul. An area of 2 hectares is being covered under this activity.

Demonstration plot on medicinal and aromatic plants

In order to popularize various medicinal and aromatic plants among people residing in the valley, demonstration plots on *Fagopyrum esculentum*, black carrot (*Daucus carota* subsp. *sativus*), clary sage (*Salvia sclarea*), ginseng (*Panax ginseng*), saffron (*Crocus sativus*), kadu (*Picrorhiza kurrooa*) and liliium were laid out at CeHAB farm and also farmers fields during April 2013 to October 2013.



Black carrot (*Daucus carota*)



Manu (*Inula racemosa*)



Lilium



***Hippophae* nursery**



Clary sage nursery



Collection of *Hippophae* germplasm from Leh. (J&K) region

R&D activities at CeHAB, Ribling and farmers field at Lahaul valley, Lahaul and Spiti, HP

Introduction of ginseng in Lahaul valley

In an effort to introduce ginseng (*Panax ginseng*) in Lahaul valley, demonstration plots were set up in farmers' fields located at different regions of the valley.



Close-up view of ginseng plants



Demonstration of ginseng plantation in farmers field



Farmer showing ginseng plant



Interaction of scientists with farmers and distribution of ginseng seeds/seedlings



***Gingko biloba* plantation at Tindi, Lahaul and Spiti**

A *Gingko biloba* plantation was raised in 1 ha area at Tindi, Tehsil Udaipur, Lahaul and Spiti (N32° 45' 00.7" E76° 28' 04.5"), HP at an elevation of 2444 m amsl. The plants are successfully growing in a properly fenced area.



***G. biloba* plantation at Tindi, Lahaul and Spiti, HP**

Food processing facility at CeHAB, Tandi

Machinery such as puffed buckwheat sifter, planetary mixer, band sealer etc. were procured for establishment of small scale processing unit at CeHAB. Seeds of local buckwheat variety were used for preparation of puffed cereal bars and other food products.

Ecological surveys

Activities such as ground truthing and plant collections were performed in whole of the Lahaul valley and Rohtang pass area for landscape analysis of satellite data and ecological sampling. While a total of approx. 550 herbarium samples belonging to about 200 plant species were collected from different localities of Lahaul, a total of approx. 210 herbarium samples belonging to about 100 plant species were collected from Rohtang pass area. Coordinates including elevations were also recorded. Moreover, surveys were conducted in a total of seven sites in Lahaul forest division for the establishment of PMPs in tree line zones. Environmental data were recorded including physiographical and topographical factors, and temperature data. Soil samples were collected from two depths 0-15 cm and 15-30 cm for physico-chemical analysis. The data were then analysed for density and diversity estimates for the major habit forms of plants.



CeHAB , Tandi



Tribal Fair at Keylong (14-16 Aug 2013)

GENOMICS AND PROTEOMICS

Transgenic *Arabidopsis* overexpressing PaSOD

Superoxide dismutase (SOD) catalyzes the dismutation of superoxide radicals ($O_2^{\cdot-}$) to molecular oxygen (O_2) and hydrogen peroxide (H_2O_2). A thermo-tolerant copper-zinc superoxide dismutase from *Potentilla atrosanguinea* (PaSOD), which retains its activity in the presence of NaCl was overexpressed in *Arabidopsis thaliana*. Cotyledonary explants from PaSOD overexpressing transgenic *A. thaliana* exhibited early callus induction and higher shoot regeneration capacity than their wild type (WT) counterparts. Growth kinetic studies showed 2.6 – 3.3 fold higher growth rate of transgenic calli as compared to WT. Regeneration frequency of calli developed from transgenic cotyledons was also 1.5 – 2.5 fold higher than that of WT. A positive regulatory effect of PaSOD and H_2O_2 was observed on different stages of callusing and regeneration. As compared to WT, the transgenics exhibited salt stress tolerance with higher SOD activity, chlorophyll content, total soluble sugars and proline content but lower ion leakage and reduction in relative water content (Fig. 29).

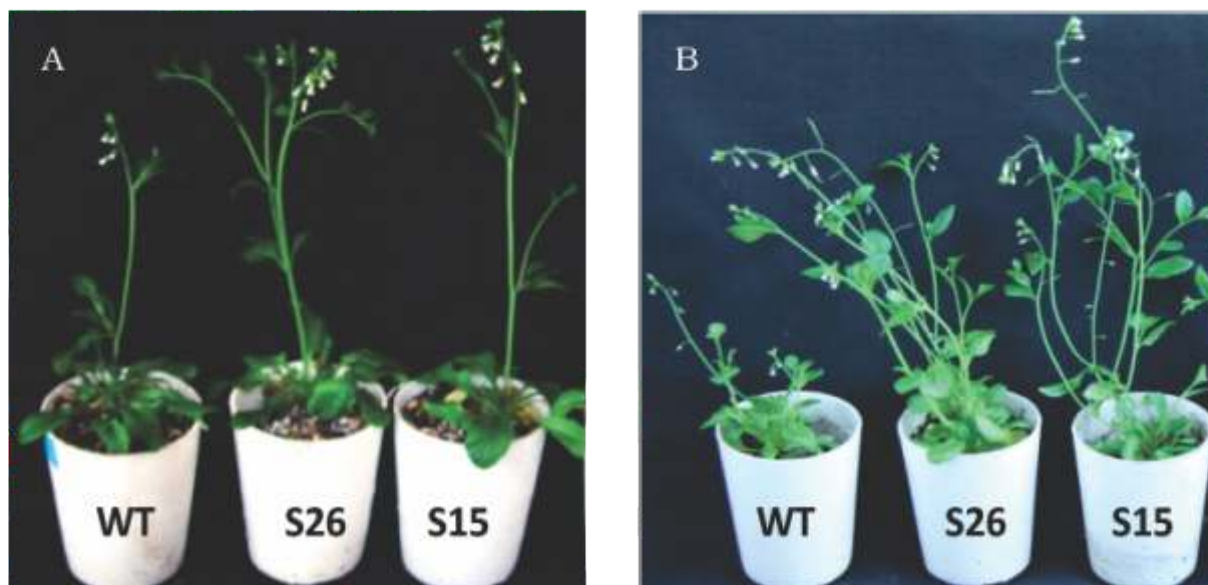


Fig. 29 Wild type PaSOD expressing transgenic lines of *Arabidopsis* under (A) control (0 mM NaCl) and (B) salt stress conditions (100 mM)

Overexpression of steviol glycoside biosynthesis pathway genes from *Stevia rebaudiana* in *Arabidopsis*

Transgenic *A. thaliana* overexpressing SrUGT85C2 cDNA from *S. rebaudiana* was developed. Besides showing a marked decrease in GA_3 content (78-83 %), the transgenics had stunted hypocotyl length, reduced shoot growth, significant fall in relative water content and chlorophyll a and contents of b (17-37 and 64-76 %) respectively (Fig. 30).

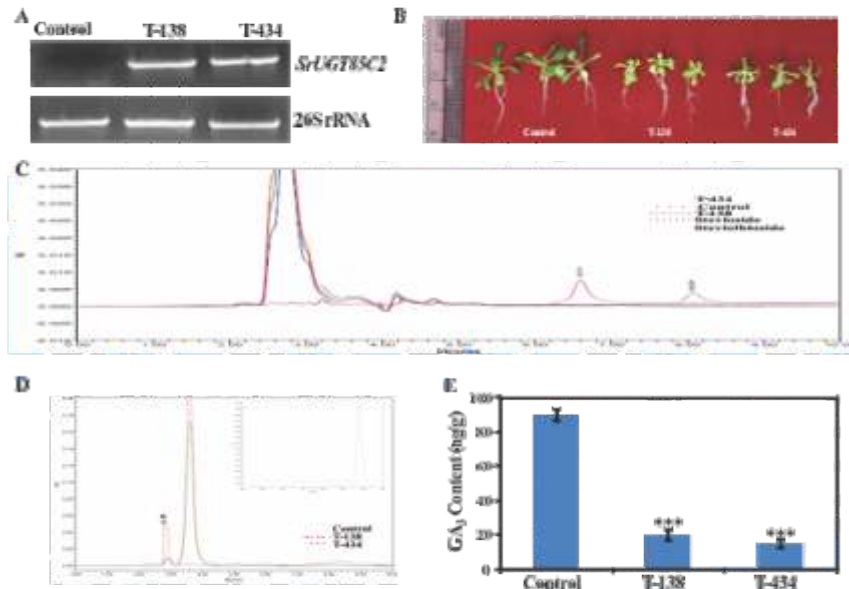


Fig. 30 Transgenic *A. thaliana* overexpressing *SrUGT85C2* (A) RT-PCR confirmation, where 26S rRNA was internal control (B) Variation in shoot height in 15 day old transgenic lines (T-138 and T-434) (C) No steviol glycoside accumulation in transgenics (D) HPLC chromatogram of $10 \mu\text{g ml}^{-1}$ GA_3 standard, showing sharp peak at RT 2.79 min. (E) Endogenous gibberellin content in control and transgenic lines

A UDP-glycosyltransferase encoded by *SrUGT74G1* catalyses the conversion of steviolbioside into stevioside in *S. rebaudiana* leaves. However, stevioside accumulation was not evident in transgenics. No change in GA_3 content was recorded on *SrUGT74G1* overexpression. Rather, significant accumulation of catechins was recorded (Fig. 31). The transgenics also showed considerable increase in shoot length, root length, rosette area, seed yield (6-15 %) and variation in trichome branching pattern on leaf surface. An increase in free radical scavenging activity was also noticed.

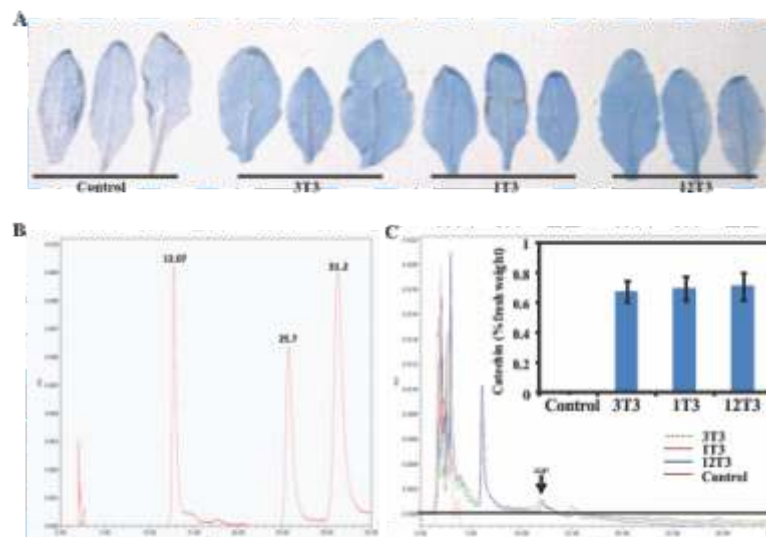


Fig. 31 *Arabidopsis* transgenics over-expressing *SrUGT74G1* (A) DMACA (dimethylaminocinnamaldehyde) staining of leaf samples; (B) HPLC chromatogram of *SrUGT74G1* transgenic lines (3T3, 1T3 and 12T3) showing catechin peaks at 12.07 min. (C) Bar diagram represents catechin content in transgenic lines vis-à-vis control

Evaluating the effect of arabidopsis *ROS1* on epigenetic regulation of flavonoid biosynthetic and antioxidant systems during salt stress in *Nicotiana tabacum* (Sponsored by Department of Science and Technology, Govt. of India)

Transgenic tobacco overexpressing arabidopsis *ROS1* gene was developed to understand the epigenetic regulation of flavonoid biosynthetic and antioxidant systems during salt stress. The recombinant vector pEGAD-*ROS1* was used to raise transgenic tobacco through agrobacterium mediated transformation and confirmed.

Unraveling the role of genes involved in the conversion of sepals to petals

A mutant tobacco transgenic line displaying homeotic conversion of sepals to petals and other phenotypic aberrations was characterized at molecular level. The transcript level of gene encoding anthocyanidin synthase (*ANS*) and petal specific class B genes *GLOBOSA* (*GLO*) and *DEFECIENS* (*DEF*) in sepals increased in the mutant line. While characterizing this mutant line for locus identification, T-DNA was found to be inserted in 3' untranslated region of the promoter of class B MADS box gene. *GLO*. CaMV 35S promoter of T-DNA might be deriving the expression of class B genes (Fig. 32).

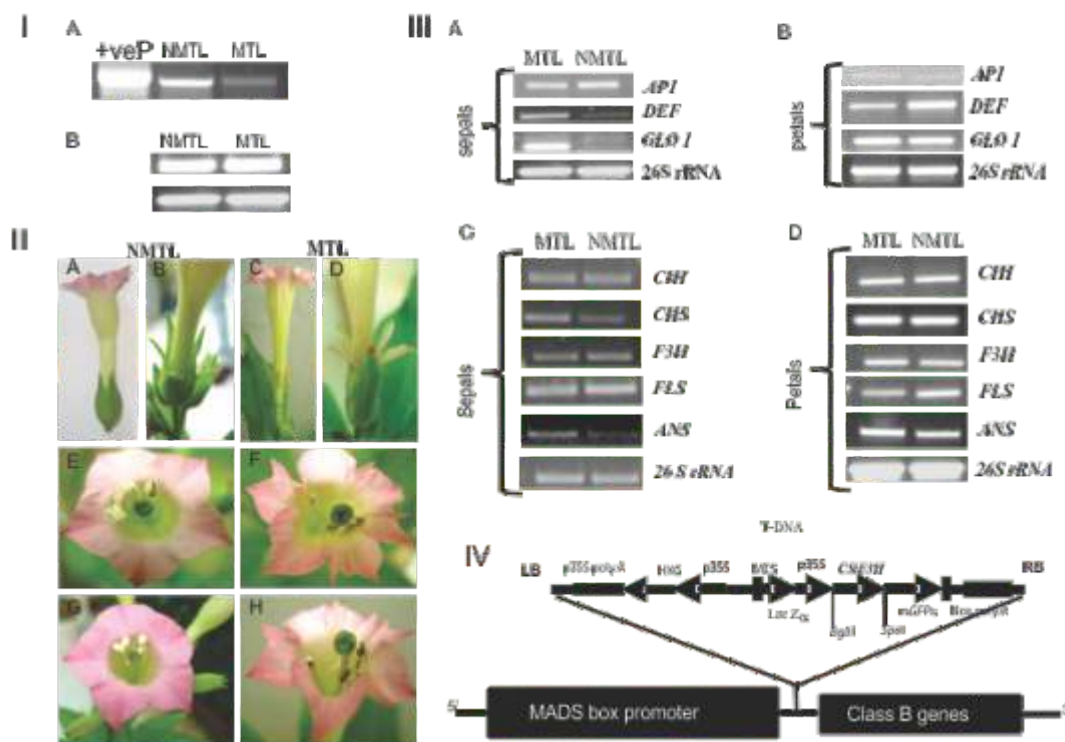


Fig. 32 (I) Characterization of non-mutant (NMTL) and mutant (MTL) transgenic tobacco lines over expressing T-DNA containing *CsF3H* gene. (A) PCR confirmation of *CsF3H* cDNA; (B) Semiquantitative RT-PCR analysis (II) Phenotypic characteristics (III) Expression analysis of MADS box genes and anthocyanin pathway genes in sepals and petals (A) A-class genes (*AP1*) and B-class genes (*DEF*, *GLO*) in sepals (B) A-class and B-class genes in petals (C) Expression of anthocyanidin synthase (*ANS*); *CHI*, Chalcone isomerase; *CHS*, Chalcone synthase; *F3H*, Flavanone 3-hydroxylase, *FLS*, Flavonol synthase. (D) Expression of anthocyanin biosynthetic pathway genes in petals of NMTL and MTL. rRNA was monitored as an internal control. (IV) Insertion of T-DNA in 3'untranslated region (3'UTR) of tobacco MADS box promoter of class B genes (*GLO* & *DEF*) in MTL

Transcriptome and small RNA analysis in horsegram drought stress

In continuation to previous work on understanding the phenomenon of drought tolerance in horsegram (*Macrotyloma uniflorum*), small RNA transcriptome analysis was done. Shoot and root tissue samples from drought-sensitive M-191 and tolerant M-249 genotypes were analysed under control and PEG-induced drought stress conditions. Using Illumina sequencing technology, a total of 229, 297, 896 PE read pairs were generated and utilized for *de novo* assembly (Table 5). Significant BLAST hits were obtained for 26,045 transcripts. A total of 21,887 unigenes were identified. Sequences containing SSRs covered 16.25 % of the transcriptome with predominant tri- and mono-nucleotides (43 %). The total GC content of the transcriptome was found to be 43.44 %. Transcription factors belonging to NAC, MYB-related, and WRKY families were highly represented under drought stress. qRT-PCR validated the expression profile of 9 out of 10 genes (Fig. 33). The genes and pathways identified in horsegram suggest active adaptation as a basal defense response against drought stress.

Table 5 Different assembly steps involved in the transcriptomic study of horsegram

Assembly steps	Total transcripts	Number of transcripts (≥1000bp)	Percent of transcripts (≥1000bp)	Maximum transcript length (bp)	Average transcript length (bp)	N 50 value (bp)	Coverage (X)
Primary assembly step	62, 065	28, 110	45.29	15, 501	1, 114.72	1, 728	295
Hierarchical clustering	29, 603	14, 855	50.18	15, 764	1, 221.20	1, 770	568
Total unique gene groups	21, 887	12, 706	58.05	15, 764	1, 364.09	1, 805	667

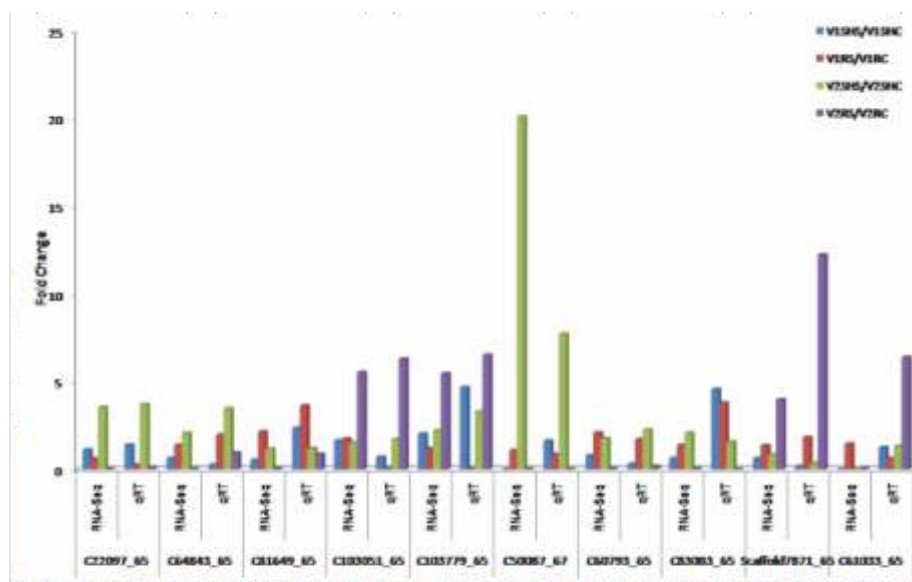


Fig. 33 Expression profile of drought responsive gene in horsegram

NANOTECHNOLOGY

NANOBIOLOGY

Nano-materials: applications and impact on safety, health and environment: (NanoSHE)

In continuation to earlier work, PLA nanoparticles (NPs) were prepared *via* green route using turmeric (*Curcuma longa*) extract (TE) as biostabiliser/biosurfactant. Out of 29 formulations, two formulations of TE synthesized PLA NPs were evaluated for encapsulation and controlled release of the well known antioxidants, curcumin (C) and quercetin (Q). Size of C and Q loaded PLA NPs were found to be 203 ± 77 and 170 ± 95 nm, respectively. The *in vitro* studies suggested initial burst followed by slow and sustained release of both the molecules. Blank PLA NPs and, C & Q encapsulated NPs were found to be safe against normal human leukocytes up to 2 mg/ml dose. Q encapsulated NPs showed better anticancer activity than C NPs on A549 cells (**Fig. 34**). TE extract stabilized PLA NPs were non-toxic, biocompatible and safe to normal human leukocytes. The technology has potential for better, effective and safer use in cancer treatments and other biological applications.

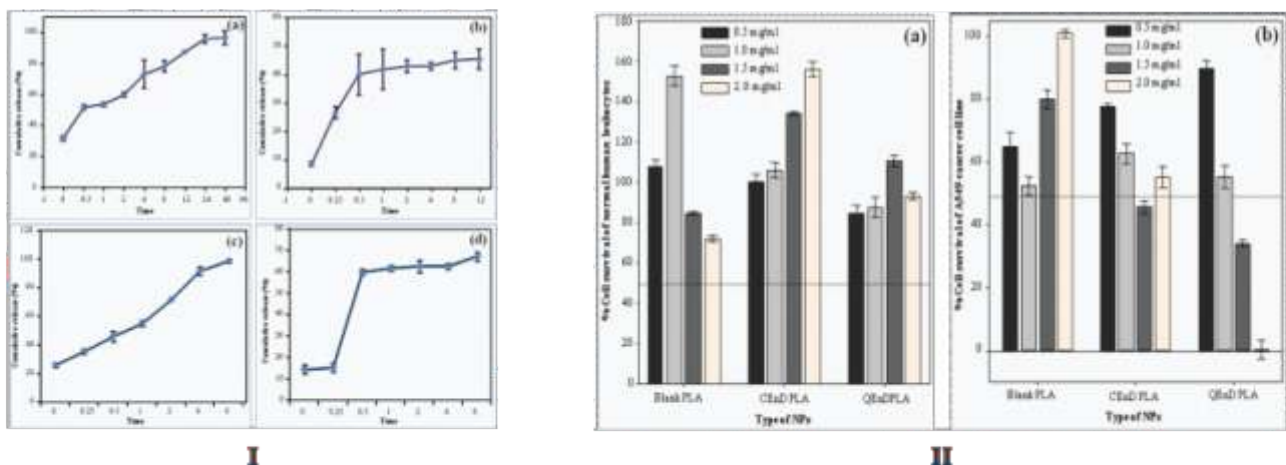


Fig. 34 (I) *In vitro* release profile of curcumin and quercetin from loaded PLA NPs and (b) its (II) cytotoxicity and anticancer evaluation

Isolation and characterization of cellulose nanofibers from bamboo species

Cellulose nanofibers were isolated from two species namely *Sasa auricoma* and *Dendrocalamus hamiltonii* by acid hydrolysis method. The isolated nanofibers were characterized by Scanning Electron Microscope (SEM), Atomic Force Microscope (AFM), Dynamic Light Scattering (DLS) and Transmission Electron Microscopy (TEM) studies (**Fig. 35**). The diameter of the nanofibers ranged between 10 to 20 nm, while the range of its length was 100-200 nm. Nanocomposites of cellulose nanofibers and silver nanoparticles was also prepared and evaluated for antibacterial activity. The nanocomposites have potential applications in biomedical, packaging, filtration and automotive industry.

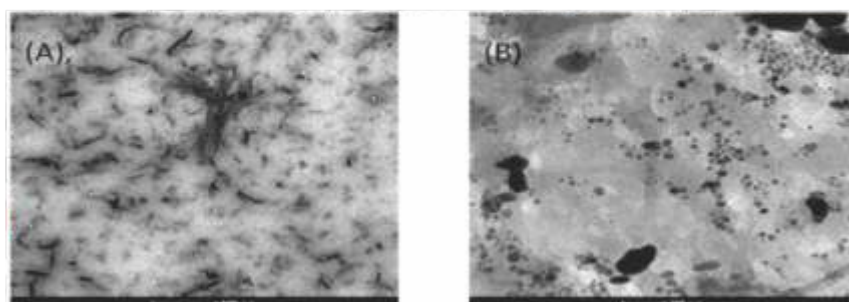


Fig. 35 TEM images of (A) nanofibers ; (B) nanocomposites isolated from *D. hamiltonii*

Encapsulation of catechin and epicatechin on bovine serum albumin (BSA) NPs

Nanoencapsulation of antioxidant molecules on protein nanoparticles (NPs) could be an advanced approach for providing stable and better nutraceuticals and anticancer drugs. Use of BSA NP mediated delivery improved the bioavailability and stability of catechin (CAT) and epicatechin (ECAT). The size of CAT and ECAT-BSA NPs were found to be 45 ± 5 and 48 ± 5 nm followed by 60.5 and 54.5 % encapsulation efficiency, respectively in TEM and AFM (Fig. 36). DPPH assay revealed the maintenance of functional activity of CAT and ECAT against A549 cell line.

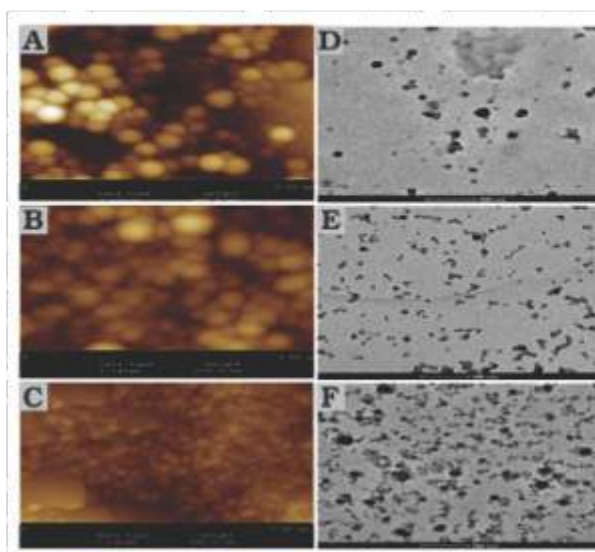


Fig. 36 AFM images of (A) blank-BSA NPs (B) CAT-BSA NPs (C) ECAT-BSA NPs (D-F) TEM images of (D) blank- BSA NPs (E) CAT-BSA NPs (F) ECAT-BSA NPs.

Hybrid nanocomposite material for multimodal imaging

In continuation to earlier work, the multifunctional hybrid nanocomposite material was conjugated with folic acid. The folic acid conjugated nanocomposites were treated with cell lines expressing folate receptor (FR). Cytotoxicity and cell uptake studies with C6 (FR^{+/+}) and A549 (FR^{-/-}) cells and normal mouse splenocytes showed that the folic acid conjugated nanocomposites were significantly toxic to C6 cells within 48 hrs but not to A549 cells. Studies on cellular uptake of the nanocomposites by blue fluorescence emission and their biodistribution by histopathological analysis showed their deposition in lung tissues (Fig. 37). Stability of the nanocomposites was also increased by coating the hybrid materials with a natural biopolymer.

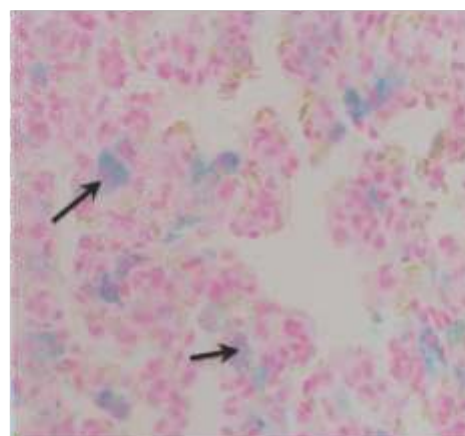


Fig. 37 The presence of blue stained iron particles (arrows) in the alveolar cells (lungs)

Nanoparticle based pesticide sensors

In another activity, a new class of nanoparticles was synthesized for their probable application in the detection of chemical pesticides in solution. Among the different pesticides studied, Dicofol was found to enhance the fluorescence intensity of the nanocomposites (**Fig. 38**).

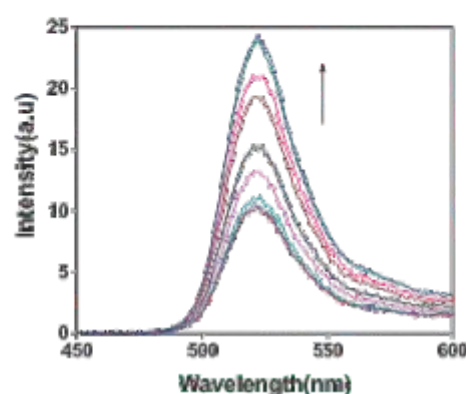
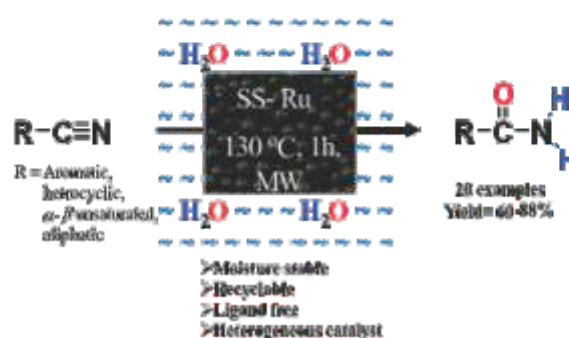


Fig. 38 Fluorescence emission response of NPs in presence of different concentrations of Dicofol.

NANOCHEMISTRY

Solid-supported ruthenium (0) nanoparticles catalyzed hydration of nitriles to amides

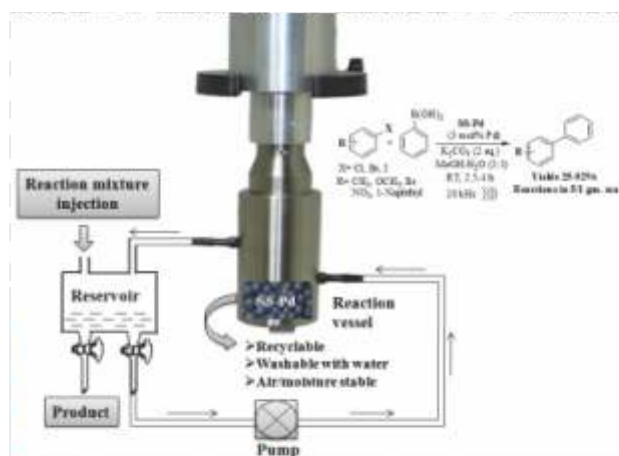
Solid-supported ruthenium (0) was synthesized by reduction deposition method and used as a heterogeneous catalyst for the hydration of nitriles to amides in microwave irradiation. A wide range of aromatic, α - β unsaturated and aliphatic nitriles were efficiently converted to their corresponding primary amides under milder condition. The catalyst was found to be very stable under moisture and microwave irradiation. It was easily separable from reaction mixture and also recyclable up to ten times without significant loss of catalytic activity.



Hydration of nitriles to amides

Solid supported palladium (0) nanoparticles catalyzed ultrasound induced continuous flow technique for large scale Suzuki reaction

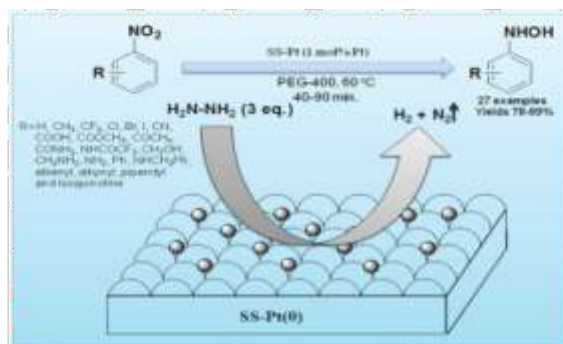
Flow reaction strategy has become extremely important in the field of organic synthesis and process development with non-conventional techniques. In the present study, an ultrasound induced continuous flow technique was developed for solid supported palladium(0) nano/ microparticles (SS-Pd) catalysed Suzuki cross coupling reaction of haloarenes (chloro, bromo and iodo) and phenyl boronic acid in gram scale. An externally conjugated reservoir was fitted for easy operation of reaction in water under milder basic condition. The SS-Pd catalyst was very stable in aqueous media, easily separable and recyclable up to five runs without significant loss of activity.



Continuous flow technique for Suzuki reaction

Solid supported platinum (0) nanoparticles catalyzed chemo-selective reduction of nitroarene to *N*-arylhydroxylamine

Solid supported platinum (0) (SS-Pt) nanoparticles were developed as heterogeneous catalyst following reduction with deposition method and well characterized by SEM, TEM and EDX analysis. The SS-Pt catalyst was applied in chemo-selective reduction of nitroarenes to *N*-arylhydroxylamine using hydrazine hydrate as a hydrogen source. A wide variety of reducible functional groups such as carboxylic acid, halides, amide, ester, nitrile, keto, alkene, alkyne and *N*-benzyl were well tolerated under the reaction condition. Further, this process was successfully employed in 10 gm scale reactions.



Nitroarene to *N*-arylhydroxylamine synthesis

Synthesis and characterization of dendrimer-drug conjugated nanodevice for drug delivery and its efficacy study (Sponsored by Department of Science and Technology, Govt. of India)

The compounds estramustine (EM) and natural podophyllotoxin (PODO) are well known anticancer agents that inhibit tubulin polymerization. Their anticancer properties are limited by low bioavailability. Therefore, their conjugation with PAMAM dendrimer (D) for enhanced activity of D-EM and D-PODO were investigated by altering their release pattern. Release kinetics indicated the synthesized conjugates to be stable against hydrolytic cleavage and showed sustained release characteristics. Release of D-EM was slow compared to D-PODO conjugate. Antitumor effect of these conjugates on glioma cells revealed increased cell death and cell cycle arrest, decreased migration and increased tubulin depolymerization as compared to free drug (Fig. 39).

Importantly, the effects of natural PODO conjugate on glioma cell survival and migration was more pronounced than D-EM. Dose dependant toxicity study of the conjugates was also evaluated in Swiss albino mice. The anti-carcinogenic activity of the conjugates on mouse model is under process.

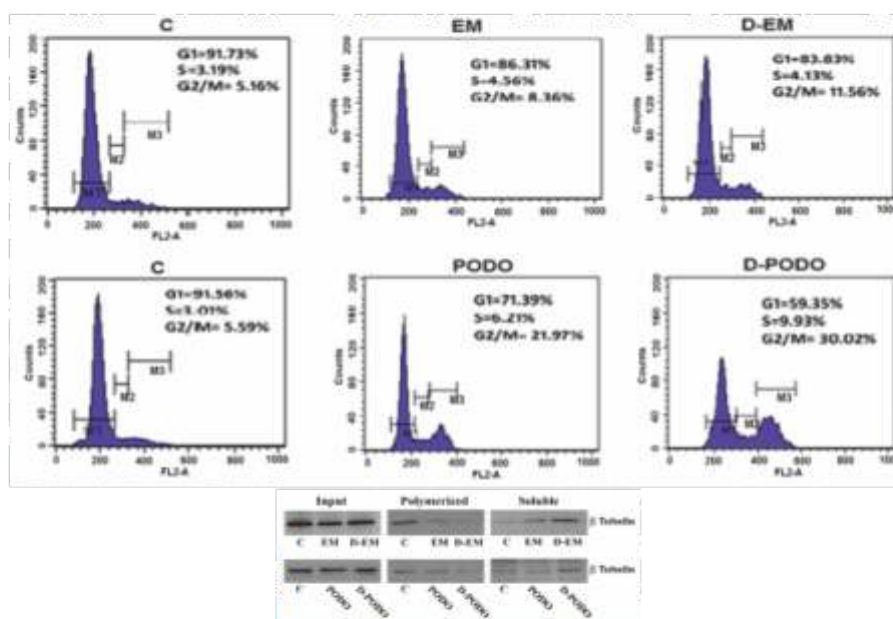


Fig. 39 Estramustine and podophyllotoxin conjugated PAMAM dendrimer study on glioma cell proliferation

COMPUTATIONAL BIOLOGY AND BIOINFORMATICS

miReader: Discovering novel miRNAs in species without sequenced genome

Computational approaches have aided the NGS led technologies in making major impacts in the area of miRNA biology and identification of novel miRNAs. However, to this date, all microRNA discovery tools compulsorily depend upon the availability of reference or genomic sequences. In this regard, a novel miReader was developed for discovering novel miRNAs without any dependence on genomic/reference sequences. It used NGS read data to build highly accurate miRNA models, molded through a Multi-boosting algorithm with Best-First Tree as its base classifier (Fig. 40). It was comprehensively tested over large amounts of experimental data from a wide range of species including humans, plants, nematodes, zebrafish and fruit fly, with consistently >90 % performance accuracy. The same tool was used over illumina read data for a plant whose genome is not sequenced such as *Miscanthus*. Twenty one novel mature miRNA duplex candidates were identified (Fig. 41). Considering the fact that miRNA discovery requires handling of high throughput data, the entire approach was implemented in a standalone parallel architecture. The miReader is expected to impact the area of miRNA discovery in a majority of species because genomic sequence availability would not be a compulsion any more.

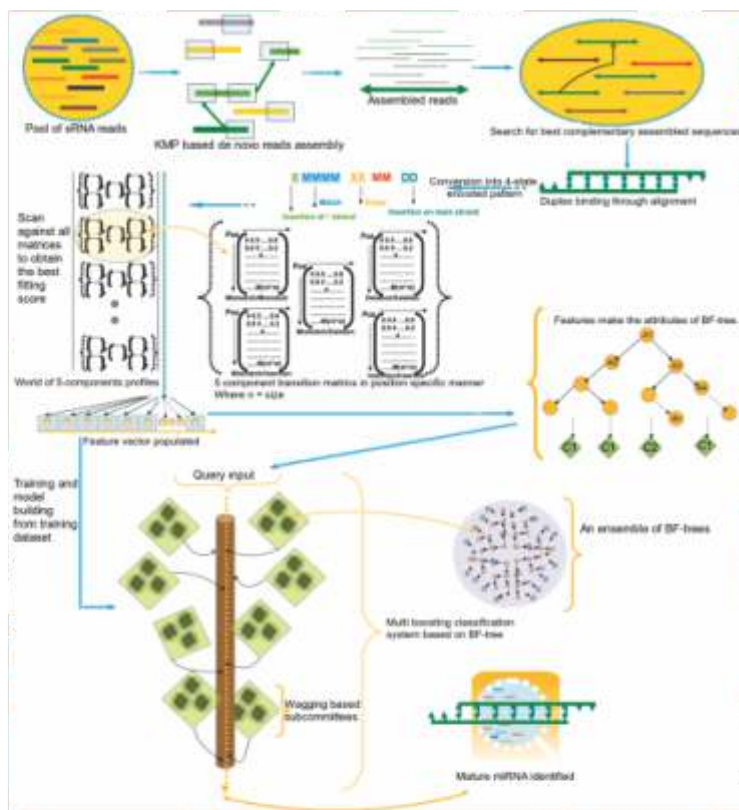


Fig. 40 Work flow of miReader algorithm

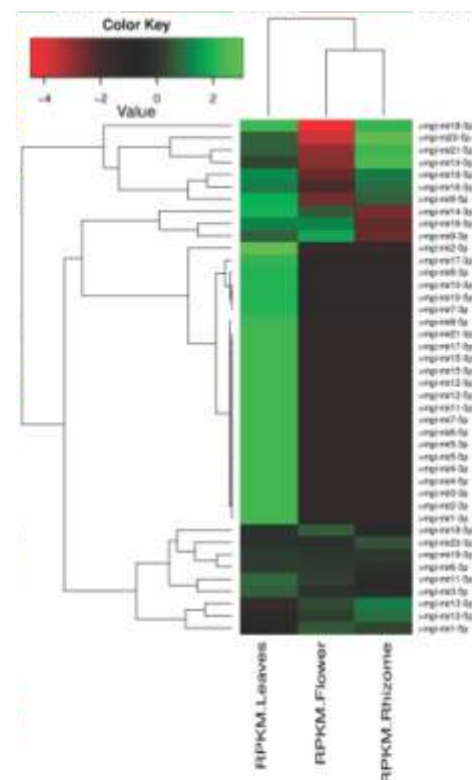


Fig. 41 Heatmap based expression representation and clustering of miRNAs identified in *Miscanthus*

Comprehensive transcriptomic study on *Macrotyloma uniflorum* (horse gram): *De novo* assembly, functional characterization and comparative analysis in relation to drought stress

Eight samples comprising of shoot and root tissues of two horse gram genotypes (drought-sensitive; M-191 and drought-tolerant; M-249) were used for comparison under control and polyethylene glycol-induced drought stress conditions. Using Illumina sequencing technology, a total of 229,297,896 paired end read pairs were generated and utilized for *de novo* assembly of horse gram (Fig. 42). Significant BLAST hits were obtained for 26,045 transcripts. 3,558 transcripts had no hits, but contained important conserved domains. A total of 21,887 unigenes were identified. SSRs containing sequences covered 16.25 % of the transcriptome with predominant tri- and mono-nucleotides (43 %). The total GC content of the transcriptome was found to be 43.44 %.

Under Gene Ontology response to stimulus, DNA binding and catalytic activity was highly expressed during drought stress (Fig. 43). Serine/threonine protein kinase dominated in Enzyme Classification but pathways belonging to ribosome metabolism followed by plant pathogen interaction and plant hormone signal transduction were predominant in Kyoto Encyclopedia of Genes and Genomes analysis. Independent search on plant metabolic network pathways suggested that valine degradation, gluconeogenesis and purine nucleotide degradation in horse gram was highly influenced under drought stress. Transcription factors belonging to NAC, MYB-related, and WRKY families were also highly represented. The expression profiles of 9 out of 10 drought stress responsive genes were validated using qRT-PCR.

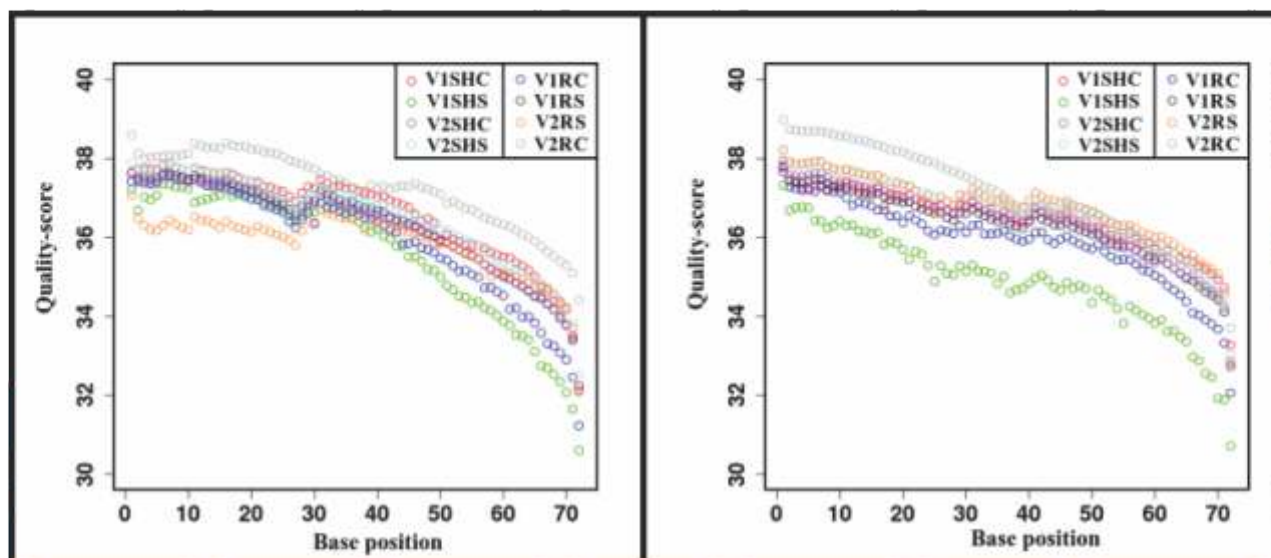


Fig. 42 Read quality-scores. Plots showing the read quality-score for all the samples in PE data. The quality-score for all the reads generated were greater than 30 for all samples

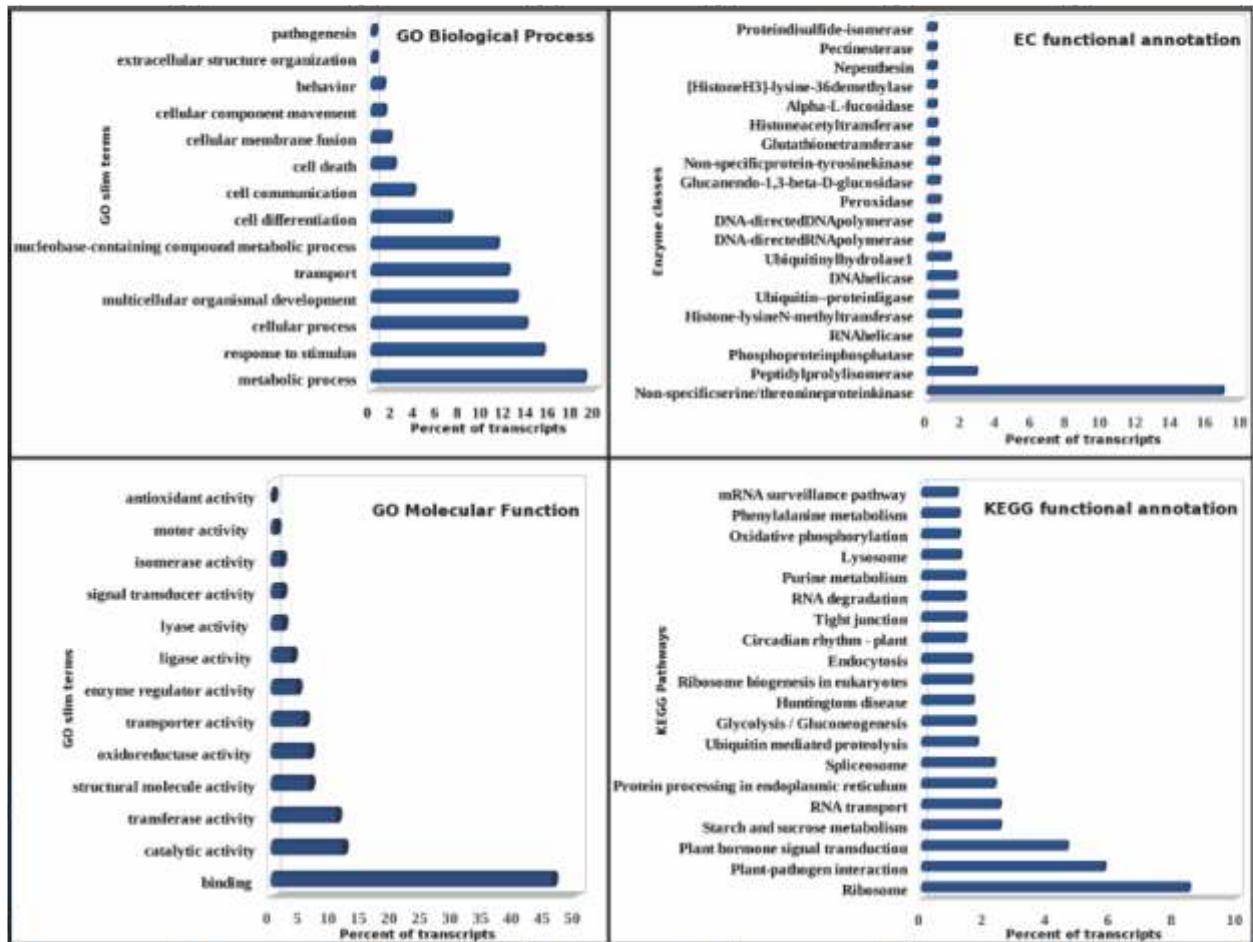


Fig. 43 Gene Ontology based study

NATURAL PRODUCTS CHEMISTRY

UPLC-DAD-ESI-QTOF-MS/MS profiling of *Tinospora cordifolia* phytochemicals

Four bioactive compounds namely, syringin (**1**), cordifolioside A (**2**), magnoflorine (**3**) and tinocordiside (**4**) were isolated from the stem of *T. cordifolia*. A rapid ultra-performance liquid chromatography coupled with mass spectroscopy method (UPLC-MS) was also developed for simultaneous determination of these four bioactive compounds. Variations were determined by the validated UPLC-DAD-ESI-QTOF-MS/MS method (Fig. 44 & 45) in these bioactive compounds from 15 different tree hosts of *T. cordifolia*. The overall concentrations of these compounds (**1-4**) were higher in the *T. cordifolia* hosted by *Azadirachta indica* and *Mangifera indica* as compared to other plants. Two compounds, palmatine (**5**) and jatrorrhizine (**6**) were characterized on the basis of mass fragmentation pattern, and further confirmed by their overlapped retention time with the isolated compounds (Fig. 46). Columbamine and menisperine were identified on the basis of their mass and UV-vis spectra.

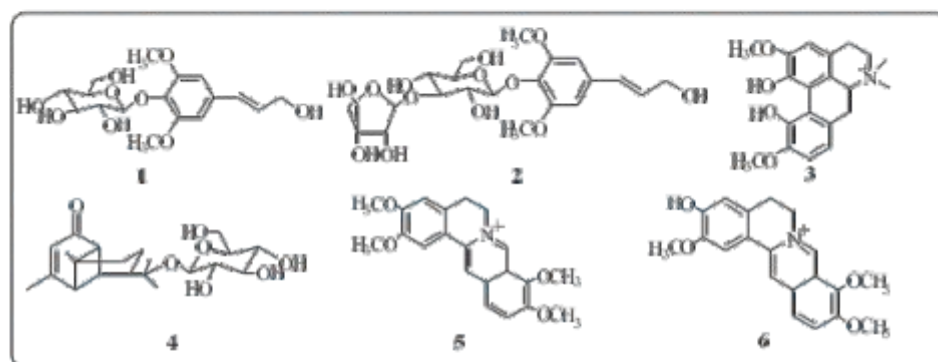


Fig. 44 Structure of isolated compounds: syringin (**1**), cordifolioside A (**2**), magnoflorine (**3**), tinocordiside (**4**), palmatine (**5**) and jatrorrhizine (**6**)

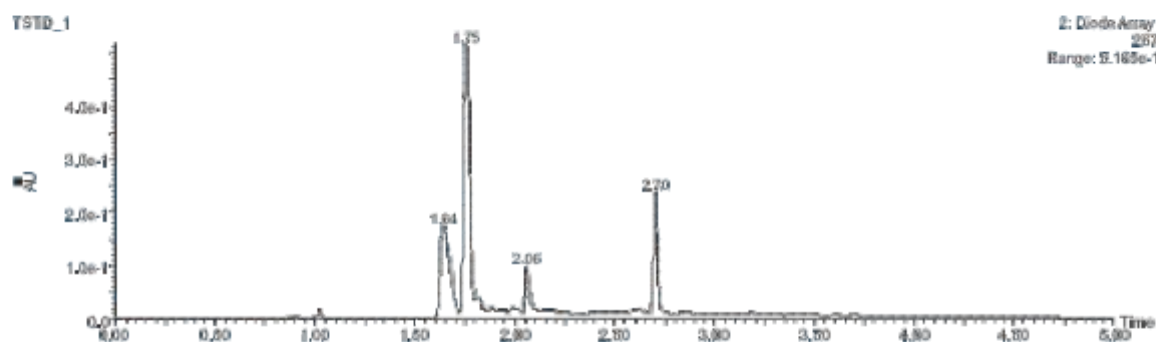


Fig. 45 UPLC chromatogram of four isolated compounds; (1.64, syringin), (1.75, cordifolioside A), (2.06, magnoflorine) and (2.70, tinocordiside)

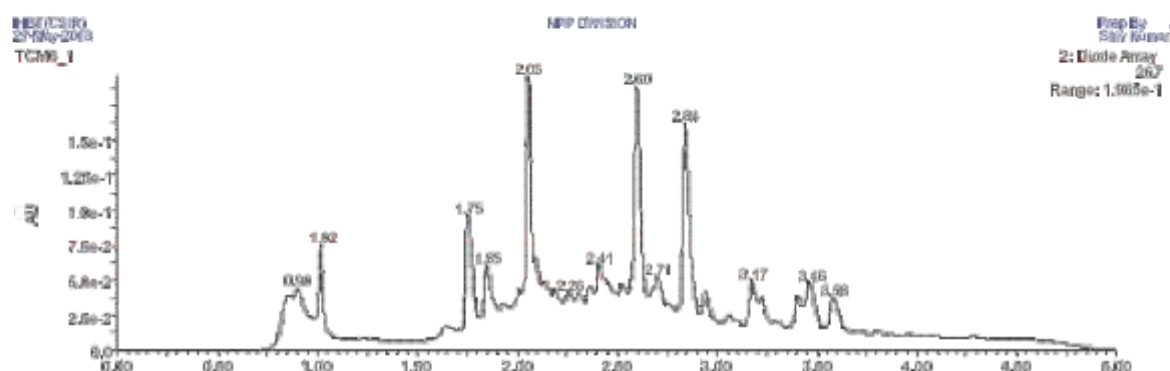


Fig. 46 UPLC chromatogram of *T. cordifolia* extract. (1.64, syringin), (1.75, cordifolioside A), (1.85, menisperine), (2.05, magnoflorine), (2.60 columbamine), (2.71, tinocordiside), (2.84jatrorrhizine) and (3.17 palmatine)

Quantitative and structural analysis of amides and lignans in *Zanthoxylum armatum* by UPLC-DAD-ESI-QTOF-MS/MS

A UPLC-DAD-ESI-MS/MS method was developed for determination of four biologically vital furofuran lignans, asarinin, sesamin, fargesin, kobusin and an amide, armatamide in *Z. armatum* (Table 6). The method was applied for quality assessment of different parts (leaves, bark and seeds) including locational variation in leaf samples. Tandem electrospray ionization-mass spectrometry (UPLC-DAD-ESI-MS/MS) of the samples led to the identification of sixteen compounds in the category of amides and furofuran lignans (Fig. 47).

Table 6 Comparative analysis of the compounds in bark, leaves and seeds and samples from different locations (n = 3)

Sample	Armatamide (7) ($\mu\text{g/g}$)	Kobusin (13) ($\mu\text{g/g}$)	Fargesin (14) ($\mu\text{g/g}$)	Sesamin (15) ($\mu\text{g/g}$)	Asarinin (16) ($\mu\text{g/g}$)	Total lignans ($\mu\text{g/g}$)
ZAB-1	1516 \pm 29	2419 \pm 34	2076 \pm 24	2229 \pm 41	823 \pm 29	7547
ZAS-1	-	-	-	-	-	-
ZAL-1	-	761 \pm 8	1938 \pm 38	481 \pm 11	541 \pm 13	3721
ZAL-2	-	752 \pm 8	2404 \pm 41	619 \pm 18	703 \pm 21	4478
ZAL-3	-	1328 \pm 21	2531 \pm 25	466 \pm 7	593 \pm 6	4918
ZAL-4	-	1123 \pm 16	2773 \pm 36	477 \pm 10	376 \pm 4	4749
ZAL-5	-	1106 \pm 22	2456 \pm 37	550 \pm 19	750 \pm 14	4862

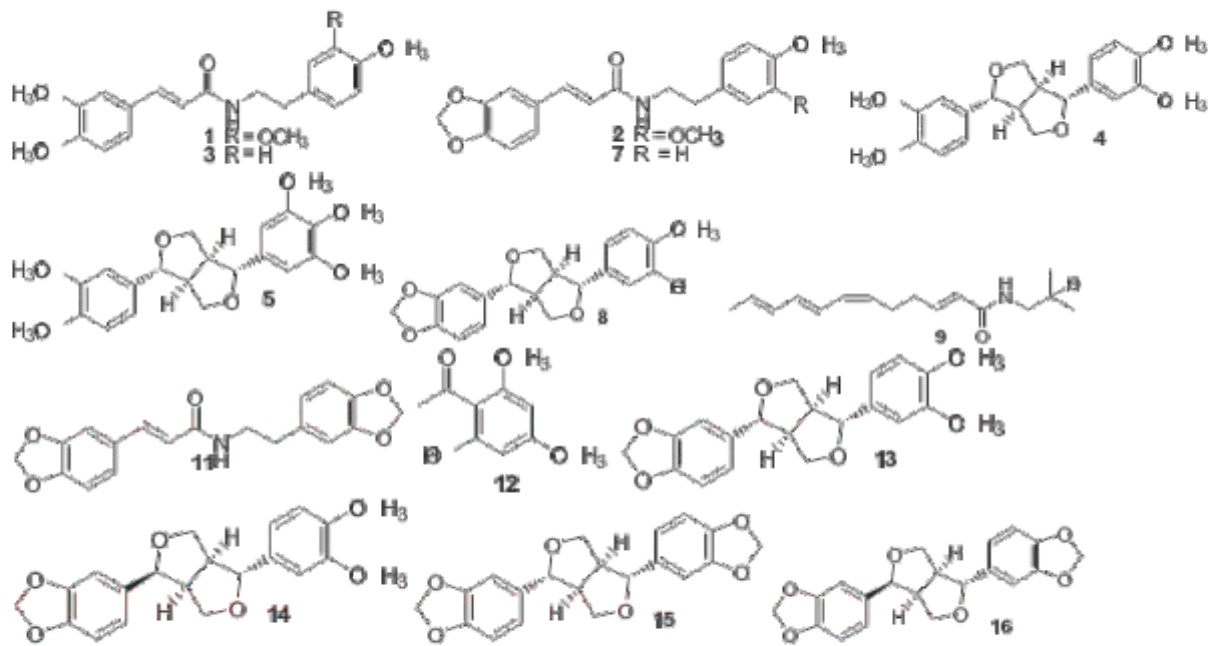


Fig 47 Chemical structures of identified compounds in *Z. armatum*

Isolation and characterization of secondary metabolites from *Cissampelos pareira*

Ethanol: water (80: 20) extract of roots was prepared and fractionated with different solvents, i.e. *n*-hexane, EtOAc, and *n*-BuOH. Seven compounds were isolated from the ethyl acetate fraction, of which, four were characterized as alkaloids and their structures were elucidated as hayatinine, hayatidine, cissamine and magnoflorine (Fig. 48).

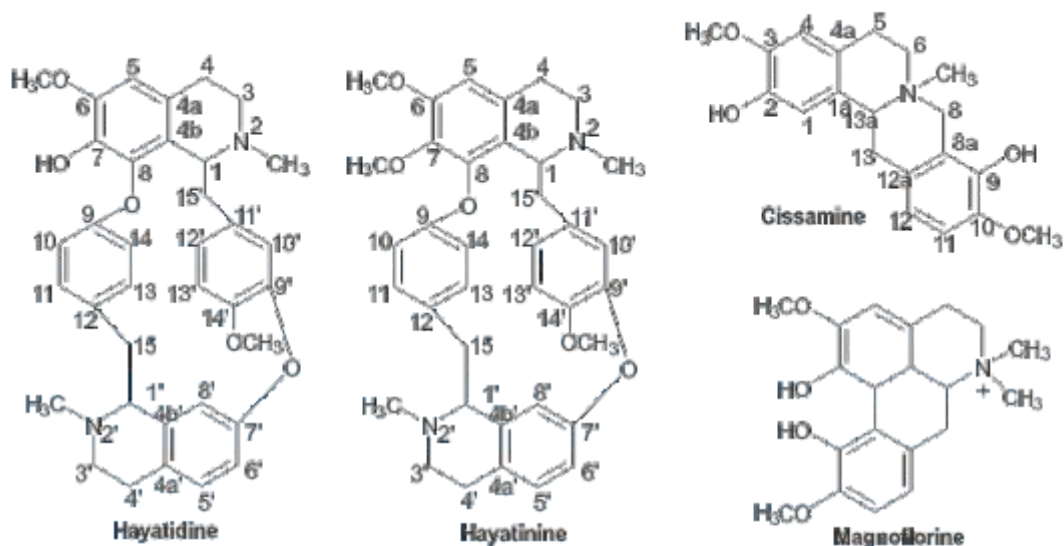
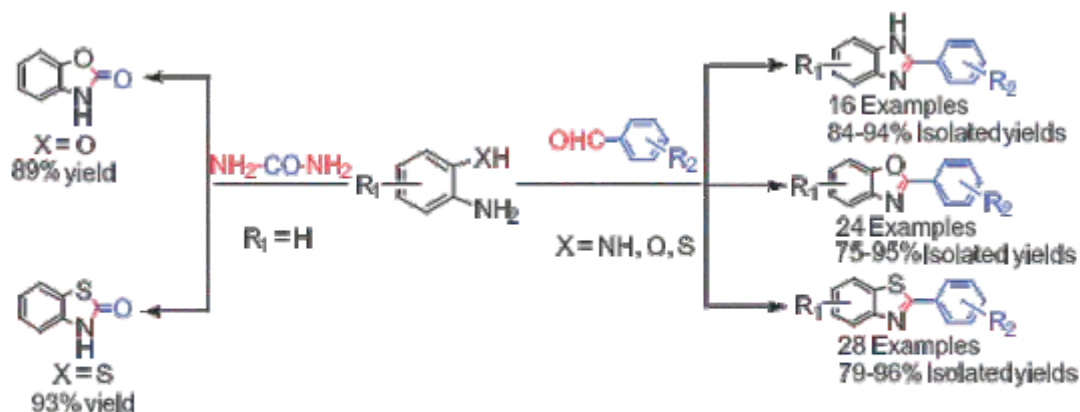


Fig. 48 Structure of alkaloids isolated from *C. pareira*

SYNTHETIC CHEMISTRY

Catalyst and base-free synthesis of 2-substituted benzimidazoles, benzoxazoles and benzothiazoles

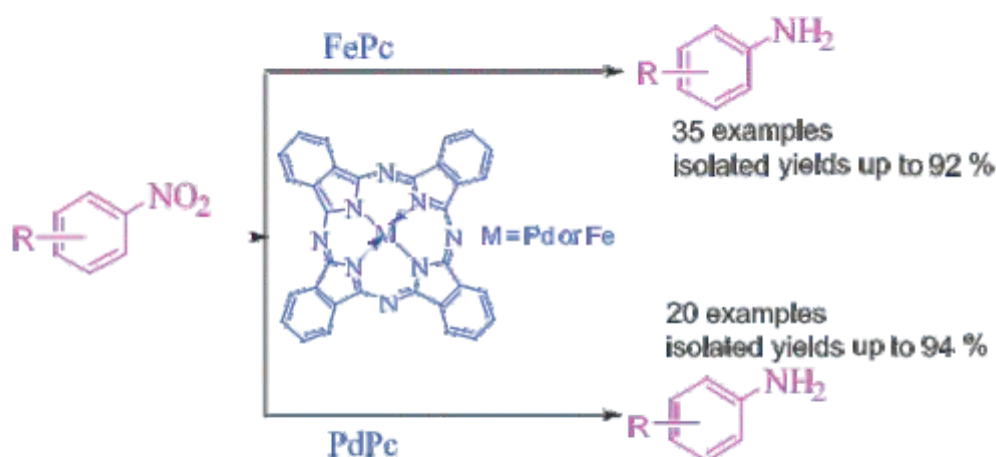
An efficient and versatile method was established for the synthesis of various 2-arylbenzazoles. It excludes the usage of any catalyst or additive, and provided excellent selectivities and yields. It was found to have high functional group tolerance during the synthesis of 2-arylated benzimidazoles, benzoxazoles, benzothiazoles and benzazolones.



Synthesis of heteroaromatics

Recyclable catalyst for reduction of nitroarenes

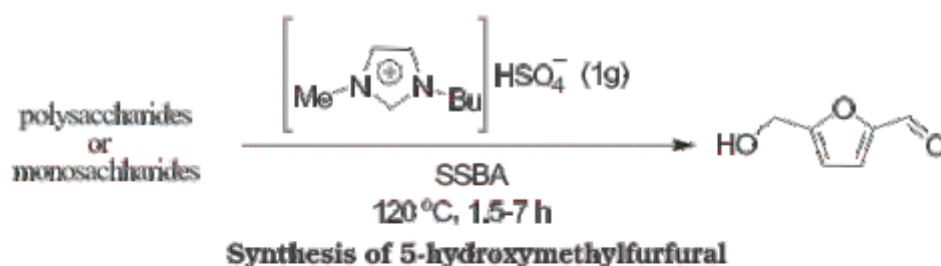
Iron and palladium (II) phthalocyanines were established as efficient recyclable catalytic systems for reduction of nitroarenes in green solvent system. These were used to reduce various nitro substituted aromatics and heteroaromatics into corresponding amines in good to excellent yields. The methods were also productively applicable for gram scale reactions.



Reduction of nitroarenes

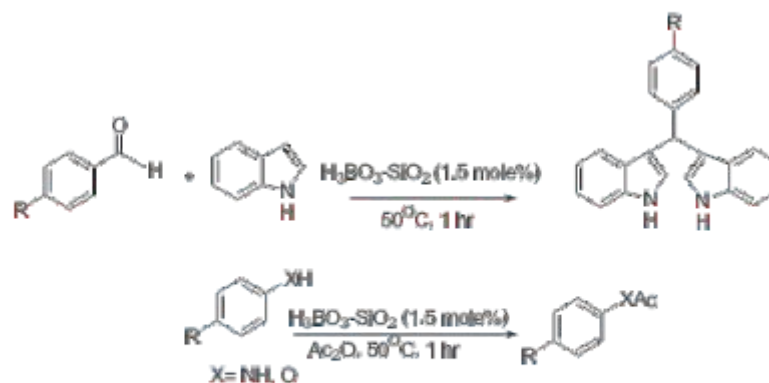
Silica-supported boric acid assisted conversion of mono- and poly-saccharides to 5-hydroxymethylfurfural in ionic liquid under mild conditions

Silica-supported boric acid (SSBA) was prepared and applied as heterogeneous catalyst for the direct conversion of inexpensive and biorenewable mono- and poly-saccharides to 5-hydroxymethylfurfural (HMF) in ionic liquid. Fructose, glucose, sucrose, inulin and cellulose were successfully converted to HMF with moderate to excellent conversion. The catalyst and the solvent system can be recycled up to four consecutive cycles without significant losses.



Silica-supported boric acid catalysed synthesis of dihydropyrimidin-2-ones, bis(indonyl)methanes, esters and amides

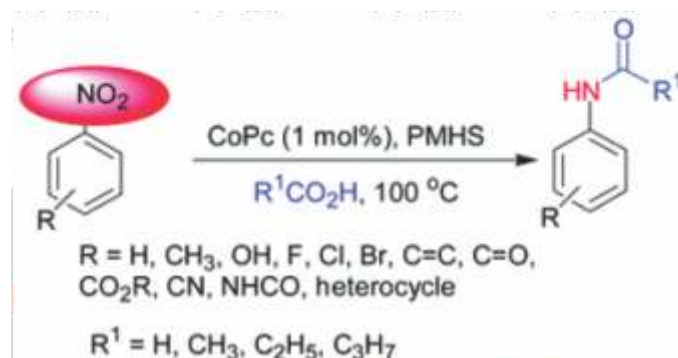
Silica supported boric acid ($\text{H}_3\text{BO}_3\text{-SiO}_2$) was utilized as a green, efficient and recyclable catalyst for the acetylation of alcohols, phenols, amines and thiols. The method was also used for the synthesis of bis(indonyl)methanes and dihydropyrimidine-2-ones. Mild reaction condition, low loading of catalyst, easy workup, solvent free and environment friendly system were its additional benefits.



Heterocycle synthesis

Use of cobalt (II) phthalocyanine/PMHS for direct reductive amidation of nitroarenes

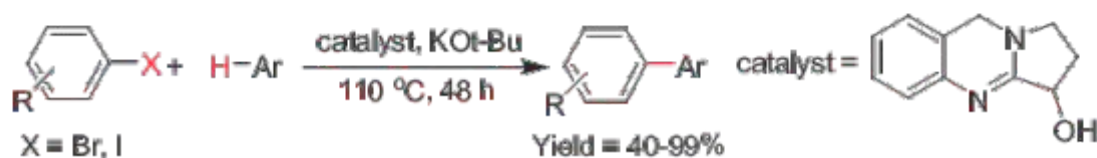
Cobalt phthalocyanine was explored as a versatile catalyst for chemo-selective and direct reductive amidation of nitroarenes with non-activated carboxylic acids. Polymethylhydrosiloxane was used as a cheap and environment friendly reducing agent. The protocol tolerated a large range of functional groups such as amide, ester, nitrile, halogen, lactone, hydroxy, alkene and heterocycles.



Direct reductive amidation of nitroarenes

Vasicine catalyzed direct C–H arylation of unactivated arenes

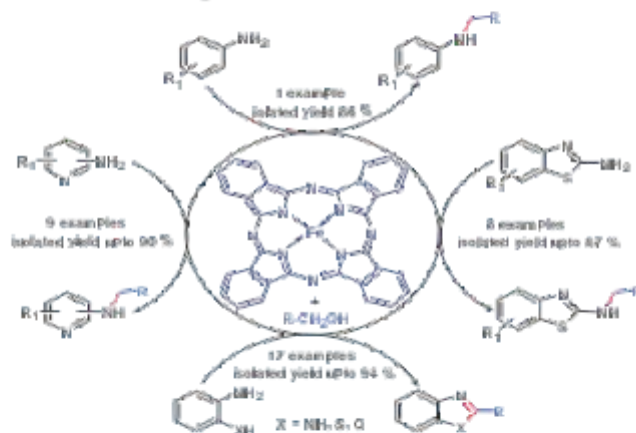
The alkaloid vasicine isolated from *Adhatoda vasica* was utilized as an organo-catalyst for direct C–H arylation of unactivated arenes with aryl iodides/bromides. The developed method lacks any prerequisite transition metal catalyst. It can be applied to a number of sensitive functional groups such as methyl, methoxy, *O*-benzyl, acetyl etc. The mechanistic study showed the participation of radical intermediates.



Direct C–H arylation of unactivated arenes

Iron phthalocyanine catalyzed N-alkylation of aryl and hetero-aryl amines

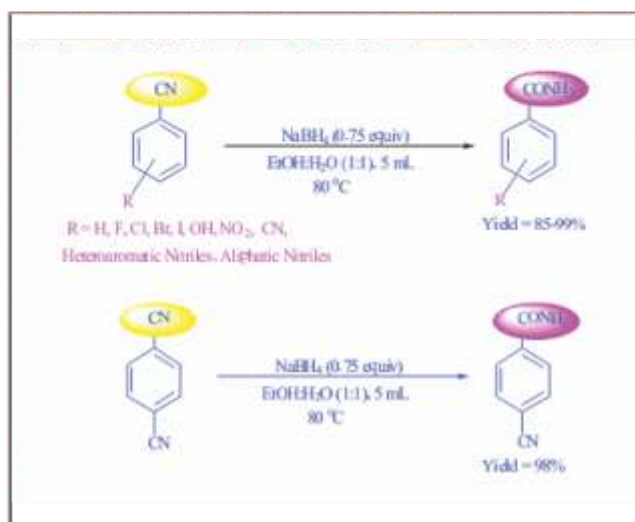
Iron phthalocyanine was explored as an efficient and versatile catalyst for the *N*-alkylation of various amines. Readily available alcohols were used as alkylating agents for direct *N*-alkylation of aminobenzothiazoles, aminopyridines and aminopyrimidines. *N*-alkylation of ortho-substituted anilines (–NH₂, –SH and –OH) led to the synthesis of 2-substituted benzimidazoles, benzothiazoles and benzoxazoles in one-pot.



N-Alkylation reaction

Controlled hydration of nitriles to amides by transition metal-free sodium borohydride

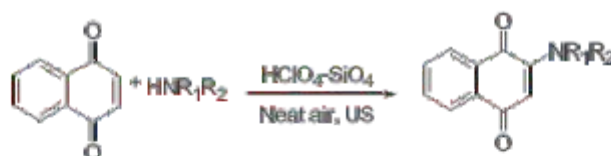
A transition metal-free process was developed for the convenient and selective hydration of nitriles to corresponding amides using catalytic amount of sodium borohydride. The developed protocol was applicable for aromatic, aliphatic, and hetero-aromatic nitriles with wide functional group tolerance. The regioselective hydration of nitrile as well as utilization of water:ethanol as a co-solvent made the process environment friendly and economical.



Hydration of nitrile to amide

Solid phase synthesis of 2-amino-1,4-naphthoquinones as antibacterial and antifungal active molecules

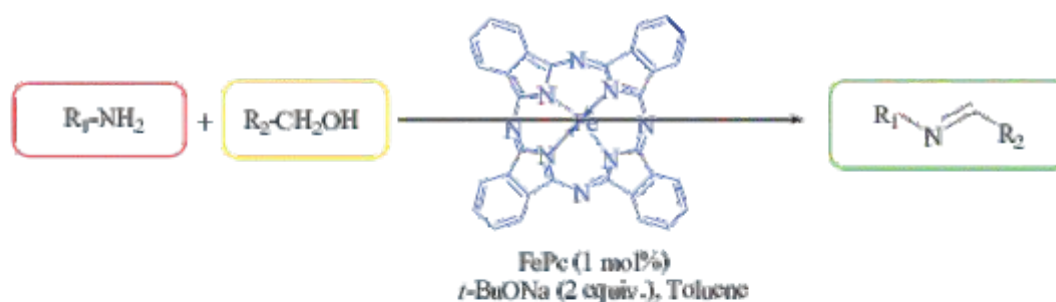
In an effort to develop antibacterial and antifungal agents, a series of 2-amino-1,4-naphthoquinones were prepared in moderate yields. For this, primary and secondary amines were added along with 1,4-naphthoquinones in the presence of HClO₄-SiO₂ as catalyst under ultrasonication and solvent free condition.



Synthesis of 2-amino-1,4-naphthoquinones

Iron phthalocyanine catalyzed oxidative synthesis of imines

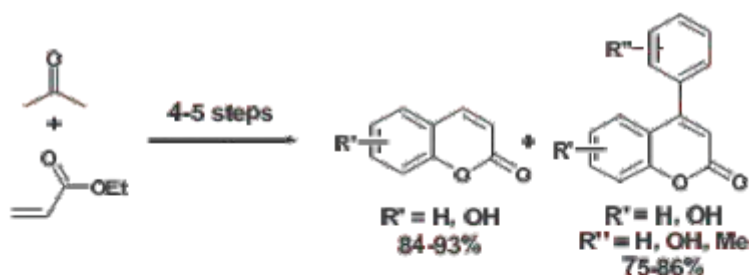
Iron phthalocyanine was employed as a highly efficient catalyst for direct coupling of alcohols with amines. Various substituted aromatic and aliphatic alcohols, and amines were well tolerated.



Oxidative synthesis of imines

Cyclohexyl iodide promoted approach for synthesis of coumarin analogs

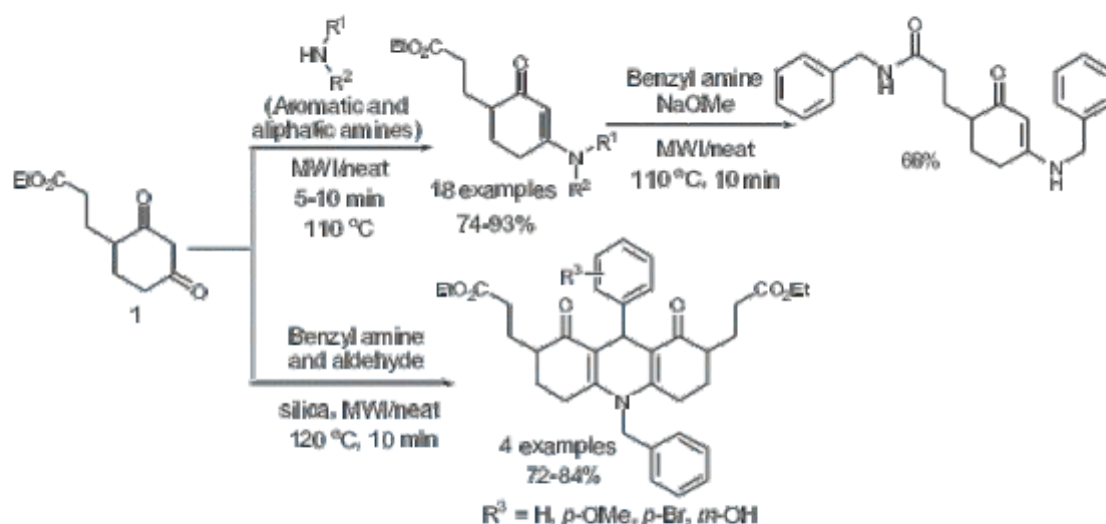
New chemical approaches were adopted for the synthesis of biologically important coumarins. Cyclohexane-1,3-dione derivatives were prepared from acetone and ethyl acrylate and used as novel scaffold. The steps for the synthesis of coumarins from cyclohexane-1,3-dione derivatives included aromatization, dehydrogenation and demethylative cyclisation. Cyclohexyl iodide was used for the first time for demethylative cyclization reaction of β,β -diaryl acrylates and synthesis of 4-arylcoumarins.



Coumarin analogs synthesis

Microwave assisted solvent and catalyst free method for the synthesis of novel classes of β -enaminoester and acridinedione

β -Enaminones and β -enaminoester derivatives (containing the $\text{N}-\text{C}=\text{C}-\text{O}$ structural unit) are versatile synthetic intermediates for a number of bioactive heterocycles, pharmaceuticals and naturally occurring alkaloids. Therefore, new classes of β -enaminoesters were synthesized from ethyl-3-(2,4-dioxocyclohexyl)propanoate **1** under solvent and catalyst free microwave-assisted conditions. No work-up procedure, milder reaction condition, wide substrate scope and high yields are important features of the present method and open up the scope for the synthesis of acridinediones as well as peptidomimetic molecule synthesis.



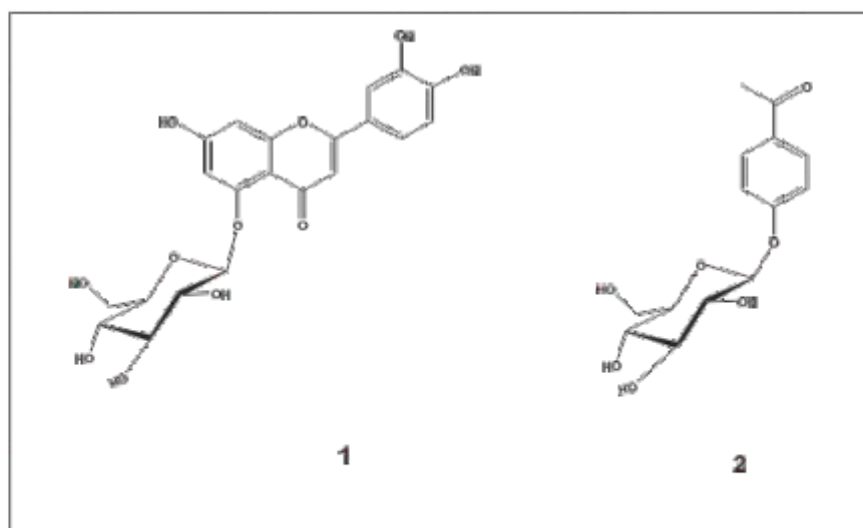
β -Enaminoester/amide and acridinedione synthesis

MULTIDISCIPLINARY APPROACHES TO CROP IMPROVEMENT

KUTKI (*Picrorhiza kurrooa*)

Evaluation of antioxidant activity of leaf extract

Two compounds, luteolin-5-O-glucopyranoside (**1**) and picein (**2**) were isolated from n-butanol extract of leaves through column chromatography. Picein (**2**) was quantified in ethanol, ethyl acetate and n-butanol extracts of leaf by HPLC. All the extracts and isolated compounds were evaluated for their antioxidant activity using DPPH and ABTS assays. n-Butanol and ethyl acetate extract showed



greater antioxidant activity as compared to ethanol extract. L-Ascorbic acid and **1** showed nearly similar antioxidant activity, whereas, **2** was found to be less active at standard concentration. The IC_{50} values for L-ascorbic acid, **1**, ethanolic extract and its different fractions (ethyl acetate and butanol) were also determined using DPPH and ABTS assay.

NMR and HPTLC fingerprints of *Picrorhiza kurrooa*

There is a huge demand in the herbal market due to its strong *P. kurrooa* hepatoprotective, cardioprotective, anticholestatic, anticancer, antioxidant and immune-modulating properties. High demand but low availability of the plant has led to its adulteration. Therefore, NMR fingerprint of *P. kurrooa* was generated in D_2O by 600 MHz NMR spectroscopy (Fig. 49). An HPTLC fingerprint (Fig. 50) was also developed on normal phase HPTLC plate using ethyl acetate: methanol: acetic acid (16: 2: 0.2 v/v/v) as solvent system.

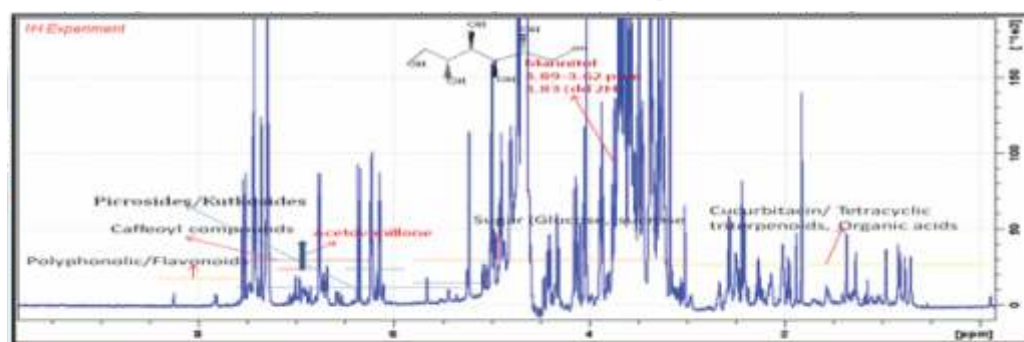


Fig. 49 1H NMR fingerprint of *P. kurrooa* rhizome

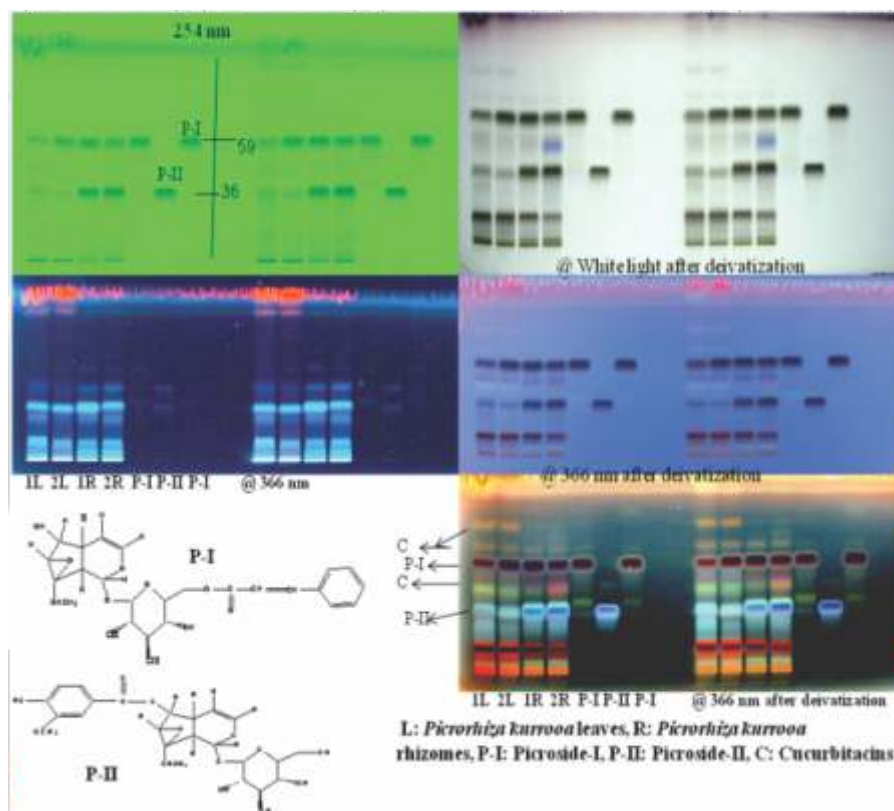


Fig. 50 HPTLC fingerprints of *P. kurrooa* leaves and rhizomes

cis-acting GATA and SORLIP motifs in the promoter of 3-hydroxy-3-methylglutaryl-CoA reductase

HMGR regulates the biosynthesis of picrosides in the endangered medicinal Himalayan plant *P. kurrooa*. A preponderance of light responsive elements including GATA and SORLIP was observed in an earlier work on *in silico* analysis of *PropkHMGR* – the upstream sequences of *HMGR*. In the current year, the *PropkHMGR* and the *cis* acting GATA and SORLIP motifs were evaluated for their ability to interact with nuclear proteins under light and dark conditions. While the GATA motif exhibited stronger DNA protein interaction with the nuclear extract of dark exposed plant (NEDP), the binding of SORLIP with nuclear extract of light exposed plants (NELP) was stronger (Fig. 51).

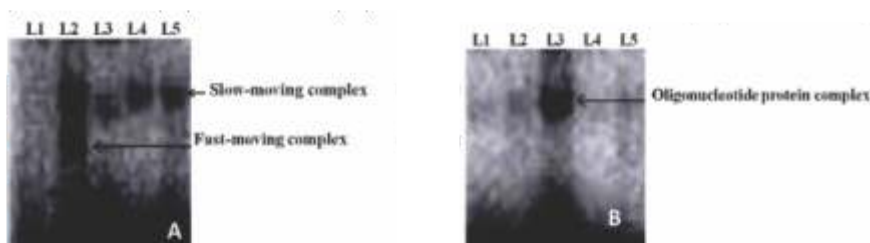


Fig. 51 Electrophoretic mobility shift assay showing interaction of nuclear proteins with (A) GATA and (B) SORLIP motifs where lane 1: radiolabelled probe without nuclear extract; lane 2: probe incubated with NELP; lane 3: probe incubated with NEDP; lane 4: probe incubated with excessive unlabeled motif and NELP; lane 5: mutated probes incubated with NEDP (A) and NELP (B)

The *PropkHMGR-D1*, -1059/-1 and its deletion fragments [*PropkHMGR-D2* (-825/-1), *PropkHMGR-D3* (-651/-1), *PropkHMGR-D4* (-452/-1), *PropkHMGR-D5* (-101/-1)] were also analyzed in arabidopsis using *gus* reporter gene. *PropkHMGR* was found to regulate gene expression in actively dividing tissues of all developmental stages excluding anthers. The *PropkHMGR* mediated gene expression was higher in dark as compared to light across four studied temperatures (Fig. 52). Expression in the shoot apical meristems, root tips and anthers of relatively older seedlings was regulated by *PropkHMGR-D2*.

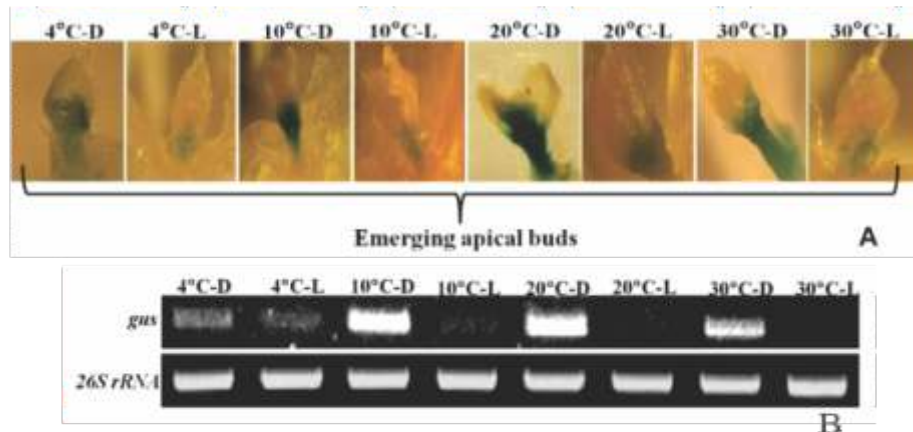


Fig. 52 *PropkHMGR* mediated gene expression in *Arabidopsis* seedlings at 4, 10, 20 and 30°C incubated under constant light and dark conditions for 48 h (A) Histochemical localization of GUS (B) Rt-PCR expression of *gus* gene at day 15 of germination where 26 s rRNA served as control (L: light, D: dark)

Both the GATA and SORLIP motifs exhibited DNA protein interaction with NELF. An inverse relationship between the strength of DNA protein interaction and gene expression in case of GATA motif, but a species specific relationship for SORLIP were observed.

HIMALAYAN MAY APPLE (*Sinopodophyllum hexandrum*)

The rhizomes of the species are a source of valuable anti-cancer lignans. In order to understand the temperature mediated molecular responses of the rhizome exposed to 15 and 25 °C, its transcriptome was studied (Table 7). Deep sequencing yielded 60,089 assembled transcripts representing 25,395 unique genes having homology with known genes. The transcriptome had an average coverage of 88.34X, average length of 543.11 bp, average guanine-cytosine (GC) content of 44.59 % and abundance of trinucleotide SSR (54.40 %). SSR markers were also identified. Using various scripts, GO, KEGG and EC based tools, and RPKM-based expression analysis, 15 °C appeared optimal for growth and development while 25 °C was stressful. Metabolic processes, transport, protein transport, cellulose biosynthesis, glycolysis and phenylpropanoid biosynthesis were up-regulated at 15 °C, whereas, up-regulation of genes involved in cell rescue, defense and virulence was noticeable at 25 °C. The data was used to construct the podophyllotoxin biosynthesis pathway. Regulatory genes were identified and the RPKM-based expression data was verified by qRT-PCR of 12 genes. There was no penalty on podophyllotoxin accumulation at either 15 or 25 °C. Analyses of CYPs, MTs and UGTs yielded hitherto unidentified genes of podophyllotoxin biosynthesis. Importantly, 15 °C favored the biology of rhizomatous tissue.

Table 7 Summary of transcriptome data generated on Illumina Genome Analyzer IIx for rhizome tissue of *S. hexandrum*

	LT	25 °C	Total/Pooled
Total number of paired end reads	146,304,154	54,176,602	200,480,756
No. of reads obtained after quality filtering	125,957,408	44,346,624	170,304,032
No. of assembled transcripts	NA	NA	60,089
Average length of transcripts (in base pair)	NA	NA	543.11
Average coverage	NA	NA	88.34

WILD TURMERIC (*Curcuma aromatica*)

Kinetically stable copper/zinc superoxide dismutase from *C. aromatica*

A Ca-Cu/Zn superoxide dismutase (*Ca-Cu/Zn SOD*) gene was cloned from *C. aromatica*. It was 692 bp in size with a 459 bp ORF. Upon expression and purification from *E. coli*, the enzyme functioned across a temperature range of -10 to +80 °C, a pH range of 4-9, and also tolerated trypsin (Fig. 53). Its temperature and pH optima were 20 °C and 7.8, respectively. It retained 50 % maximum activity after autoclaving (Fig. 54). The enzyme was kinetically stable with potential for various industrial applications.

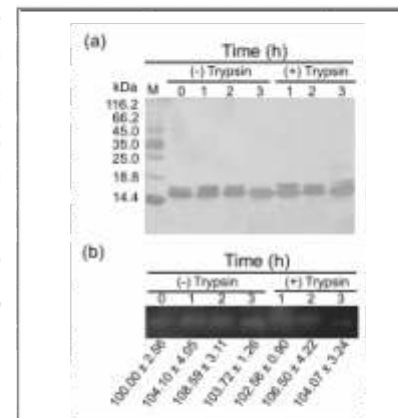


Fig. 53 Effect of trypsin on *Ca-Cu/Zn SOD* (a) SDS-PAGE with 1 µg of *Ca-Cu/Zn SOD* where lane M: molecular weight marker; (b) gel showing % relative SOD activity w.r.t control. Values are mean ± SE of three separate replicates

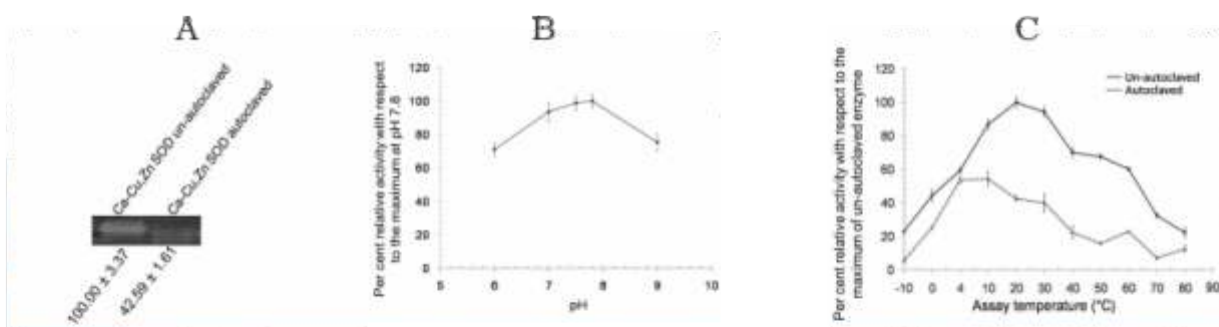


Fig. 54 *Ca-Cu/Zn SOD* activity (A) after autoclaving (B) at different pH (C) at different temperatures. Values are mean ± SE of three replicates

A new dihomosesquiterpene termioic acid A, from *Curcuma aromatica*

A new dihomosesquiterpene, termioic acid A (**1**) and two known compounds curdione (**2**) and β -sitosterol (**3**) were isolated from ethanolic extract of rhizomes. The compound **1** was identified as (1S, 4S, 5R, 6S, 8E, 10Z)-1,13-dihydroxy-4-epoxy-8(12),9(10)-diene-termi-11-oic acid with the help of 1D- and 2D-NMR (^1H , ^{13}C , DEPT, ^1H - ^1H -COSY, HMQC, HMBC, and NOESY) spectroscopic techniques (Figs. 55 & 56). The yield of compound **1** was 0.04% as assessed by HPLC analysis.

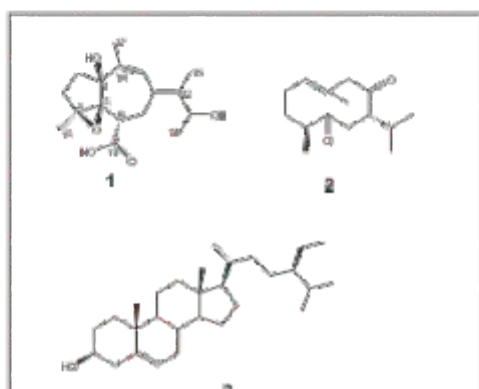


Fig. 55 Structure of compounds (1-3) isolated from *C. aromatica*

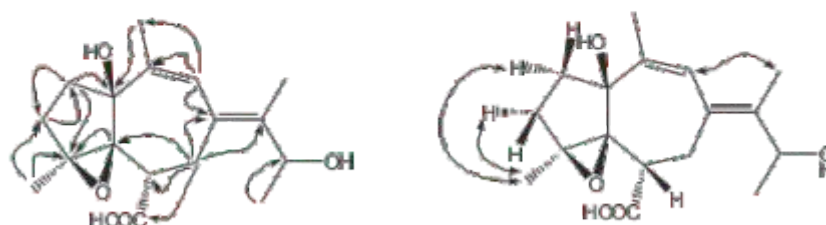


Fig. 56 Key HMBC (H→C) and NOESY (H↔H) spectral data of **1**

COLEUS (*Coleus forskohlii*)

Production of phytochemicals from best chemotypes of some medicinal plants through modified cultivation and *in vitro* production technologies (Sponsored by National Fund for Basic, Strategic and Frontier Application Research in Agriculture (NFBSFARA), ICAR, New Delhi)

In a new activity, *Coleus forskohlii* were collected from the states of Jammu and Kashmir, Punjab and Haryana. Aseptic cultures from nodal segments were raised from J&K and Haryana collections. *In vitro* leaf and root explants were used for rhizogenesis and callus induction for secondary metabolite production. Excised root cultures were also established on solid medium and multiplied (Fig. 57).

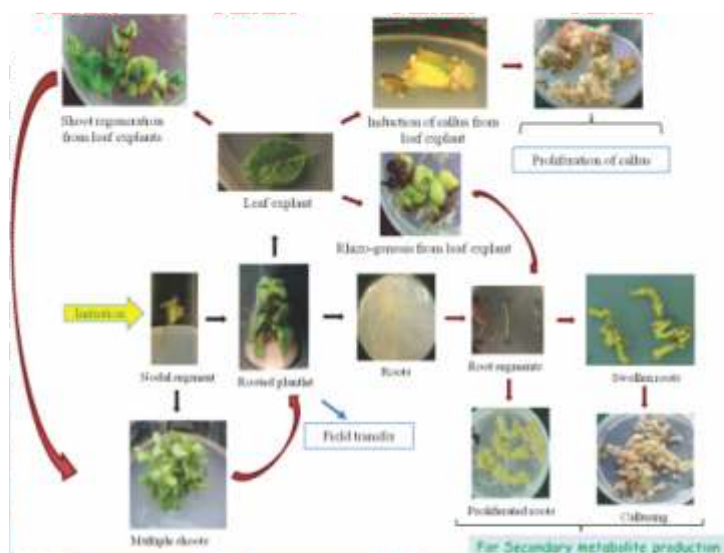


Fig. 57 *In vitro* strategies for multiplication of plants and production of secondary metabolites in *C. forskohlii*

STEVIA (*Stevia rebaudiana*)

Characterization of (*E*)-4-hydroxy-3-methylbut-2-enyl diphosphate reductase

Steviol glycosides are the popular non-calorific sweetener found in the leaves of *S. rebaudiana* (Berltoni). The steviol moiety of the glycosides is synthesized *via* the plastidial 2C-methyl-D-erythritol 4-phosphate pathway, where (*E*)-4-hydroxy-3-methylbut-2-enyl diphosphate reductase (HDR) is a key enzyme. HDR catalyzes the simultaneous conversion of (*E*)-4-hydroxy-3-methylbut-2-enyl diphosphate into five carbon isoprenoid units, isopentenyl diphosphate and dimethylallyl diphosphate. Upon genetic complementation, stevia HDR (*SrHDR*) successfully rescued the lethal *E. coli* HDR mutant strain MG1655 *ara<>ispH*. (Fig. 58). The upstream region of the gene was also cloned to identify possible regulatory elements. Putative *cis*-acting elements were detected by *in silico* analysis. In electrophoretic mobility shift assay, GATA showed the binding of nuclear proteins (NP) from leaves during light hour of day (10:00 h) but not with the NP from leaves during dark hour (20:00 h) (Fig. 59). The results suggested involvement of GATA box in the light mediated regulation of *SrHDR* and diurnal variation in gene expression.

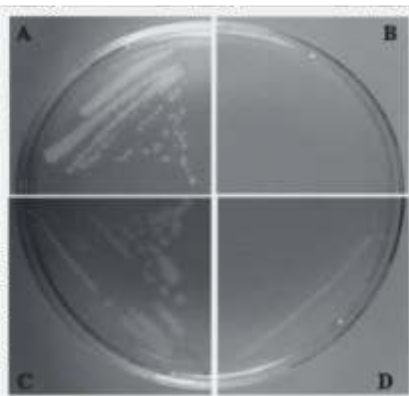


Fig. 58 Complementation of *E. coli* HDR mutant strain MG1655 *ara<>ispH* by *SrHDR* (A-B) growth of mutant on LB medium containing (A) 0.2 % arabinose (B) 0.2 % glucose (C-D) growth of mutant on medium containing 0.2 % glucose (C) mutant transformed with stevia HDR cDNA (pQE-*SrHDR*) (D) mutant transformed with pQE-30 vector without *SrHDR* (control).

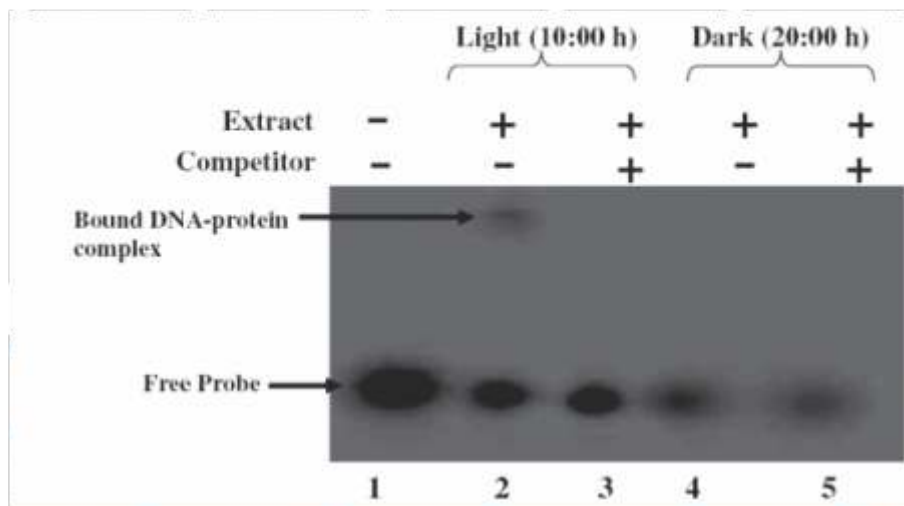


Fig. 59 Electrophoretic mobility shift assay showing DNA-protein interaction where lane 1: radio-labelled GATA sequence (RLGS); lane 2: RLGS incubated with nuclear protein (NP) isolated from leaves harvested during light hour; lane 3: RLGS incubated with NP from leaves harvested during light hour and specific competitor i.e., unlabeled GATA sequence; lane 4: RLGS incubated with NP isolated from leaves harvested during dark hour; lane 5: RLGS incubated with NP from leaves harvested during dark hour and specific competitor i.e., unlabeled GATA sequence; '+' = desired component added '-' = component not added

RNA interference (RNAi) mediated silencing of steviol glycoside biosynthesis pathway genes

Agrobacterium mediated transient gene silencing (AMTS) approach was used for *SrKAI3H* and three *SrUGTs* (*SrUGT85C2*, *SrUGT74G1* and *SrUGT76G1*) genes. The genes are known to encode ent-kaurenoic acid-13 hydroxylase and three UDP glycosyltransferases (UGTs) of steviol glycoside biosynthesis pathway (Fig. 60). Results showed significant reduction in the expression of targeted endogenous genes as well as total steviol glycoside accumulation. However, silencing of *SrUGT85C2* and *SrKAI3H* caused significant enhancement of GA_4 . The metabolite flux of steviol glycoside pathway was shifted towards GA_4 biosynthesis. Molecular docking of three *SrUGT* proteins showed highest affinity of *SrUGT76G1* for the substrates of alternate pathways of steviol glycosides biosynthesis silencing of *SrUGT76G1* accounted for maximum reduction in steviol glycoside content. Finally *SrKAI3H* and *SrUGT85C2* were identified as regulatory genes influencing carbon flux between steviol glycoside and gibberellin biosynthesis (Figs. 61 & 62).

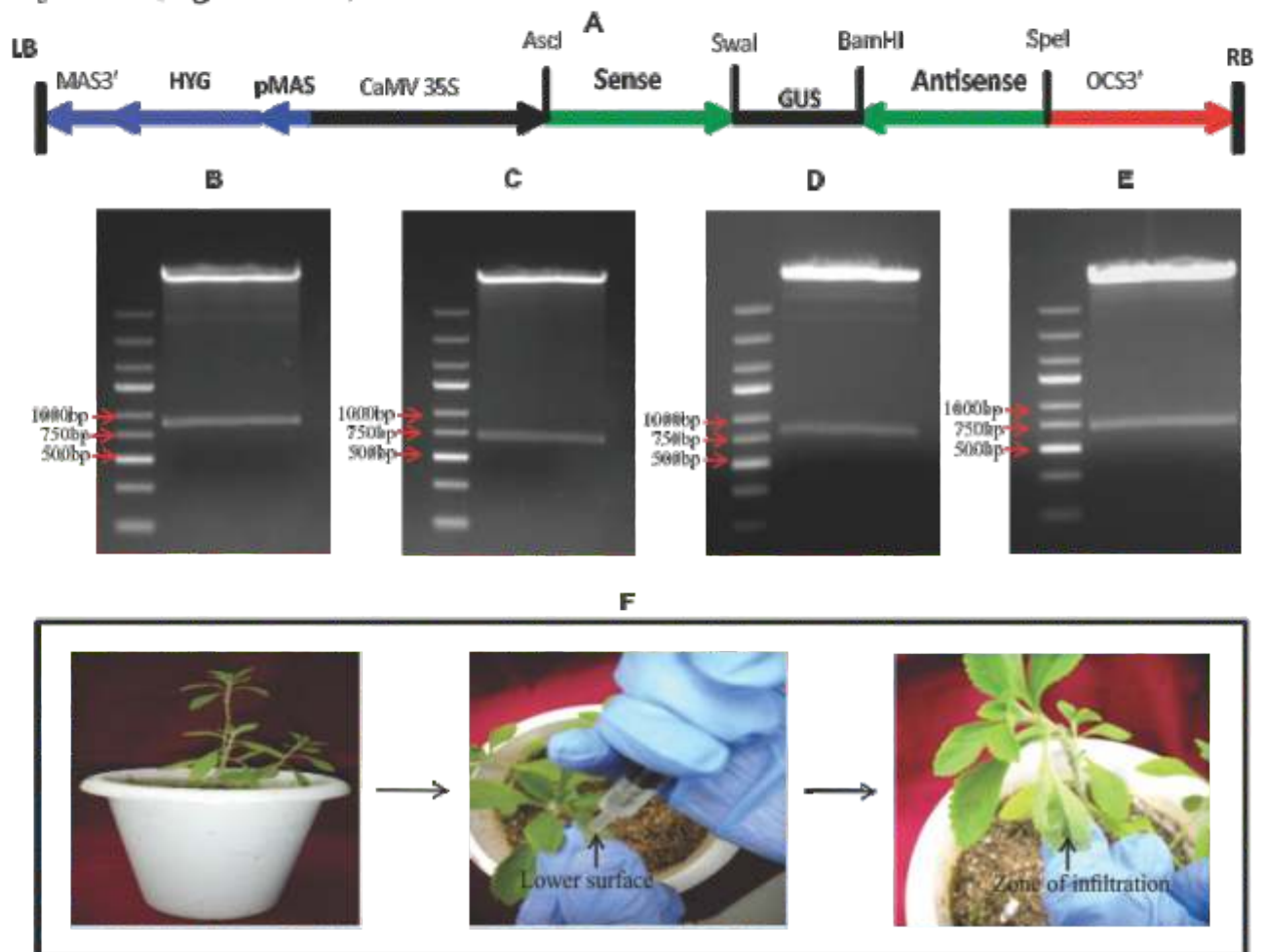


Fig. 60 (A) Diagrammatic representation of RNAi silencing constructs prepared using pFGC1008 vector backbone (B) *SrKAI3H* (858 bp) (C) *SrUGT85C2* (714 pb) (D) *SrUGT74G1* (846 bp) (E) *SrUGT76G1* (726 bp) and (F) Syringe mediated agroinfiltration of stevia leaves

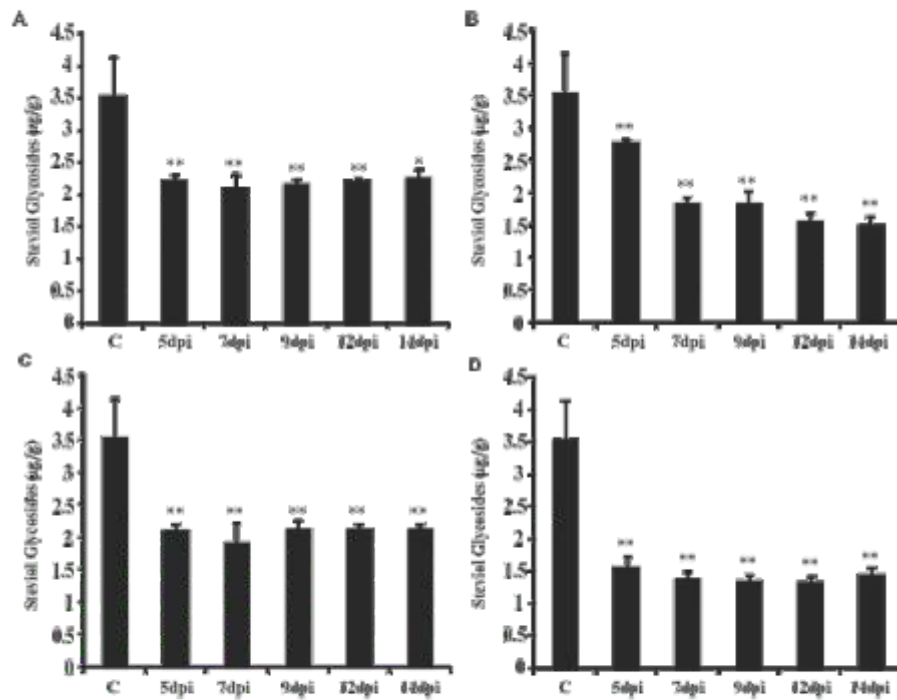


Fig. 61 Steviol glycoside content after *Agrobacterium* mediated silencing of (A) *SrKA13H* (B) *SrUGT85C2* (C) *SrUGT74G1* and (D) *SrUGT76G1*. Data presented as mean \pm standard deviation of three independent measurements, (**, $p < 0.01$; *, $p < 0.05$)

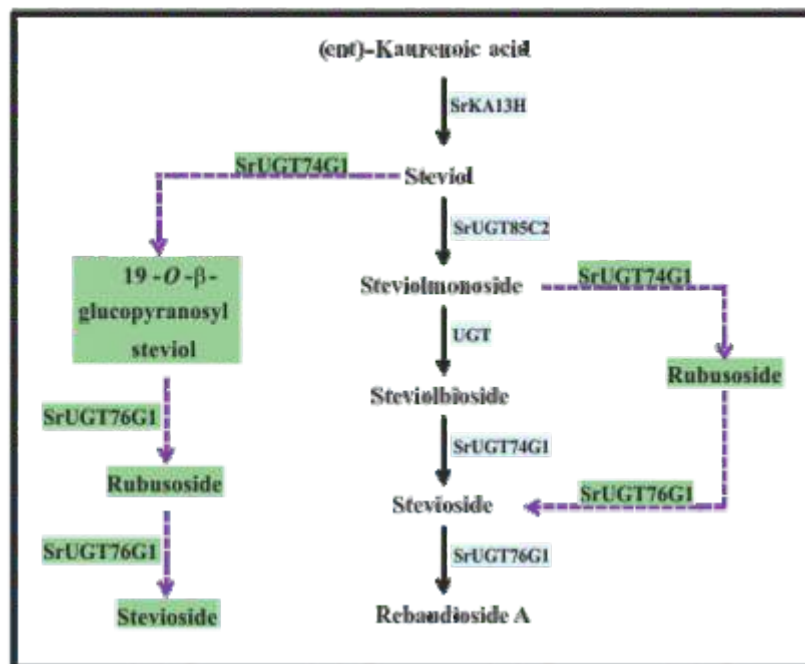


Fig. 62 Proposed steviol glycoside biosynthesis pathways. Dotted blue lines and green text boxes indicate alternate steps

Functionally relevant novel microsatellite markers for efficient genotyping in *Stevia rebaudiana* Bertoni (Sponsored by CSIR & Department of Biotechnology, Govt. of India)

Self-incompatibility, poor seed viability, low germination rates and entomophilous pollinations are among the major challenges in management and genetic improvement in *S. rebaudiana*. A total of 2,977 unigenes (2,225 singletons and 752 contigs) representing 2.58 Mb of sequence were predicted from 5,548 publicly available ESTs of *S. rebaudiana*. Ninety nine unigenes containing 107 SSRs (excluding mono repeats) were identified with tri- repeats being the most abundant (72.9 %) followed by di- (11.2 %), hexa- (6.5 %), tetra- (5.6 %) and penta- (3.7 %) type of repeat motifs. Eighty five SUGMS markers were highly efficient with amplification success rate of 89.5 % showing unigene derived microsatellites robust source of SSR marker development. Each marker was subsequently utilized for evaluating 40 accessions. Fifty two primer pairs (61.2 %) were found to be polymorphic. Number of alleles were 2-15 with an average of 4.7 alleles per SSR locus. Expected heterozygosity (HE) and observed heterozygosity (Ho) ranged from 0.03 – 0.92 (avg. 0.63) and 0.03–1.00 (avg. 0.80), respectively. Heterozygosity values of almost all markers showed deviation ($H_o > H_e$) from Hardy-Weinberg equilibrium (HWE) at $p < 0.05$. This suggested a highly outcrossing nature of the crop. Genetic diversity based on Jaccard coefficient ranged from 39.2 % (between SR-30 and SR-31) to 76.1 % (between SR-19 and SR-26) with an overall diversity of 61.3 %. Cluster analysis based on 247 alleles derived from 52 polymorphic primers were successfully tested for diversity characterization of 40 random *S. rebaudiana* genotypes and grouped into two major clusters (Fig. 63)

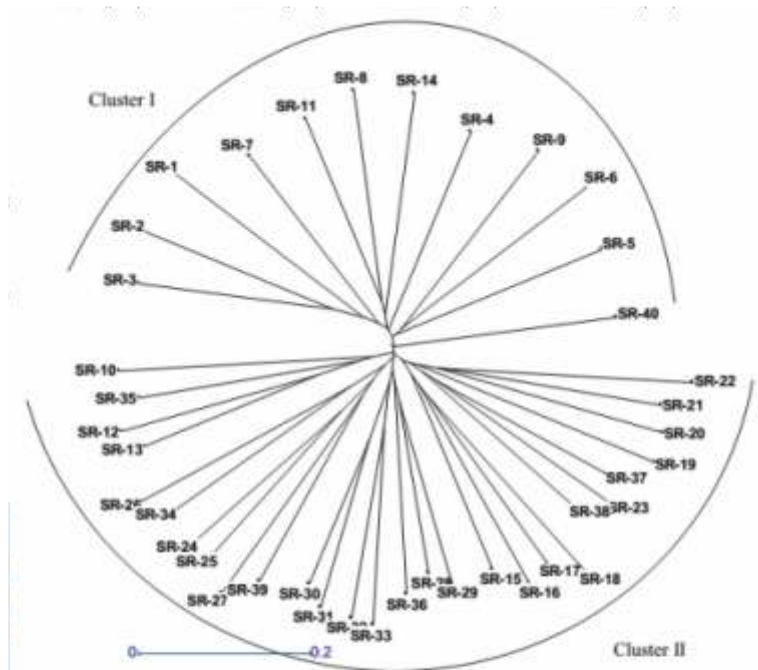


Fig. 63 Dendrogram showing genetic relationships among 40 random genotypes of *S. rebaudiana* based on 247 polymorphic alleles produced by 52 SUGMS markers. Scale represents Jaccard's similarity coefficient

Essential oil composition of flowering twigs

Essential oil from the flowering twigs was extracted by hydrodistillation and fractioned by column chromatography (silica gel 60-120 mesh). Forty-three constituents were characterized with the help of GC, GC-MS and other spectroscopic techniques. A complex mixture of mono- and sesquiterpenes were found with β -pinene (12.5 %), linalool (5.5 %), (*E*)-caryophyllene (15.9 %), (*Z*)- β -farnesene (4.2 %), α -humulene (6.6 %), germacrene D (6.1 %), bicyclogermacrene (14.6 %), *trans*-nerolidol (3.8 %), caryophyllene oxide (3.9 %) and *epi*- α -cadinol (3.9 %) as major components. The oil and its fractions showed promising cytotoxicity against two cancer cell types viz. C-6 (rat glioma cells) and CHOK1 (Chinese hamster ovary cells). Highest activity of 95.6 ± 0.6 % was obtained against C-6 cell line at a concentration of 400 μ g/mL. This was comparable with that of the standard drug vinblastin.

Essential oil composition and antimicrobial activity of leaves and stem

Essential oil in the leaves and stem were evaluated for their chemical compositions and antimicrobial activity. In GC and GC-MS analysis, a complex mixture of mono- and sesquiterpenoids were found. The major constituents were β -elemene, β -caryophyllene, β -farnesene, germacrene D, bicyclogermacrene, (*E*)-nerolidol, spathulenol, and viridiflorol with quantitative variations (Table 8). The oils showed antibacterial activity against *Micrococcus luteus*, *Staphylococcus aureus*, and antifungal activity against *Aspergillus ochraceus*, *A. flavus* and *Trichophyton rubrum* with potential activity against *A. sydowii* and *A. parasiticus*.

Table 8 Major constituents of *S. rebaudiana* essential oil from leaves and stem

No.	Components	Retention Index		Essential oil	
		DB-5	DB-FFAP	Leaves (%)	Stem (%)
1	Linalool	1095	1565	5.5	1.6
2	β -Elemene	1397	1590	3.4	2.6
3	α -Gurjunene	1409	1527	0.8	1.4
4	β -Caryophyllene	1417	1600	11.1	5.3
5	α -Bergamotene	1434	1582	1.4	0.9
6	β -Farnesene	1448	1695	4	19.1
7	α -Humulene	1452	1680	4.7	t
8	Germacrene D	1484	1710	7.7	4.9
9	β -Selinene	1489	1718	1.6	4
10	Bicyclogermacrene	1500	1730	9.5	7.4
11	β -Bisabolene	1506	1740	nd	3
12	<i>E</i> -Nerolidol	1563	2040	9.5	5
13	Spathulenol	1577	2122	2.4	1.2
14	Caryophyllene oxide	1582	1970	2.6	t
15	Globulol	1586	2070	nd	3.5
16	Viridiflorol	1588	2081	1.6	1.1
17	Torreyol	1648	2180	2.6	2.1
18	α -Cadinol	1654	2220	3.7	4.8
19	Phytol	2112	2618	2.2	1.2

Studies on floral development

In order to define the stage of pollen collection for hybridization and good seed set, studies were conducted on floral development using light and scanning electron microscopy (SEM) (Fig. 64). Nine distinct stages with tetrad formation and microspore production at stage-2 were recorded. Highest pollen viability (72.8 %) and pollen grain production at stages 4 and 5, respectively were identified to be the best stage for pollen collection and manual hybridization.

No pollen dispersal beyond 2 m from the plant and successful pollination with bumble bee thorax indicated entomophilous pollination but low pollen dispersal through air. Moreover, no seed set upon bagging, selfing by hand pollination and germination of selfed pollens indicated incompatibility in stevia (Fig. 65).



Fig. 64 (A-B) SEM micrographs showing selfed pollen grains adhered on to stigma at 30 x to 700 x and (C) anthers covering immature stigma (D) stigma emerging through anthers

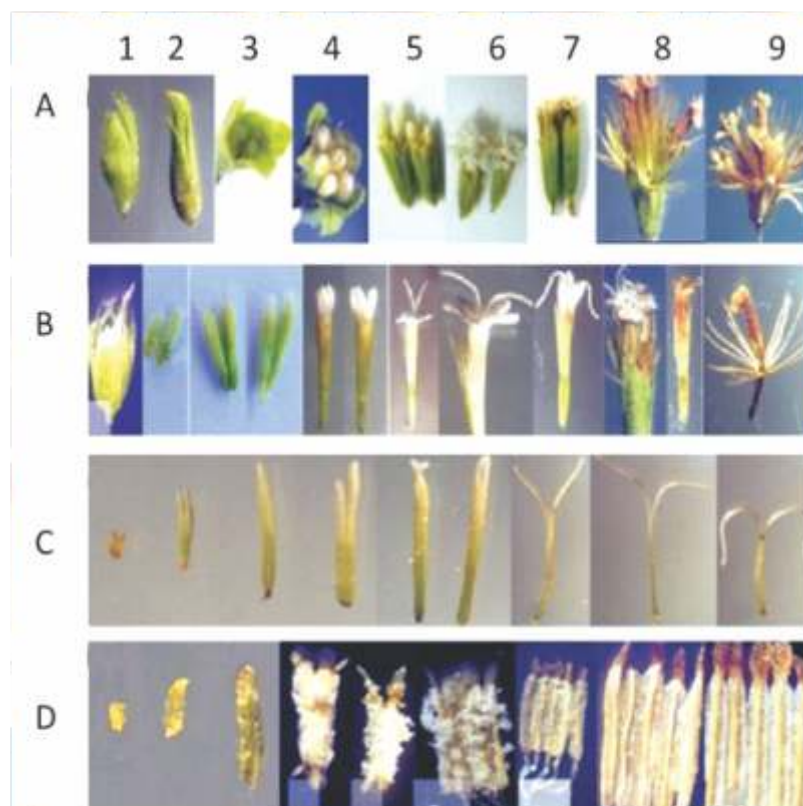


Fig. 65 Stages of flower development in stevia (A) flower (B) floret (C) stigma (D) anthers

GINKGO (*Ginkgo biloba*)

A field experiment was initiated in January 2011 on plant spacing (1.0 x 1.0, 1.5 x 1.5, 2.0 x 2.0 and 2.5 x 2.5 m²) in interaction with two levels of FYM (15 and 30 t/ha) for optimizing leaf yield per unit area per unit time. The unit plot size was 7.5 x 7.5 m². Plant height and stem diameter at collar level were not affected by any of the treatments. However, the leaf yield was significantly higher when the plant spacing was 1.0 x 1.0 m² (637 kg/ha) followed by 1.5 x 1.5 m² (243 kg/ha). The remaining two wider spacings were statistically comparable.

TEA (*Camellia sinensis*)

Markers genomic resource creation in tea (Sponsored by Department of Biotechnology & CSIR, Govt. of India)

Microsatellite or simple sequence repeat (SSR) markers are valuable tools for phylogenetic, fingerprinting and molecular breeding studies. However, such marker resources are unavailable in Assam tea (*Camellia assamica* ssp. *assamica*; Masters). Thus, the repertoire of microsatellite markers in traditional tea was enriched. One hundred eighty five novel microsatellite (150 genomic and 35 genic) markers were identified from (GA)n-enriched genomic libraries and public expressed sequence data in Assam tea. High-quality 0.412-Mb non-redundant (NR) genomic data set derived from nucleotide sequencing of (GA)n-enriched genomic positive clones were then utilized for identification of genomic and genic microsatellite markers. The average number of alleles and polymorphic information content (PIC) recorded for the newly developed SSR markers were 6.17 and 0.398, respectively. The average observed (Ho) and expected (He) heterozygosity varied from 0.626 to 0.697, respectively. These markers were highly transferable (74.5–100 %) to cultivated (*C. sinensis*, *C. assamica* ssp. *lasiocalyx*) and five wild *Camellia* species (Fig. 66).

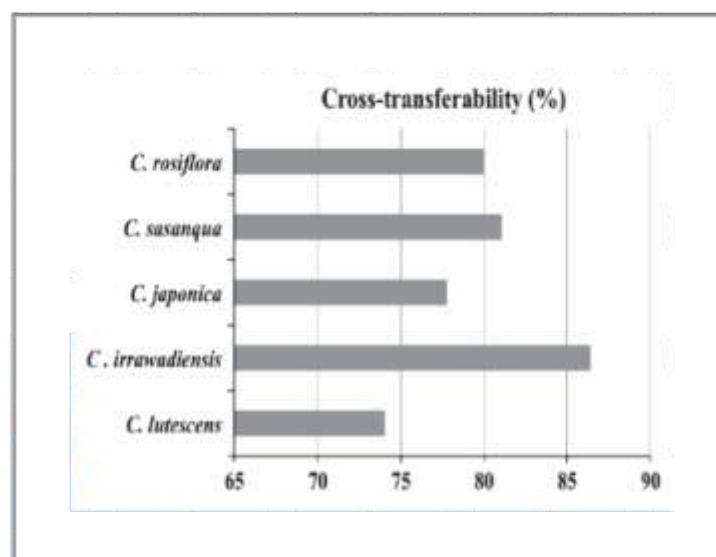
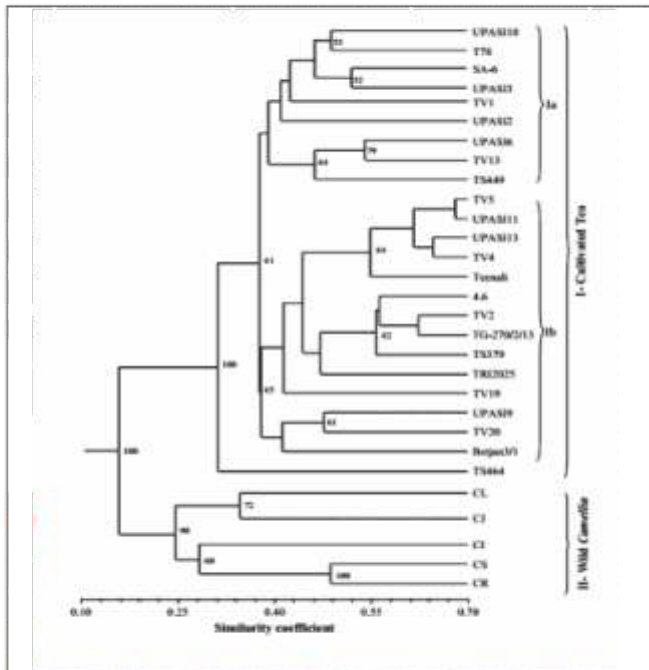


Fig. 66 Graphical presentations of cross-transferability percentage of 185 microsatellite markers in different wild *Camellia* species



Genetic diversity coefficient detected a high level of divergence in 24 cultivated tea accessions (69.3 %). Phylogenetic analysis revealed that major groupings were broadly in accordance with taxonomic classification of tea, and all the wild species remained as an out-group (Fig. 67). The high polymorphic content coupled with high rate of cross-transferability demonstrated wider applicability of novel microsatellite markers in genotyping, genetic diversity, genome mapping and evolutionary studies in various *Camellia* species.

Fig. 67 Phylogenetic relationships among 29 accessions of *Camellia* spp. identified on the basis of 110 novel microsatellite markers identified in this study. Unweighted pair group method with arithmetic mean dendrogram is based on Jaccard's coefficient of similarity, and tree branched with bootstrap values greater than 60 %

Mapping disease resistance

In a hybridization program on mapping of blister blight resistance in tea, a biconal population was developed. The disease resistant SA06 was used as a parent for hybridization with Kangra Asha, having good quality but susceptibility to the disease. The population was scored for disease incidence in field for three consecutive years. The resistant genotypes are being propagated for selecting disease resistant high yielding quality clones. In a separate activity, 17 anthocyanin rich tea selections were made (Fig. 68).



Fig. 68 Tea foliage rich in anthocyanin

Selection of elite planting material

Previous activities on evaluation of germplasm raised from selected mother bushes of Kangra jat and biconal seed stocks were continued. Accessions having average productivity over 1,500 KMTH (made tea kg/ha) for three consecutive years were identified (Table 9). In Germplasm Block-G, CEF-01 among China hybrid tea and the Assam type tea selections i.e., SST-09 and SST-02 among the biconal seed stock populations were found to be promising. In Germplasm Block-F, the productivity of China hybrid accessions, BGP-017 and BGP-156 was over 1500 KMTH despite being lower than that of the control clone, UPASI-9.

Table 9 Performance evaluation of elite planting material for selection of accessions with productivity >1500 KMTH

Accession	Number of bushes/plot	Average yield (KMTH)	
		2010-2012	2013
Germplasm Block - F			
BGP-017	13	1834	1520
BGP-063	30	1539	1157
BGP-066	27	1513	1077
BGP-072	30	1586	1383
BGP-144	19	1612	1251
BGP-146	19	1923	1438
BGP-156	9	1686	1596
UPASI-9*	25	1725	2111
Germplasm Block - G			
CEF-01	12	2029	2383
SST-01	19	1737	1670
SST-02	10	2014	2708
SST-09	9	3796	4136
UPASI-9*	23	1692	2626

* High yielding clone served as control

Mechanization of farm practices

A prototype of an improved adjustable type, 3-rowed diamond shaped hand hoe was designed and fabricated for cultivating land between rows. It has a wheel, a diamond shaped frame for mounting tynes, beam and handle. The frame of the hand hoe has a special provision for placing tynes at requisite spaces as per soil type, crop spacing and strength of the operator. It also has the provision to extend the frame on either side for offset intercultural operations without disturbing the plantation/crop. The lowest count for fixing tynes is 25 mm with a potential to cater to intercultural operations up to 600 mm. The developed prototype was finally fabricated.

Plant growth promoting bacteria from tea rhizosphere

A total of 337 bacteria were isolated from rhizospheric soils collected from different locations in Kangra valley. These were screened for multiple plant growth promoting activities, including phosphate solubilization, ACC-deaminase activity and auxin production. Of 337 bacteria, 73 isolates showed phosphate-solubilization on modified Pikovskaya agar while p-liberation in 45 ranged between 0.6-761 µg/ml in NBRIP broth. Fifty-two isolates showed ACC-deaminase enzyme activity ranging from 0.15-312564 nM α-ketobutyrate h⁻¹ mg protein⁻¹. Production of IAA-like auxins by 45 bacteria ranged from 0.7-78 µg/ml at 28 °C after 48 h incubation in tryptophan-supplemented nutrient broth. Characterization based on 16S rRNA gene sequencing showed their affiliation to *Bacillus*, *Burkholderia*, *Citrobacter*, *Cupriavidus*, *Hafnia*, *Enterobacter*, *Kluyvera*, *Lysinibacillus*, *Pantoea*, *Pseudomonas*, *Serratia* and *Viridibacillus*.

Computational epigenomics and epigenetic study

Active and dormant stages tea bud and old leaf tissue were collected from TV23 (Combod), UPASI 9 (Assamica) and Him Sphurti (Chinary) cultivars. RNA was isolated from these samples and used for cDNA library preparation. Using the Illumina sequencing platform, approximately 192,820,752 RNA-Seq reads were obtained. These reads were assembled into 25,703 transcripts with an average length of 1,101 bp having 1,622bp N50 value. In total, 18,913 unigenes were identified.

Enzymatic synthesis of theanine from glutamine and ethylamine HCl

Theanine is a unique amino acid produced by tea roots. It is known to reduce stress and promote relaxation without drowsiness. Therefore, a total of 185 bacterial isolates from rhizospheric soils and roots of tea were screened for microbial biotransformation of ethylamine HCl and glutamine into theanine. Seven isolates showed 40-55% conversion ratio to theanine (Table 10, Fig. 69).

Table 10 Conversion of glutamine to theanine by rhizospheric and endophytic microorganisms from tea

Isolate	Source	% Conversion ratio*	Most closely related species (% identity)	16s rRNA gene sequence (bp)
IHB B 1033	Tea rhizosphere	48.45	<i>Citrobacter farmer</i> (99.2)	1483
IHB B1510	Tea rhizosphere	44.86	<i>Enterobacter asburiae</i> (99.6)	1505
IHB B1516	Tea rhizosphere	50.86	<i>Bacillus subtilis</i> (98.9)	1515
IHB B 1518	Tea rhizosphere	53.27	<i>Enterobacter ludwigii</i> (99.9)	1480
IHB B 1544	Tea rhizosphere	46.01	<i>Pseudomonas plecoglossicida</i> (99.3)	1479
IHB B 1644	Tea rhizosphere	50.86	<i>Bacillus altitudinis</i> (99.4)	1495
IHB B 1647	Tea rhizosphere	48.42	<i>Bacillus cereus</i> (99.8)	1516
IHB B 8022	Tea roots	37.03	<i>Staphylococcus arlettae</i> (99.1)	1503
IHB B 8023	Tea roots	22.22	<i>Lysinibacillus xylanilyticus</i> (99.3)	1507
IHB B 8024	Tea roots	36.32	<i>Bacillus cereus</i> (99.6)	1498

*Theanine to glutamine

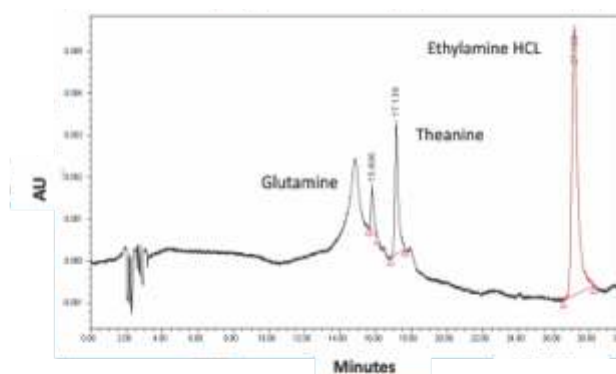


Fig. 69 HPLC-profile of theanine (synthesized from glutamine and ethylamine HCl by *Enterobacter ludwigii* IHB B 1518 mediated biotransformation)

Production of transgenics

A protocol was developed for biolistic-gun mediated genetic transformation and production of transgenic tea plants (Fig. 70). A total of 4,500 somatic embryos were bombarded using nine combinations of variable target distances and burst pressures but constant gap (0.6 cm) and macrocarrier flight distances (16 mm). A total of 90 independent, PCR-positive lines were generated. Twenty six out of 27 PCR-positive lines (three independent lines from each of the nine parameter combinations) tested positive in Southern hybridisation. Target distance was crucial for transgene integration, whereas, concentration of plasmid DNA, burst pressure and target distance affected transgene expression (Table 11). This was evident from strong signals in northern hybridisation and RT-PCR. The transgenic plants showed robust growth and improved stress tolerance in contained poly house.



Fig. 70 Biolistic gun mediated genetic transformation of tea (A) globular somatic embryos with hypertrophied structures and calli on medium containing 200 µg ml⁻¹ kanamycin (B-C) putative transformants on medium containing 200 µg ml⁻¹ kanamycin (D) 1-year old transgenic plant (E) 4-year-old transgenic and non transformed control plants growing in contained polyhouse. Horizontal bar line in A-C = 1.5 cm; Vertical bar lines in D-E = 35.0 cm

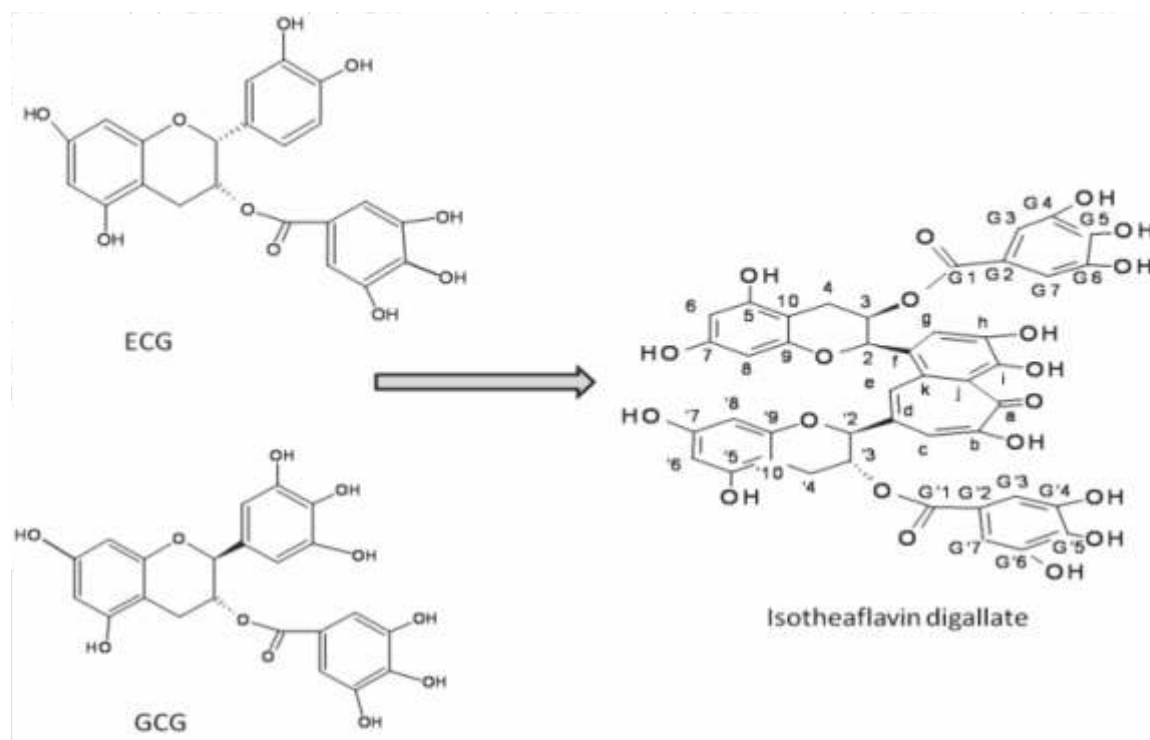
Table 11 Effect of burst pressure and target distance on the efficiency of transgene integration

Target distance	Burst Pressure (kPa)			Mean
	6205.28	7584.23	9307.92	
6 cm	3.33±0.58 ^{cd}	2.00±1.0 ^{abc}	2.67±0.58 ^{bcd}	2.67 ^b
9 cm	0.67±0.58 ^a	1.00±0 ^{ab}	1.67±0.58 ^{abc}	1.11 ^a
12 cm	3.33±0.58 ^{cd}	3.33±1.53 ^{cd}	4.50±0.58 ^d	3.67 ^c
Mean	2.44	2.11	2.89	2.48
SV	SEM±	CD (p <0.01)		
Target distance	0.086	0.27		
Burst pressure	0.086	NS		
Interactions	0.257	NS		

(±) Values are means ±SD (n=3). Mean values followed by a different lower-case letter in each row/column are significantly different at p≤ 0.01 by DMRT

Isotheaflavin digallate- A new black-tea theaflavin

A new isotheaflavin digallate was identified from tea shoots. As compared to theaflavin and theaflavin digallate, the compound showed higher cytotoxic activity against C6 (rat glioma cells) and CHOK1 (Chinese hamster ovary) cell lines in SRB assay. Isotheaflavin digallate is formed by polyphenol oxidase mediated oxidation of purified (-) GCG and (-) ECG.



A multi-sensing impedometric technique for interpretation of tea antioxidants

In collaboration with CSIR-CSIO, Chandigarh, a study was conducted for impedance based interpretation of antioxidant levels in 12 different orthodox samples of tea. Platinum, gold, silver, glassy carbon, polyaniline (emeraldine salt) and poly pyrrole working electrodes were used to measure the impedance response in the different tea infusions at a frequency range of 1 Hz to 100 kHz for 30 days. The impedance responses and the determined chemical concentrations were subjected to Principal Component Analysis (PCA), and the antioxidant levels in the tea samples were mapped. Impedometric analysis using multi electrode system showed that leaves plucked under different environments from same site can be well differentiated through PCA tool. The single GC electrode/single gold electrode had the potential to classify tea quality at broad frequency ranges. The multi/single-electrode system in variable frequency domain can serve as a potential tool for classifying tea quality based on antioxidant levels.

BAMBOO (*Dendrocalmus* and *Bambusa* spp.)

Tagging, sampling and tracking the development of flowers are difficult in a slender and 15-25 m tall plant like *D. hamiltonii*. Therefore, MS medium supplemented with 2% sucrose, 2.22 μ M BAP and 1.23 μ M IBA was optimized for induction of *in vitro* flowering (Fig. 71). Six distinct stages of *in vitro* development were identified. The flowers were protogynous and comparable with that of *in planta* sporadic ones. As compared to 68% viability of *in planta* pollens, the *in vitro* ones had 47% viability with storability for medium and long terms (Fig. 72). The system can facilitate easy tracking of flower development under controlled environmental conditions for understanding the hitherto unknown and complex systems of floral transition, *in vitro* fertilization, seed production etc.



Fig. 71 *In vitro* flower development in *D. hamiltonii* (A) head-of-spikelets (B-C) protogynous development with purple coloured plumose bifid stigma shown within blue circles (D) *in vitro* flower with androecium and gynoecium. Bars A-C=1 cm, D = 1 mm

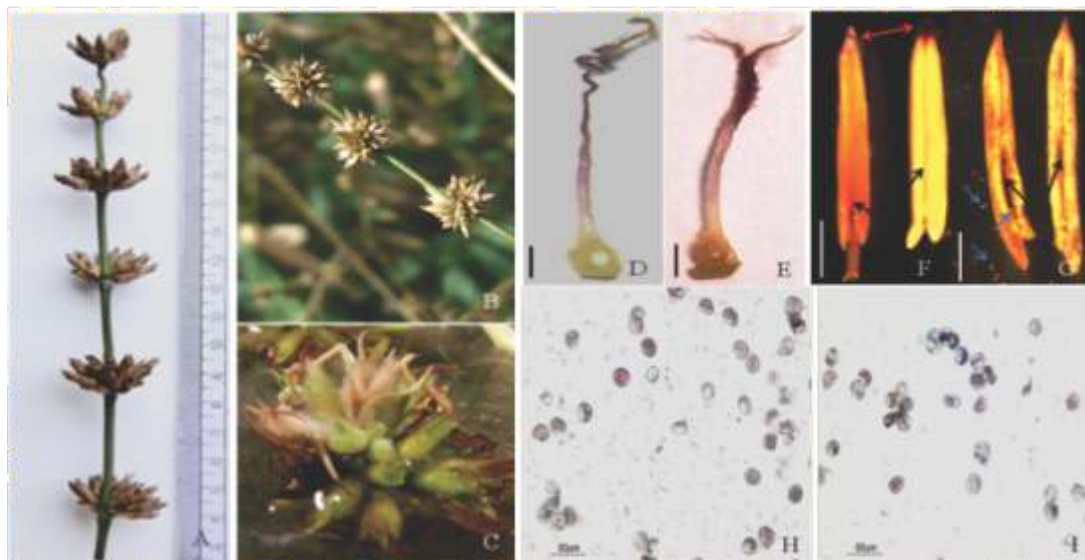


Fig. 72 Comparison of flowering in *D. hamiltonii* (A-C) head-of-spikelet (D-E) gynoecium (F-G) anthers at different stages of maturity (H-I) [A-B, E, F] *in planta in vitro* and (C, D, H) pollen shown within blue circles (D) *in vitro* flower with androecium and gynoecium. Bars A-C=1 cm, D = 1 mm

Identification, cross transferability and comparative mapping of novel genic microsatellite markers derived from expressed sequence data of *Dendrocalamus latiflorus*

Microsatellite markers are the tool for assessing genetic variation and dissecting complex traits. However, such markers are limited in bamboo and non-existent in *D. latiflorus*. Therefore, a total of 4,663 (2.7 Mb) unigenes were predicted from 9,574 publicly available express sequence tags (ESTs). Of these, 106 (2.27 %) unigenes containing 111 SSRs and 23 transposable elements were identified. SSR frequency was one in every 24.3 Kb of non-redundant (NR) EST sequences, with di (40.3 %) and tri (39.4 %) nucleotide repeats being the most abundant. Eighty two (77.4 %) SSR containing sequences showed known/putative function, including 10 (9.4 %) unigenes coding for 12 enzymes involved in different molecular pathways (Fig. 73).

Ninety primer pairs were designed from NR dataset and 66 successfully validated in *D. latiflorus*. Overall cross-transferability across 36 bamboo species and 5 related crop species ranged from 67 to 100 % with an average of 85.2 %. A total of 835 allelic variants (12.7 alleles per SSR locus) were recorded with polymorphism information content (PIC) ranging from 0.102 to 0.493. *In silico* comparative mapping of validated 56 (84.8 %) novel microsatellite markers with *Oryza sativa* genome suggested the presence of significant orthologues of rice in bamboo. Phylogenetic analysis based on newly developed markers was broadly as per the taxonomical classification of bamboo.

Micropropagation

Micropropagation protocols for three important edible bamboos viz. *Bambusa bambos*, *B. balcooa* and *D. asper* were standardized using nodal segments from field selected plants. The size of explants and their season of collection greatly influenced the frequency of bud break in all the

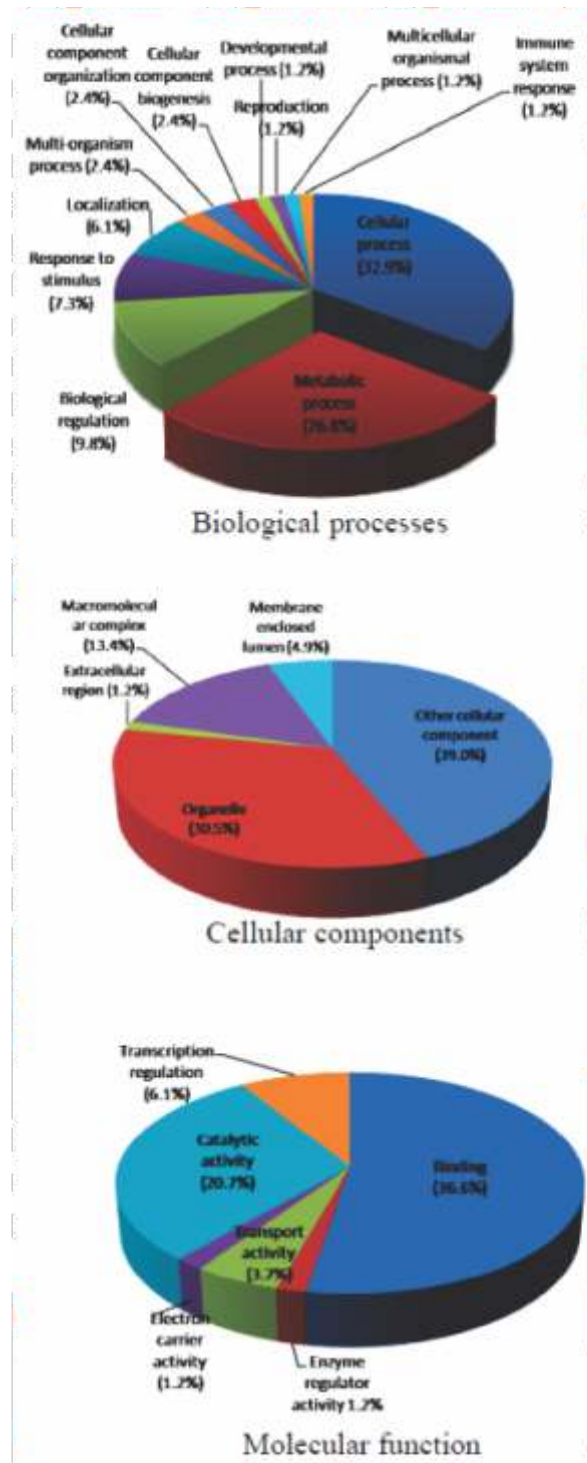


Fig. 73 Classification of the SSR containing unigenes based on Gene Ontology terms.

three species. Rooting was induced in bunches of 3-5 shoots after multiple shoot formation (Fig. 74). The hardened plants showed >90 % survival in polyhouse.



Fig. 74 *D. asper* (A) axillary bud break; (B) multiple shoot proliferation; (C) rooting on medium; (D) rooted plants; (E) healthy plants growing in green house

The genetic uniformity of the micropropagated plants of all the species was also established using random amplified polymorphic DNA (RAPD) and inter single sequence repeat (ISSR) makers (Fig. 75). A marked difference in biochemical and physiological parameters were observed in the *ex vitro* and *in vitro* raised plants growing under green house conditions (Table 12).

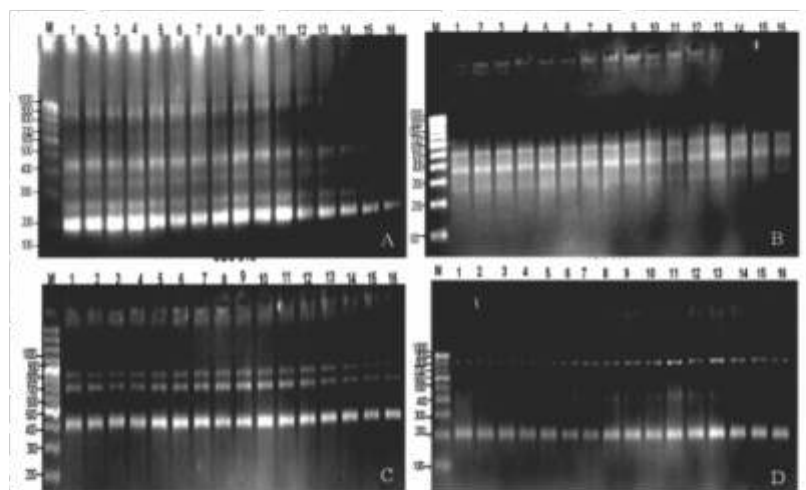


Fig. 75 Establishment of genetic uniformity in *B. balcooa* with RAPD and ISSR markers (A) OPT 08 (B) OPT 06 (C) UBC 810 (D) UBC 850 where lane M = 100 bp ladder, lane 1 = Mother plant, lanes 2–16 = Tissue culture raised plants

Table 12 Biochemical and physiological parameters in *Bambusa balcooa*

Physiological parameters	<i>In-vitro</i>	<i>Ex-vitro</i>
Relative water content (%)	72.7 ± 2.3 a	67.7 ± 3.3 b
Water saturation deficit (%)	27.3 ± 2.3 a	32.3 ± 3.3 b
Electrolyte leakage (%)	57.7 ± 2.7 b	67.4 ± 2.4 a
Leaf area index (cm ²)	1.06 ± 0.44 b	4.66 ± 0.81 a
Lignin content (mg ⁻¹)	17.90 ± 2.16 b	28.74 ± 1.59 a
Total soluble sugars(mg g ⁻¹ fw)	16.5 ± 0.78 a	13.38 ± 2.03 b
Starch (mg g ⁻¹ fw)	6.32 ± 0.55 a	4.76 ± 0.51 b

Values are mean of five replicates where different letters within a column indicate significant difference by Duncan's multiple range test, p ≤ 0.05; fw = fresh weight.

Development of molecular markers for evaluation of population genetic structure of the *Aquilaria malaccensis* in Northeast India: implication for its use and conservation
(Sponsored by Department of Biotechnology, Govt. of India)

Understanding the patterns of genetic diversity and population genetic structure of *Aquilaria malaccensis*, a high value endangered plant was important for its effective management and conservation. The genetic relationships of 127 *A. malaccensis* accessions collected from ten plantations of three states of Northeast India were assessed using AFLP. A total of 1153 fragments were amplified, out of which 916 (79.4 %) were polymorphic. Polymorphic information content (PIC) and marker index (MI) of each primer combination correlated significantly with the number of genotypes resolved. Overall high genetic diversity (avg, 71.85 %) was recorded. Further, high gene flow (N_m : 3.37), low genetic differentiation (F_{ST} : 0.069) and high within population genetic variation (93 %) suggested that most of genetic diversity was restricted within population.

The Neighbor Joining (NJ), principal coordinate analysis (PCoA) and Bayesian based STRUCTURE grouped all the accessions in two clusters with significant intermixing between populations. This suggested that the two genetically distinct gene pools are operating in the *A. malaccensis* plantations cultivated in Northeast India (Fig. 76). Based on the various diversity inferences, five diverse populations (JOH, FN, HLF, DHM and ITN) were identified. The findings can be potentially exploited to propose conservation strategies for *A. malaccensis*.

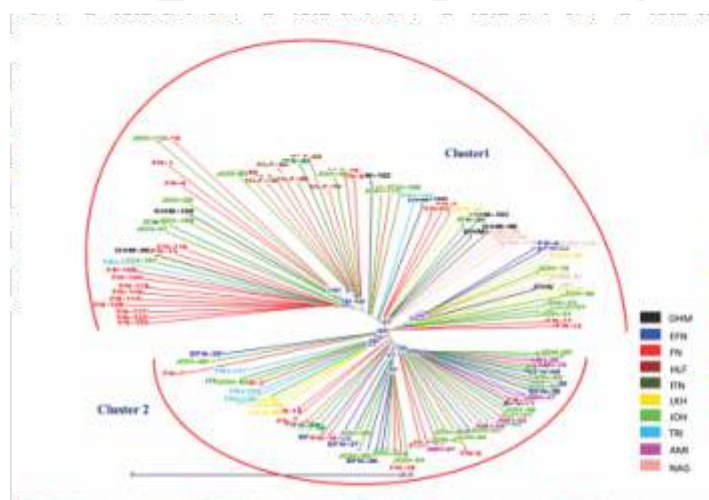


Fig. 76 Bootstrapped neighbor-joining (NJ) tree of 127 *A. malaccensis* accessions using AFLP markers

APPLE (*Malus sp.*)

Systematic analyses of abiotic stress in *Malus domestica*

Abscisic acid response elements (ABREs) control gene expression via b-ZIP-type ABA responsive element binding protein (ABREB). Therefore, different ABREB proteins of *Arabidopsis thaliana* viz. AREB1/ABF2, AREB2/ABF4, ABF1 and ABF3 with defined functional roles were isolated. As full genome sequence of *M. domestica* was available, genome wide analyses of the AREB subfamily was done and a total of 9 members with a basic leucine zipper (bZIP) domain were found. Chromosomal locations and phylogenetic analyses revealed a close relationship of some arabidopsis AREB members with ABREs of *M. domestica*.

Micropropagation

An efficient liquid culture system was developed for the micropropagation of two rootstocks, MM106 and B9 (Fig. 77). An 8 times reduction in cost (i.e. Rs. 6.29 per litre) was recorded when liquid medium was used. The cost was further reduced to Rs. 0.125 because 20 ml as

opposed to 50 and 100 ml liquid media supported maximum growth and multiplication. The shoots micropropagated in liquid medium also showed high rates of rooting and survival under field conditions.

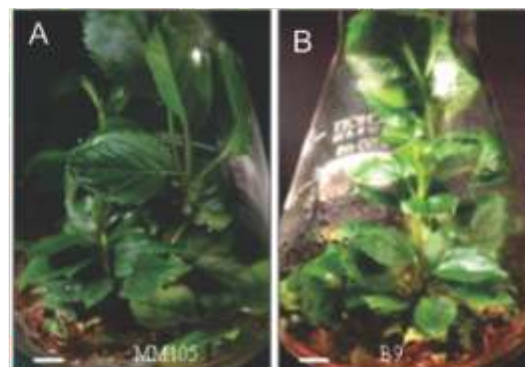


Fig. 77 Micropropagation of apple rootstocks in 20 ml PGR free liquid MS0 medium (A) MM106, (B) B9. Bar = 1 cm

Arabinan-type polysaccharides from industrial apple pomace waste

Two water soluble polysaccharides (AS-3 and AS-5) were isolated and identified as arabinans on the basis of GC-MS, IR, 1D, 2D NMR and MALDI-TOF-MS studies. GC-MS analysis of alditol acetate derivatives of AS-3 suggested the presence of arabinose and glucose sugars in the ratio of 4:1, whereas, AS-5 was comprised only arabinose. The structure of AS-3 was found to be circular with three arabinose and one glucose in circle and one arabinose unit branched at C-4 position of one of the arbinose. AS-5 was consisted of four arbinose units, out of which three were linked linearly through 1→5 and 1→3 linkage and one in side chain linked through 1→2 linkage (Fig. 78).

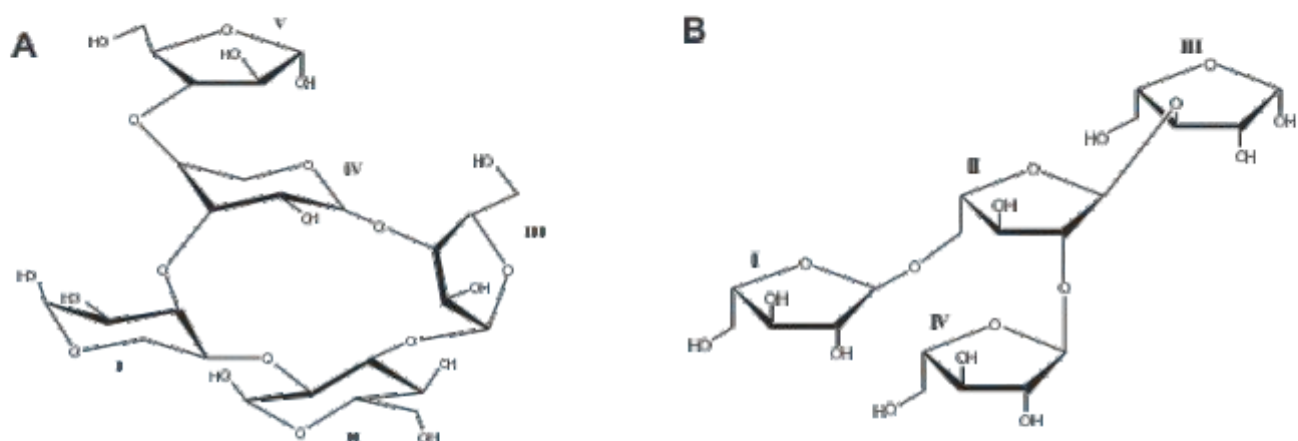


Fig. 78 Probable structures (A) AS-3 (B) AS-5

Processing of apple pomace for value added product development (Sponsored by Ministry of Food Processing Industries, Govt. of India)

Huge quantities of apple pomace are generated in juice-processing industries throughout the world and continuous efforts are being made for its inclusive utilization. In this regard, apple seeds were separated from industrial pomace and used for extraction of oil. The fatty acid composition, physicochemical, antioxidant as well as *in vitro* anticancer properties of the extracted oil were assessed for its suitability in food and therapeutic applications. Dominance of oleic and linoleic acid was recorded (Table 13) along with high iodine (121.8 g I 100 g⁻¹) and saponification value (184.91 mg KOH g⁻¹ oil). The acid value, refractive index and relative density were 4.28 mg KOH g⁻¹, 1.47 and 0.97 mg ml⁻¹, respectively. The antioxidant potential (IC₅₀) of apple seed oil was 40.06 µg ml⁻¹. Cytotoxicity of apple seed oil against CHOK1, SiHa and A549 cancer cell lines ranged between 0.5±0.06 and 88.6±0.3 %. Higher cytotoxicity was observed with increase in oil concentration. Vinblastine (1 µg) reached a maximum of 90 % cytotoxicity on CHOK1, while 2 mg of tested sample reached 88.6 % in 72 h. Interestingly, apple seed oil at 2 mg displayed a similar trend on SiHa cell line and inhibited 56 % cells. The study revealed a good pharmacological potential of apple seed oil.

Table 13 Fatty acid composition of apple seed oil

Compound	RI	Percentage
Palmitic acid	1927	7.25
Linoleic acid	2099	43.81
Oleic acid	2107	46.5
Stearic acid	2126	1.72
Arachidic acid	2325	0.72

Utilization of apple pomace for high end product development (Sponsored by Department of Biotechnology, Govt. of India)

Apple pomace was earlier utilized for extraction of polyphenolics for their utilization as nutraceutical or dietary food supplement. This year, a simple, fast and reproducible reversed-phase high performance liquid chromatography (RP-HPLC) method using diode array detector was developed and validated for simultaneous separation of different phenolics present in industrial apple pomace (Fig. 79). Method showed reliable and reproducible intraday (0.2-4.0 % RSD) and interday (3.7 -8.1 % RSD) precision with LOD and LOQ values in the range of 0.14-0.58 µg ml⁻¹ and 0.48-1.95 µg ml⁻¹, respectively for all phenolics. Different solvent mediated extraction of dried pomace powder was also performed for the evaluation of total antioxidant potential using standard spectrophotometric assays.

The major phenolics found in industrial apple pomace extracts were quercetin (1.4-10.3 $\mu\text{g mg}^{-1}$), phloretin (1.1-9.3 $\mu\text{g mg}^{-1}$) and phloridzin (0.62-2.0 $\mu\text{g mg}^{-1}$).

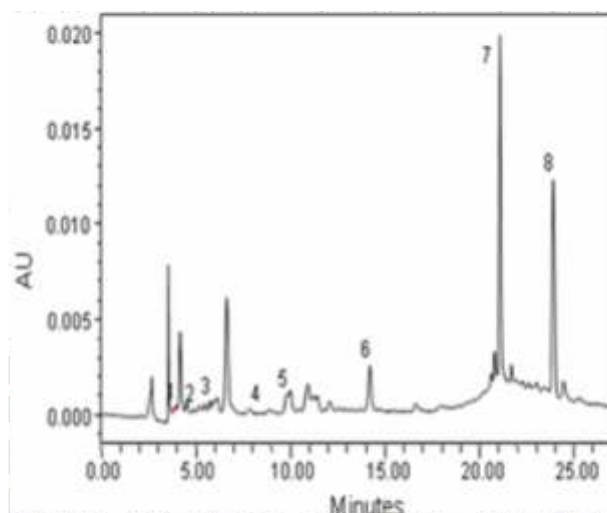


Fig. 79 RP-HPLC-DAD chromatogram of IAP methanol extracts at 280 nm (1) chlorogenic acid (2) epicatechin (3) caffeic acid (4) quercetin-3-glucoside (5) coumaric acid (6) phloridzin (7) quercetin (8) phloretin

Chemical modification of apple pomace for removal of Cd^{2+} ions from aqueous solution

In continuation to previous work, apple pomace (AP) was chemically modified (CMAP) with succinic anhydride by a simple ring opening mechanism. This provided larger surface area to AP for cadmium adsorption. The ability of CMAP to remove cadmium (Cd^{2+}) ions from aqueous solution was then assessed by equilibrium studies, kinetics and thermodynamics. As compared to Freundlich isotherm, the Langmuir adsorption isotherm equation was more suitable for AP and CMAP adsorption data. The adsorption of cadmium ions onto AP and CMAP followed pseudo-second order kinetics. The dose of CMAP required for cadmium removal was 50 times less than AP. Moreover, CMAP could be reuse up to three cycles with removal efficiency of 76.6 %, while the efficiency of AP reduced significantly after a single cycle (Fig. 80).

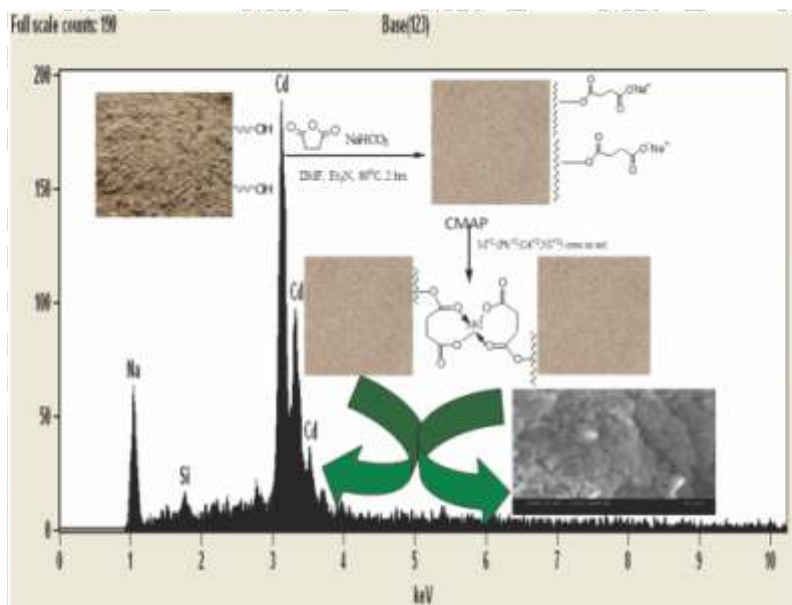


Fig. 80 Chemical modification of apple pomace

ORNAMENTAL ROSE (*Rosa* spp.)

Evaluation and utilization of wild roses

Strains of wild roses were collected from mid hills of HP on the basis of morphological characteristics such as colour, shape and size of the opening buds, flower type i.e. single or double, size and vigour of the plant. The collected strains were conserved at CSIR-IHBT and the surviving 21 strains were identified as *Rosa brunonii*, *R. cathayensis*, *R. moschata*, *R. multiflora* and one strain similar to *R. alba*; making a total of five species of wild roses. These strains were compared with a rootstock *R. indica* var. *odorata* (IHBT-0) as the standard control. Screening of these domesticated wild rose strains was based on criteria like winter-active growth, compatibility of strain to scion, suitability of grafting methods and seasons on compatibility, number and length of flowering shoots. Based on the compatibility performance in the first experiment (Table 14), the plants of seven strains, viz. IHBT-WR-21 (similar to *R. alba*), IHBT-WR-16 (*R. brunonii*), IHBT-WR- 24 (*R. multiflora*), IHBT-WR-27, IHBT-WR-01, IHBT-WR- 26 and IHBT-WR-23 (all *R. cathayensis*) were selected and planted in field for further evaluation of flower producing potential.

Table 14 Description and mean performance of wild rose germplasm for winter active growth and compatibility pooled over two years

S. No.	Strain No.	Species	Voucher specimen number	Winter active growth (%)	Compatibility (%)
1	IHBT-WR-01	<i>R. cathayensis</i>	PLP 9536	42.61	26.85
2	IHBT-WR-23	-do-	PLP 9535	44.68*	47.19*
3	IHBT-WR-27	-do-	PLP 9391	47.45*	28.69
4	IHBT-WR-26	-do-	PLP 9534	45.22*	44.43*
5	IHBT-WR-25	-do-	PLP 9565	31.4	23.14
6	IHBT-WR-03	<i>R. multiflora</i>	PLP 9562	12.82	15.74
7	IHBT-WR-04	-do-	PLP 9386	60.89*	19.43
8	IHBT-WR-18	-do-	PLP 9533	8.39	22.21
9	IHBT-WR-19	-do-	PLP 9390	1.37	9.26
10	IHBT-WR-24	-do-	PLP 9531	4.41	42.58*
11	IHBT-WR-10	<i>R. brunonii</i>	PLP 9388	4.51	3.7
12	IHBT-WR-15	-do-	PLP 9566	11.67	22.2
13	IHBT-WR-16	-do-	PLP 9530	24.81	29.62
14	IHBT-WR-17	-do-	PLP 9567	2.16	15.74
15	IHBT-WR-06	<i>R. moschata</i>	PLP 9549	40.3	0
16	IHBT-WR-08	-do-	PLP 9387	14.36	2.78
17	IHBT-WR-11	-do-	PLP 9561	10.32	3.7
18	IHBT-WR-13	-do-	PLP 9389	16.35	0
19	IHBT-WR-14	-do-	PLP 9563	7.99	1.85
20	IHBT-WR-22	-do-	PLP 9564	13.86	11.11
21	IHBT-WR-21	Similar to <i>R. alba</i>	PLP 9532	53.46*	23.14
22	IHBT-0	<i>R. indica</i> var. <i>odorata</i>		2.45	24.99
	Overall mean			22.79	19.01

*significant at p=0.05

Observations on four plants of each strain were recorded over four years with respect to different grades of marketable flower shoot production (A> 60 cm; B=45-60 cm; C=30-45 cm) of total number of flowering shoots and their height and diameter. The variations between the strains were analyzed using ANOVA (Table 15).

Table 15 Morphological traits of selected strains of roses

Source of variation	Degree of freedom	Mean of squares					
		Total flowering shoots (No.)	Grade A (> 60 cm) shoots (No.)	Grade B (45-60 cm) shoots (No.)	Grade C (30-45 cm) shoots (No.)	Average height of flowering shoot (cm)	Average diameter (mm)
Year	3	32.71*	12.17*	2.36*	1.44	53.19*	0.86
Strain	7	142.72*	99.99*	11.27*	26.25*	627.94*	3.25*
Error	21	3.12	1.19	0.89	0.86	18.39	0.56
H (%)		97.81	98.81	92.1	96.72	97.07	82.76

p ≤ 0.05

Four elite strains having better or at par compatibility, winter activity and flower producing potential with respect to control were identified as suitable indigenous wild rose germplasm and are being maintained *in situ* as mother stocks. These strains were registered with Plant Germplasm Registration Committee, National Bureau of Plant Genetic Resources (NBPGR), ICAR, New Delhi.

Cytological studies of the four potential strains, IHBTWR- 24, IHBT-WR-16, IHBT-WR-23 and IHBT-WR-21 revealed diploid chromosome count (2n=2x=14) of the strains (Fig. 81).

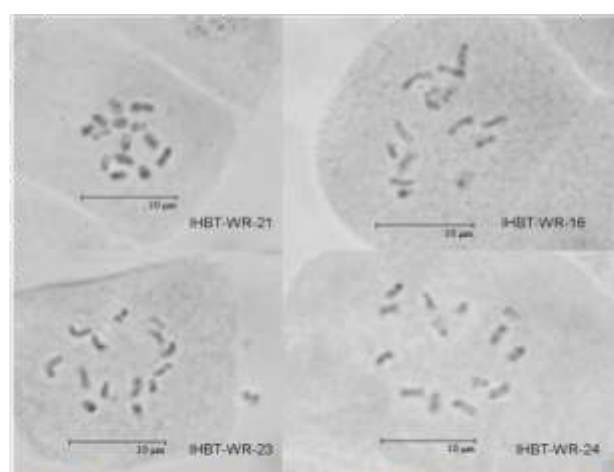


Fig. 81 Chromosome count (2n=2x=14) of the four potential strains

BREEDING

Inter-specific and inter-varietal hybridization were undertaken to generate new floral variations among scented, ornamental and wild roses (Table 16). Six different *Rosa* species viz., *R. bourboniana*, *R. damascena*, *R. multiflora*, *R. centifolia*, *R. rugosa* and *R. indica* were studied to generate desirable variations for flower, fruit and essential oil characters. Inter-varietal crosses involving reciprocals were attempted in *R. damascena* and *R. hybrida* (ornamental roses), respectively. Overall, 717 seeds from 305 pollinations involving inter-specific crosses, 109 seeds from 57 pollinations in crosses involving ornamental roses, 87 seeds from 165 pollinations in back-crosses and 23 seeds from 54 pollinations in inter-varietal crosses among varieties of Damask rose were obtained.

Table 16 Seed setting under inter-varietal and interspecific hybridization programme

Cross	No. of pollinations	No. of seeds
Inter-specific	305	717
Inter-varietal		
Damask rose	54	23
Ornamental rose	57	109
Back-cross	165	87

GERBERA (*Gerbera jamesonii*)

Two pigment markers *viz.*, anthocyanin pigment at the base of flower stalks and yellow colour pigment at the base of ligules were studied in parental accessions of gerbera and their progenies developed through controlled crosses. The two colour attributes corresponded with flavonoid and carotenoid pigmentation in flower colours and led to identification of acyanic genotypes for yellow and white flowers (Fig. 82 & 83). Crosses involving cyanic genotypes (with flavonoid pigments) as parents segregated for yellow pigment at the base of ligules in 1:1 and 3:1 ratios among the progenies, while anthocyanin pigment at the base of flower stalks segregated in 3:1 ratio for cyanic and acyanic genotypes in one of the crosses. Acyanic genotypes for white and yellow colours were found to breed true, whereas crosses involving white cyanic and white acyanic genotypes (similar flower colour expression) resulted in digenic segregation of flower colours (15:1) in the progenies. Crosses involving yellow cyanic and yellow acyanic genotypes segregated in digenic manner (9:7). The study postulates presence of an inhibitory gene (x+) for suppression of flower colour expression in cyanic genotypes when present in homozygous form.

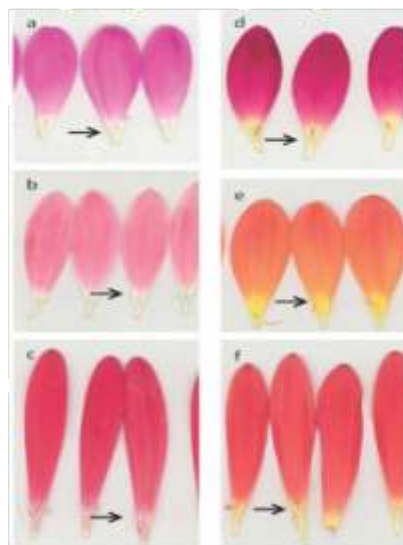


Fig. 82 Yellow pigment at base of ligules corresponding to carotenoid pathway in gerberas (marked with arrows: a, b and c – no colour; d, e and f – yellow colour at the ligule base)

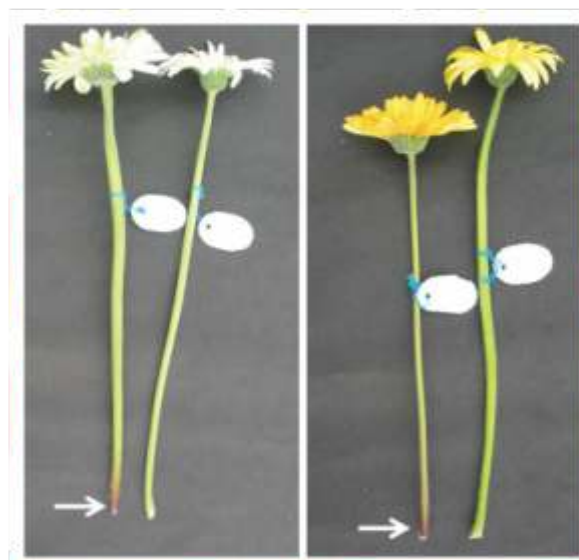


Fig. 83 Anthocyanin pigment at the base of flower stalks corresponding to flavonoid pathway in white and yellow colour cyanic gerberas (marked with arrows); no pigment in white and yellow acyanic gerberas

Promising gerbera genotypes with improved floral traits were selected through a hybridization program (Fig. 84). Considerable variations were observed among the genotypes for the floral traits viz., flower colour (white and yellow-orange), shape (double and semi-double types), diameter (standard and mini sizes), disc colour (dark brown/green), scape length (tall/dwarf), ray floret width (spider/standard types) and ray floret number. The gerbera genotypes (IHBT-Gr-23, IHBT-Gr-24-6 and IHBT-Gr-E-3) were selected on the basis of flower characteristics (Table 17) and are being cultured *in vitro* for large scale production of planting material.



Fig. 84 Potential gerbera genotypes with high *in vitro* proliferation (left to right: 23, E-3, 24-6)

Table 17 Details of floral features of gerbera F₁ selections

Plant no.	Flower colour	Peduncle length (cm)	Flower diameter (cm)	Flower shape	Disc colour	Flower type	Vase life (days)
IHBT-Gr-23	Yellow orange	41.2	10.8	Double	Green	Standard	18
IHBT-Gr-246	Yellow orange	29.6	11.7	Semi-double	Brown	Standard dwarf	16
IHBT-Gr-E-3	White	33.1	7.9	Double	Green	Minidwarf	14

INCARVILLEA (*Incarvillea emodi*)

Seed production

Incarvillea emodi is a rare plant found growing on rocks in mid Himalaya. In nature, its seed setting is poor. CSIR-IHBT domesticated the plant successfully and developed agrotechniques for its conservation. Studies on its seed-oil production and bioprospection were initiated and its seed production in the plant was studied (Fig. 85)

The antioxidant potential and polyphenol content of its shoots, roots and flowers were also compared using different solvents. The phenolic content (280.4–294.31 mg/g as gallic acid equivalent) and total antioxidant potential (280.95–384.64 mg/g as trolox equivalent) were higher in the ethyl acetate fraction of roots and shoots as compared to flowers. Major iridoid glucosides were isolated from the dried flowers. Cytotoxic studies were conducted using these iridoids against five different human cancer cell

lines. Boschnaloside (2) showed promising anticancer activity against THP-1, A-549 and PC-3 belonging to leukaemia, lung and prostate cancers, respectively. Plantarenaloside (1) expressed relevant cytotoxic activity against THP-1 cell lines of leukaemia.



Fig. 85 Seed pod production in *L. emodi*

MICROBIOLOGY AND PLANT PROTECTION

Development of biopesticides

In continuation to previous activities on development of biopesticides, the essential oils of *Mentha* spp., *Curcuma aromatica*, *Cinnamomum camphora*, *Hedichium spicatum* and lemon grass showed repellent, larvicidal, feeding deterrent and growth (feeding) inhibition activities against larvae of diamondback moth, *Plutella xylostella* (Lepidoptera: Yponomeutidae).

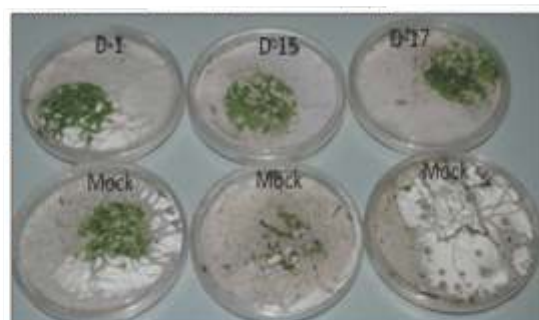
Development of risk reduced pest management package and management of pesticide residues in apple and its products (Sponsored by Department of Biotechnology, Govt. of India)

Field efficacy trial of acaricides against apple mites

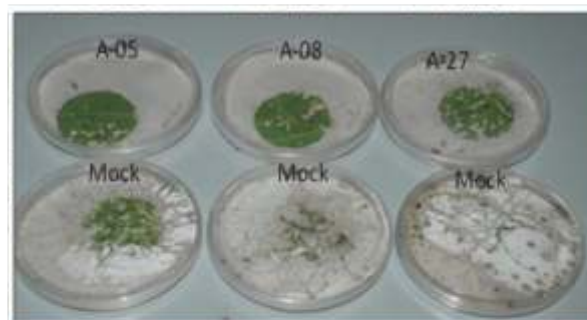
Apple orchards of Kullu district, HP were surveyed for infestation of insect pests and mites. While mites were found to be the major pests, the minor pests included woolly apple aphids, aphids, scales insects, caterpillars, stem borers and termites. Mite infestation increased in the month of July and their count ranged between 42.33-61.17 adult mites per leaf. Thus, field efficacy trials of acaricides (spiromesifen, chlorfenapyr, fenpyroximate, hexythiazox, abamectin, neem formulations, horticultural mineral oil (HMO), fenazaquin and dicofol) were conducted against apple mites (*Panonychus ulmi*) at Naggur, Kullu (HP) in the second season of July, 2013. All the treatments reduced the mite population but spiromesifen gave the best result on 28 days after treatment (DAT). HMO was the least effective. Hexythiazox was the best followed by spiromesifen, chlorfenapyr, fenpyroximate, abamectin, fenazaquin, neem, dicofol and HMO after 42 DAT. The adulticidal, nymphicidal and ovicidal activities of spiromesifen, hexythiazox, chlorfenapyr, fenpyroximate were significantly superior than dicofol (The standard check) but were at par with fenazaquin. Horticultural mineral oil was the least toxic.

Dihydroflavono 4-reductase and anthocyanidin reductase overpressing transgenic tobacco

Transgenic tobacco plants expressing the genes for the key regulatory enzymes of flavan-3-ols biosynthesis i.e., dihydroflavonol 4-reductase (*CsDFR*) and anthocyanidin reductase (*CsANR*) from *Camellia sinensis* were evaluated for predation by *Spodoptera litura* larvae. Leaf discs of the transgenics for these genes showed less feeding by *S. litura* as compared to control (Fig. 86).



A



B

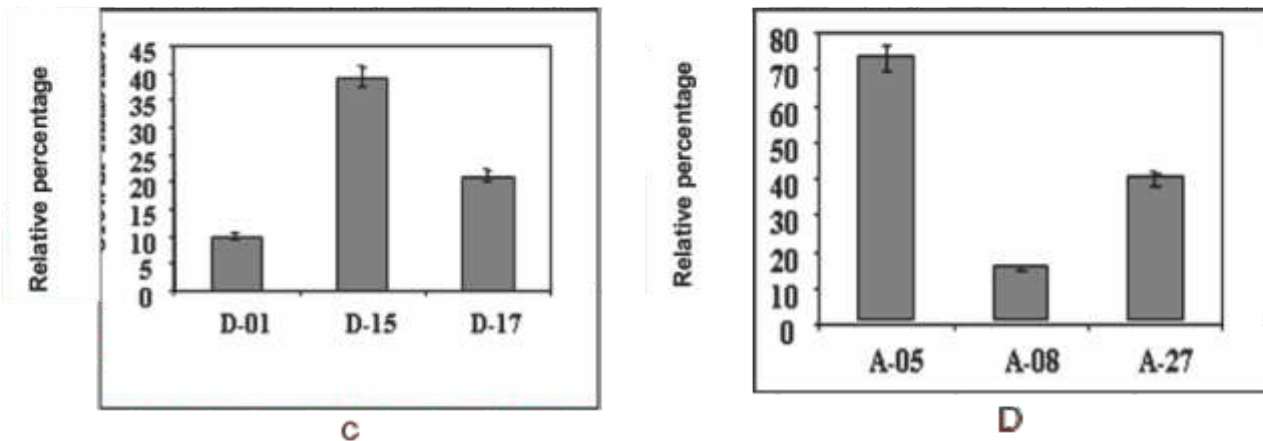
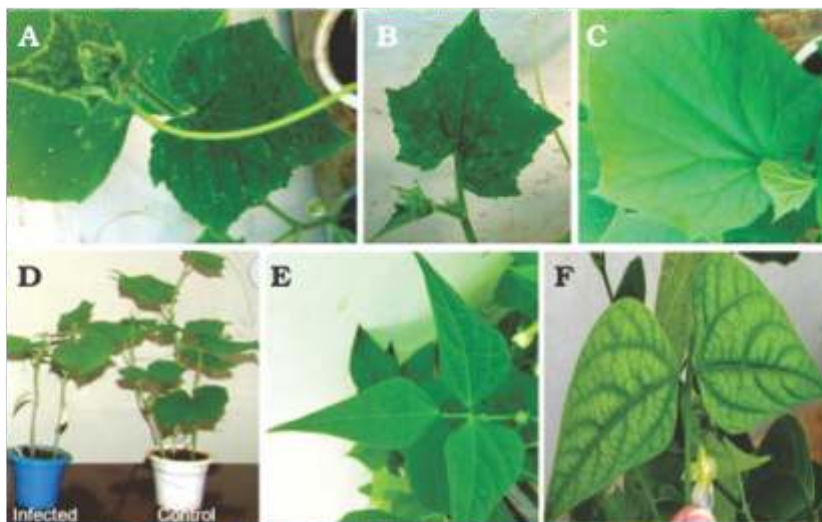


Fig. 86 *S. litura* feeding on leaf discs of transgenic tobacco as compared to control (A) *CsDFR* (B) *CsANR* (C&D) relative percentage growth inhibition of *S. litura* on transgenic leaf discs as compared to control

Biotechnological interventions for improvement of apple through virus & genetic fidelity certification and production of virus tested elite planting material (Sponsored by Department of Biotechnology, Govt of India)

Experimental host range Apple scar skin viroid infecting apple

Apple scar skin viroid (ASSVd), the type member of the genus *Apscaviroid* of the family *Pospiviroidae* causes scarring and dappling of apple fruits. Its herbaceous host range was identified using an infectious dimeric clone. Among 13 plant species inoculated with the viroid, nine were systemic while three served as indicator hosts (**Fig. 87**). The viroid was transferred to the hosts through agroinoculation, rubbing of dimeric RNA transcripts, dimeric DNA plasmids and sap inoculation. Single-strand confirmation polymorphism (SSCP) analysis of the progeny



obtained after infection showed the presence of four sequence variants (V1, V2, V3 and V4). There were confirmed by sequencing. Two sequence variants (V1 and V3) were identified as dominant, representing 47 and 36% of the total progeny, respectively. The V4 sequence variant was similar to the wild type and occurred at a frequency of only 4-5% of the total progeny (**Fig 88**).

Fig. 87 ASSVd symptoms on inoculated herbaceous hosts as indicated by (A, B): chlorosis on cucumber leaf cv. PSI and (C) healthy control without any symptoms (D) symptoms on cucumber cv. Summer Green [mild stunting in infected plant as compared to the control] (E) healthy common bean (cv. G. komal) control (F) interveinal chlorosis symptoms in an infected common bean plant

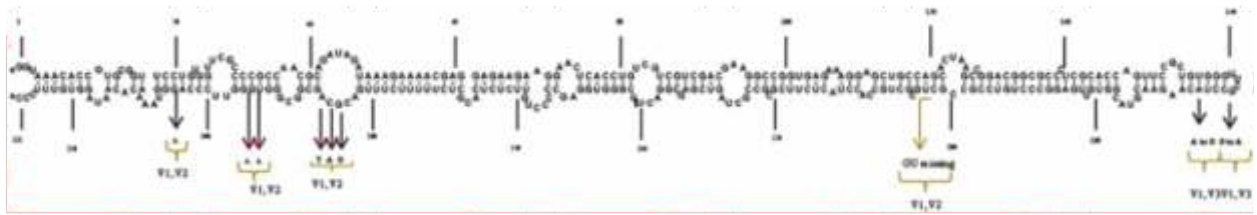
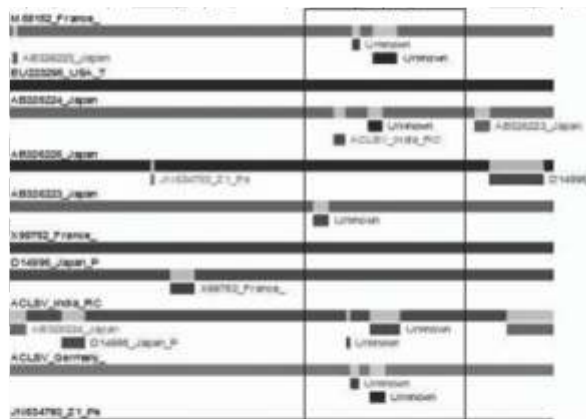


Fig. 88 Predicted secondary structure of ASSVd and the locations of the residue changes observed among V1, V2 and V3 variants

Molecular characterization and recombination analysis of the complete genome of *Apple chlorotic leaf spot virus*

The complete nucleotide sequence of an Indian isolate of *Apple chlorotic leaf spot virus* (ACLSV) was determined and found to be 7,525 nt in length. The genome organization was similar to known isolates of ACLSV, encoding three ORFs. Comparisons indicated high sequence variability among known isolates with overall nucleotide sequence identities of 80 to 84%. A striking variable region was identified among the replicase protein, upstream of the RNA-dependent RNA polymerase (aa 1510–1590). It showed a 41–43 % match with the corresponding regions in other isolates.



Phylogenetic analysis at the nucleotide level, clustered the isolates into three groups without any relation to geographical origin. Analysis showed the isolate to be a recombinant. Its recombination sites were spread throughout the genome, especially in the polymerase gene region (nt 4700–5400) (Fig. 89 & 90) and were mostly bordered by an upstream region (5') of GC-rich and downstream region (3') of AU-rich sequences of similar length.

Fig. 89 Recombination obtained among various isolates of ACLSV using 'RDP v. 3'. Box shows region where maximum recombination events occurred

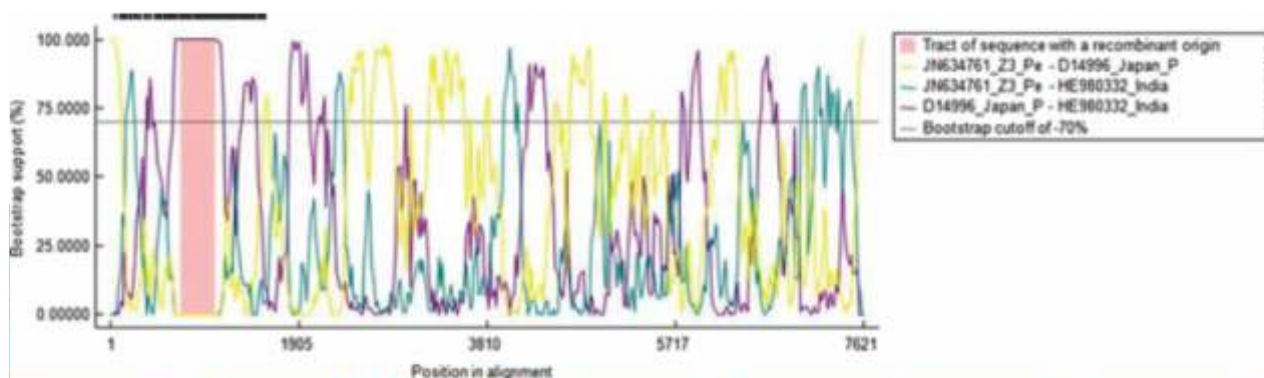


Fig. 90 Recombination event 1. MAXCHI evidence for the recombinant origins of ACLSV (100 bootstrap replicates, Jukes-Cantor distances), constructed for 200-nt sequence windows, step size 20

Simultaneous detection of major pome fruit viruses and a viroid

A reliable, sensitive, simple, rapid, cost-effective mRT-PCR assay was developed to detect major apple viruses, namely *Apple mosaic virus* (ApMV), *Apple stem pitting virus* (ASPV), *Apple stem grooving virus* (ASGV), *Apple chlorotic leaf spot virus* (ACLSV) and *Apple scar skin viroid* (ASSVd). Five specific primer pairs were tested and confirmed for these viruses and viroid together in a single tube giving amplicons of ~198, ~330, ~370, ~547 and ~645 bp corresponding to ASGV, ASSVd, ASPV, ApMV and ACLSV, respectively (Fig. 91). Use of a guanidium-based extraction buffer along with a commercial kit resulted in better quality RNA suited for multiplex RT-PCR. A rapid, time and yield effective CTAB method was also developed for RNA isolation from apple tissue. The protocol was validated on approximately 85 samples collected from field. In a sensitivity test of the mRT-PCR, up to 10^1 titre of all pathogens were detected with hot-start Taq, whereas sensitivity reached 10^2 with the multiplexing kit. The determined sensitivity limit defines its use in different seasons when there is variation in viral titre. The mRT-PCR kit can be opted for early screening of nursery raised plants, mother plants, raising virus free planting material through tissue culture and other phytosanitary purposes. Results from multiplex RT PCR can be obtained approximately within 7-8 hours and is useful in quarantine and certification programs as well as virus surveys where large numbers of samples are tested.

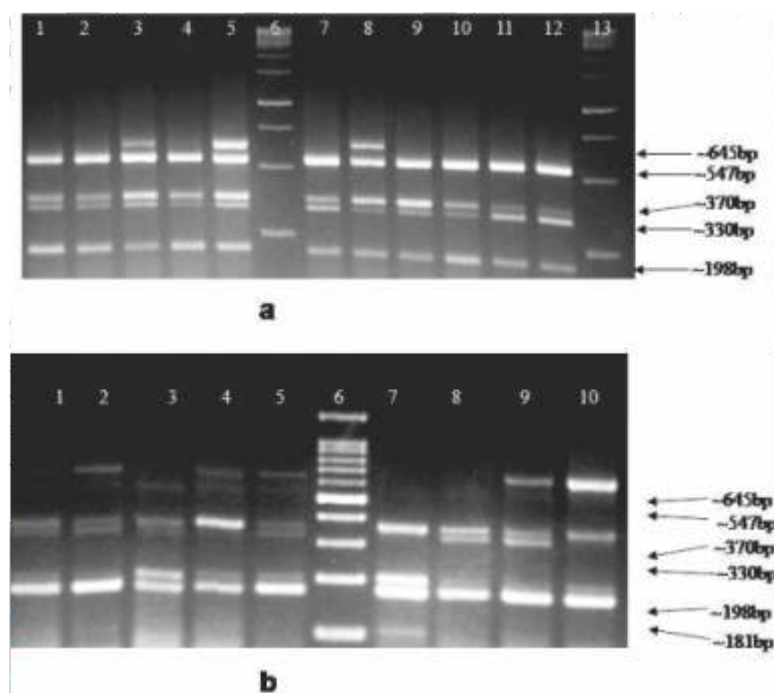


Fig. 91 Multiplex RT-PCR with and without internal control fractionated on a 3% agarose gel. a). Lanes 1- and 2: amplified product of M7 showing specific amplification of all four pathogens except ACLSV; lanes 3 & 4: product of Red Crimson (RC) & Golden Delicious (Gd-3); lane 5 & 8: amplicon of Gd-7; lane 6 & 13: 100 bp marker (Genedirex); lane 7: product of sample 106; lanes 9 and 10: amplified product of Gd-1; lane 11 and 12: amplicons of T6/109 sample. b). Multiplex RT-PCR with internal control (*nad5*). Lanes 1-5: amplicons of samples RC, T9/109, Rd-1, Gd-6 and Gd-7; lanes 7-10: amplicons of Kw-2, Kw-3, K-4 and Kw-4; lane 6: 100 bp marker

Cold-tolerant *Trichoderma* species for management of *Fusarium* wilt of tomato plants

Cold-tolerant *Trichoderma* species (Fig. 92) capable of growing at 5°C were isolated from rhizosphere soils of western Himalayan region. Sequencing of Internal Transcribed Spacer region indicated the taxonomic affiliation of the isolates to *T. gamsii*, *T. velutinum* and *H. lixii*. One isolate PETX-Behli-1 (*T. gamsii*) showing maximum antagonism against *Fusarium oxysporum* f.sp *lycopersici* (FOL) was elucidated for its chitinolytic ability. The isolate displayed maximum chitinolysis on chitinase detection agar and recorded higher chitinase activities (63.1 to 83.8-folds) at 5 to 37 °C in the extracellular proteins of minimal synthetic broth (MSB) amended with colloidal chitin. Extracellular proteins of cell free extracts of MSB amended with and without chitin contained 26-180 kDa polypeptides (Fig. 93). In plate assays, the crude extract containing chitinases displayed 46.2% inhibition of mycelial growth of the pathogenic fungus (Fig. 94). Seed bacterization and soil

application of chitin-supplemented talc-based formulation of PETX-Behli-1 challenge-inoculated with FOL resulted in significantly lower incidence (61.9% reduction) relative to the non-bacterized pathogen control in a greenhouse (18-20°C) (Fig. 95). This was associated with an increase in the plant vigour index, fruit number and fruit weight of 64.8, 205.4 and 210.8%, respectively, relative to the pathogen control. In native gel activity assays, PETX-Behli-1 with challenge-inoculation, expressed high intensity or more isoforms of chitinase, peroxidase and polyphenol oxidase. The results suggest that the cold active PETX-Behli-1 may be a potential agent for to control *Fusarium* wilt of tomato plants during winter.

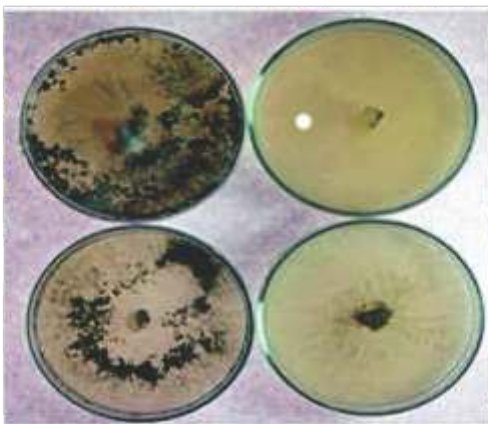


Fig. 92 Growth of cold active *Trichoderma* spp. on potato dextrose agar plates (a) PETX-Behli-1 (b) PETX-Behli-2 (c) GITX-Behli-1 (d) GITX-Bararighat

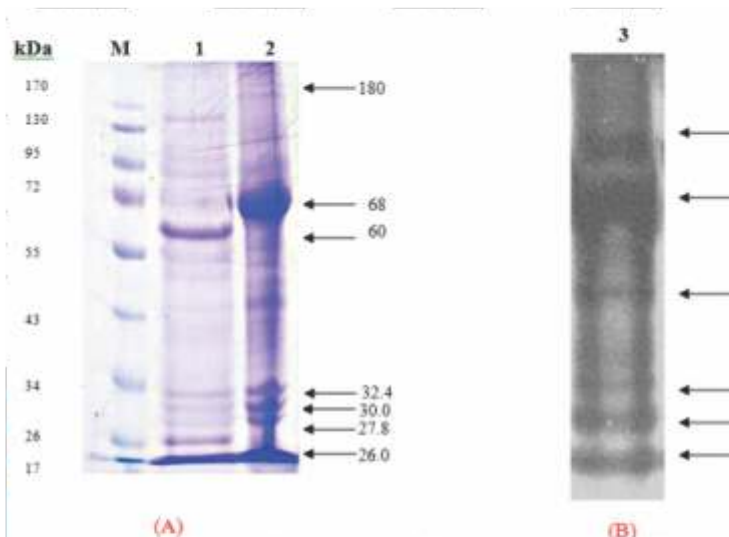


Fig. 93 Extracellular protein profiles of PETX-Behli-1 grown on different media (A) SDS-PAGE where lanes M: Marker (Genei); lane 1: un-induced MSB alone; lane 2: induced (MSB+colloidal chitin). Proteins were stained with Coomassie brilliant blue R-250 (B) Native gel assay where lane 3: PETX-Behli-1 on MSB+chitin; Arrows indicate isoforms



Fig. 94 Antifungal activity of chitinase containing crude extracellular proteins of PETX-Behli-1 inhibiting the mycelial growth of *F. oxysporum* f.sp. *lycopersici*. Wells 1-phosphate buffer (100 mM/L; pH 6.0); 2: phosphate buffer+fungal spores (3×10^5 conidia/ ml); 3: extracellular protein (400 μ g)+fungal spores



Fig. 95 Performance of PETX-Behli-1 in pot experiments. i. Plants treated with PETX-Behli-1 challenged with *Fusarium oxysporum* f.sp. *lycopersici*; ii and iii: pathogenic controls

Genetic diversity of *Fusarium* spp. inciting rhizome rot of ginger and its management by PGPR consortium in the western Himalayas

The genetic variability of 32 *Fusarium* isolates from diseased ginger rhizomes from the western Himalayas in India was analyzed by the unweighted pair group method with arithmetic averaging using randomly amplified polymorphic DNA amplicons. Two major clusters formed. One was dominated by *F. oxysporum* and the other by *F. solani*. Talc-based formulations of the plant growth promoting rhizobacteria (PGPR) strain XXBC-TN (*Bacillus subtilis*) and a mixture of S2BC-1 (*B. subtilis*) with TEPF-Sungal (*Burkholderia cepacia*) which also inhibited *F. oxysporum* and *F. solani*, were developed for rhizome dressing and soil application in ginger fields. Maximum rhizome production (85.2 %) (Fig. 96) with fewer yellows and reduced rhizome rot incidences (87.8 % and 88.4 %) over the control was recorded in a polyhouse.

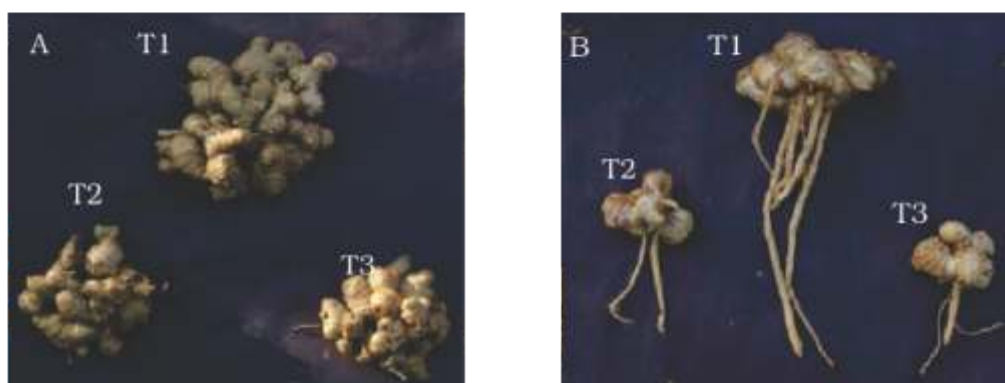


Fig. 96 Performance of the antagonistic strain mixture, S2BC-1 (*B. subtilis*)+TEPF-Sungal (*Burkholderia cepacia*) in pot experiments (A) rhizome yield and (B) root length where T1: S2BC-1+TEPF-Sungal; T2: untreated control; and T3: pathogenic control

An associated increase in chitinase, b-1,3-glucanase, and polyphenol oxidase was also recorded (Fig. 97). The strain mixture treatment also promoted plant growth and enhanced rhizome production by 45.8 % in field experiments. The PGPR strain mixture reduced yellows and rhizome rot incidences by about 50.5 % and was comparable to a mixture of carbendazim and mancozeb fungicide.

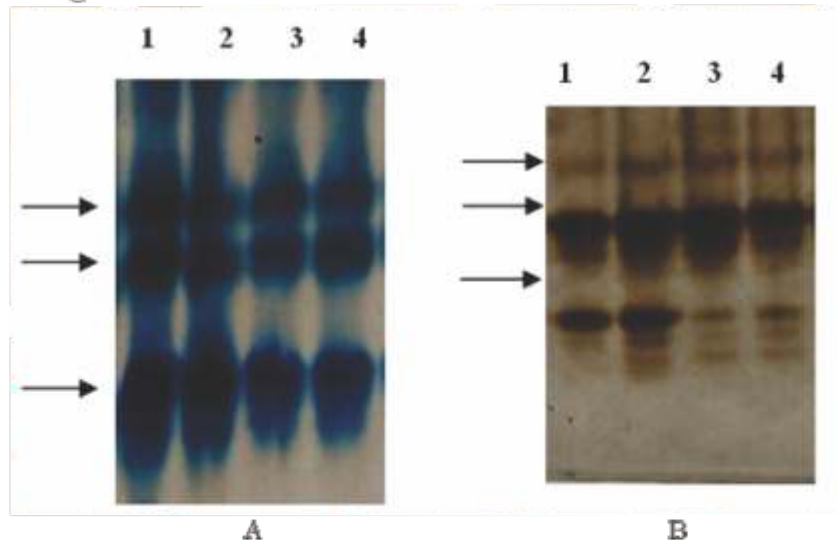


Fig. 97 Native-PAGE analyses for (A) peroxidase and (B) polyphenol oxidase isoforms induced by the antagonists in ginger rhizomes on challenged inoculation with isolates as GIFOZ-UHF (*F. oxysporum*) and GIFU-Kohli-3 (*E. solani*) respectively. Lane 1: XXBC-TN; lane 2: S2BC-1+TEPF-Sungal; lane 3: pathogenic control; lane 4: untreated control; and arrows indicate the isoforms

PLANT MICROBE AND SOIL INTERACTIONS

Understanding pathogenesis of *Venturia inaequalis*

In an earlier study on transcriptome analysis, some map kinases were identified in the secretome of *V. inaequalis*. Among these, HOG1 MAPK was found to have a good level of similarity with *M. grisea* HOG1. Bioinformatically, it was found to associate with- MAP kinase PBS2, bZIP transcription factor, tyrosine protein phosphatase-1, HPT superfamily protein, dual specificity phosphatase, catalase-1 and aquaporin-9.

Similarly, SLT2 kinase (having similarity with *Sclerotinia sclerotiorum* was found to have an interaction network with- MAP kinase kinase pec1 like protein, serine/threonine-protein phosphatase, MADS superfamily transcription factor, putative tyrosine protein phosphatase pmp1 protein, bZIP transcription factor and KH domain RNA binding protein.

Identification of putative defense-related gene(s) induced in response to biocontrol agents

SDS-PAGE protein profiles of tomato (Yash) plants induced by biocontrol agents after challenge inoculation with *F. oxysporum* isolates, TOFOL-IHBT (A), TOFS-IIVR (B) and TOFU-CBE1(C) indicated significant differences in the banding patterns relative to pathogen control. In suitable profile obtained after several attempts six proteins were differentially expressed when these were trypsin digested and subjected to MALDI ToF ToF analysis, putative defensin-like protein 270, NADH dehydrogenase and putative lipoxygenase 5 were identified by MASCOT analyses (Fig. 98).

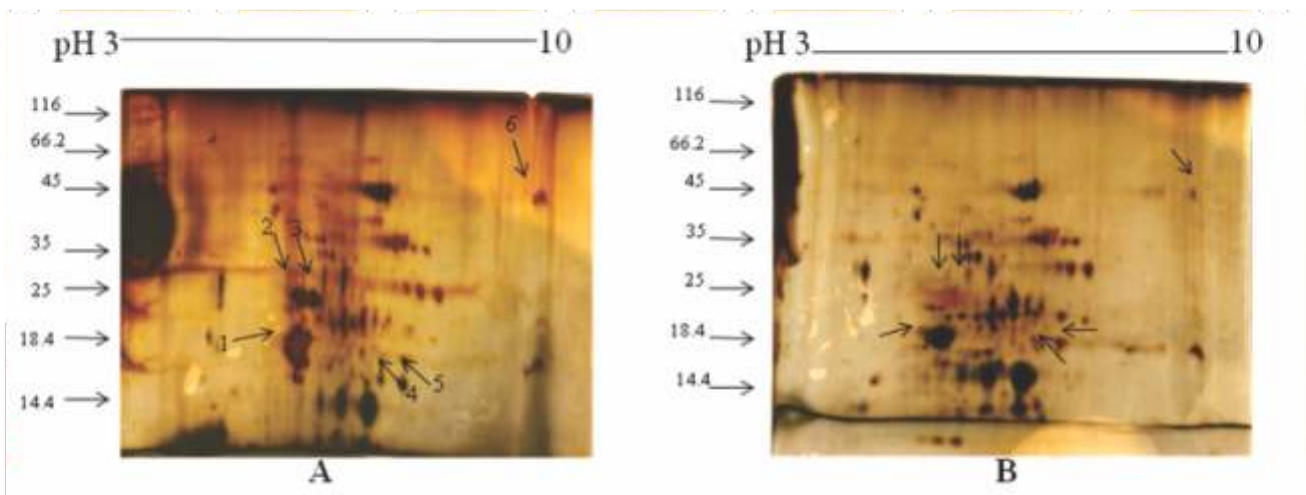


Fig. 98 2-Dimensional electrophoresis of protein profiles of tomato (Yash) plants induced by *Trichoderma* spp. after challenge inoculation with *Fusarium oxysporum* isolates (A) CAUTX Kukum (treatment) (B) TOFS-IIVR [control], Arrows on the gel indicate the number of spots upregulated and downregulated; Spots 1-6 in treatment are upregulated and slightly appeared or absent in control. These spots from treatment were taken further for mass spectrometry.

Understanding role of transcription factors during disease development by *Cucumber mosaic virus*

During *C. sativus* infection by CMV, several following transcription factors with altered expression profile were identified. These included- B3 (14x regulated), RFC3 replication factor C subunit 3, G Box binding factor, MADS box binding protein AGL8, Ethylene-responsive transcription factor RAV1, Transcription activator LFY-like protein, Ethylene-responsive transcription factor 7, Transcription factor GTE6, MYB123, Transcription factor EGL1, Nuclear transcription factor Y subunit C-2 and Ethylene-responsive transcription factor RAP2-12.

Molecular evidence of *Cucumber mosaic virus* subgroup II infecting *Capsicum annum L.* in the western region of India

Viral infections are one of the major limitations in the production of *Capsicum annum L.* (Chilli-pepper). Therefore, a survey was conducted in chilli growing areas of HP and samples (leaves and fruits) showing symptom of viral disease were exclusively collected and tested for the presence of various known plant viruses found in chilli-pepper. On the basis of serological and molecular based reactions, the viruses were identified as *Cucumber mosaic virus* (CMV), *Tomato spotted wilt virus* (TSWV), poty virus and gemini viruses and CMV was found to be the most abundant. When the isolate was mechanically transmitted to the indicator plants belonging to *Cucurbitaceae*, *Chenopodiaceae*, *Solanaceae* and *Fabaceae* families, they exhibited characteristic symptoms of mosaic and mottling. The coat protein [CP] gene of the CMV was amplified using RT-PCR with CP Gene-specific primers, cloned and sequenced. Sequence analysis revealed that the CP gene had homologies of 95-99 % at nucleotide level with the sequences of CMV subgroup II. The phylogram assigned that the CMV isolate infecting chilli-pepper is clustered well with the other analyzed isolates belonging to subgroup II.

Recombination study on this virus isolate revealed the virus is a major parent involved in recombination event of isolate 241. The findings will be useful in understand the role of CMV subgroup II as a major virus-causing disease infecting chilli in western Himalayan region of India.

Simultaneous detection and identification of four cherry viruses by two step multiplex RT-PCR with an internal control of plant nad5 mRNA

A multiplex reverse transcription-polymerase chain reaction (mRT-PCR) was developed and standardized for the simultaneous detection of four cherry viruses: *Cherry virus A* (CVA, genus Capillovirus), *Cherry necrotic rusty mottle virus* (CNRMV, unassigned species of the Betaflexiviridae), *Little cherry virus 1* (LChV-1, genus Closterovirus) and *Prunus necrotic ringspot virus* (PNRSV, genus Ilarvirus) with nad5 as plant internal control. A reliable and quick method for total plant RNA extraction from pome and stone fruit trees was also developed. Conditions were optimised and all four viruses were detected successfully by mRT-PCR in artificially created viral RNA mixture and field samples of sweet cherry (Fig. 99). The identity of the viruses was confirmed by sequencing. The assay could detect above viruses in diluted cDNA (10^{-4}) and RNA (10^{-5}) except for PNRSV which was detected only in ten times lesser dilution. The developed mRT-PCR has potential use in the detection of viruses from single or multiple infections of sweet cherry and other stone and pome fruits virus indexing, plant quarantine and certification programs.

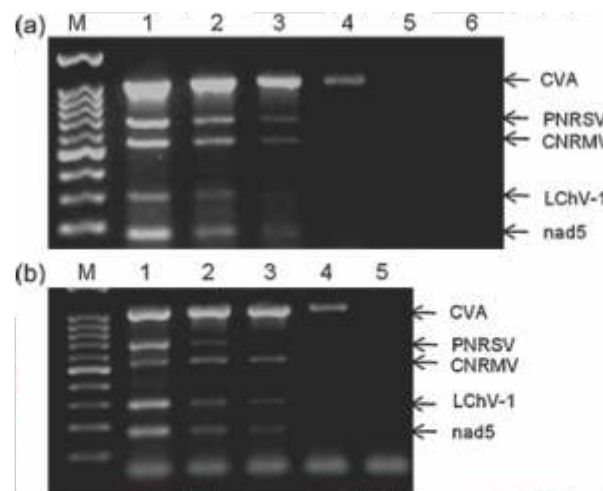


Fig. 99 (A) Sensitivity limits of mRT-PCR for all four cherry viruses (CVA, PNRSV,CNRMV and LChV-1) using 10-fold serial dilutions of cDNA (B) total plant RNA where nad 5 mRNA is internal control, lanes 1–6: 10⁰–10⁻⁵ serial dilutions, lane M: 100 bp DNA ladder

Immunodiagnosics for *Cherry virus A* and *Cherry necrotic rusty mottle virus*

Cherry necrotic rusty mottle virus (CNRMV) and *Cherry virus A* (CVA) are important graft transmitted viruses in the family Betaflexiviridae, infecting cherry. CVA in combination with other stone fruit viruses cause severe symptoms and disease in both cherry and non-cherry hosts. CNRMV infected tree showed reduced growth, significant yield loss and early death.

Therefore, a DAS-ELISA and IC-RT-PCR based diagnostics for CVA, and first report of DAS-ELISA based diagnostics for CNRMV were developed for the first time. A total of 74 and 43 samples were checked for CVA and CNRMV, respectively. Forty out of 74 samples tested positive for CVA and 20 out of 43 tested samples were positive for CNRMV. Antibodies raised against recombinant CNRMV CP also detected the virus consistently in western blot analysis with high sensitivity and specificity. IC-RT-PCR was then developed for the detection of CVA using the produced antibody.

Molecular characterization and intermolecular interaction of coat protein of *Prunus necrotic ring spot virus*: implications for virus assembly

Coat protein (CP) and RNA3 from *Prunus necrotic ringspot virus* (PNRSV-rose), the most prevalent virus infecting rose in India were characterized and regions in the coat protein important for self-interaction, during dimer formation were identified. The sequence analysis of CP and partial RNA 3 revealed that the rose isolate of PNRSV in India belongs to PV-32 group of PNRSV isolates. Apart from the already established specific features of PV-32 group member's additional group-specific and host specific features were identified. Presence of methionine at position 90 in the amino acid sequence alignment of PNRSV CP gene belonging to PV-32 group was identified as the specific conserved feature for the rose isolates of PNRSV. As protein-protein interaction plays a vital role in the infection process, the portions of PNRSV CP responsible for self-interaction using yeast two-hybrid system was identified. Analysis of the deletion clones revealed that the C-terminal region of PNRSV CP (amino acids 153-226) plays a vital role in the interaction during dimer formation. N-terminal of PNRSV CP is previously known to be involved in CP-RNA interactions, but this study suggested that N-terminal of PNRSV CP represented by amino acids 1-77 interacts with C-terminal (amino acids 153-226) in yeast two-hybrid system and has probable involvement in the CP-CP interaction.

REGULATORY RESEARCH

Anthocyanins rich black carrot extract (BCE) was evaluated for acute oral toxicity using female wistar rats. When the test formulation was dissolved in distilled water and orally fed to the animals after overnight fasting, no toxic signs and mortality was observed. No gross and microscopic lesions were found in the vital organs. The LD_{50} of the test formulation was found to be greater than 2000 mg/kg body weight (bw) **Fig. 100**.

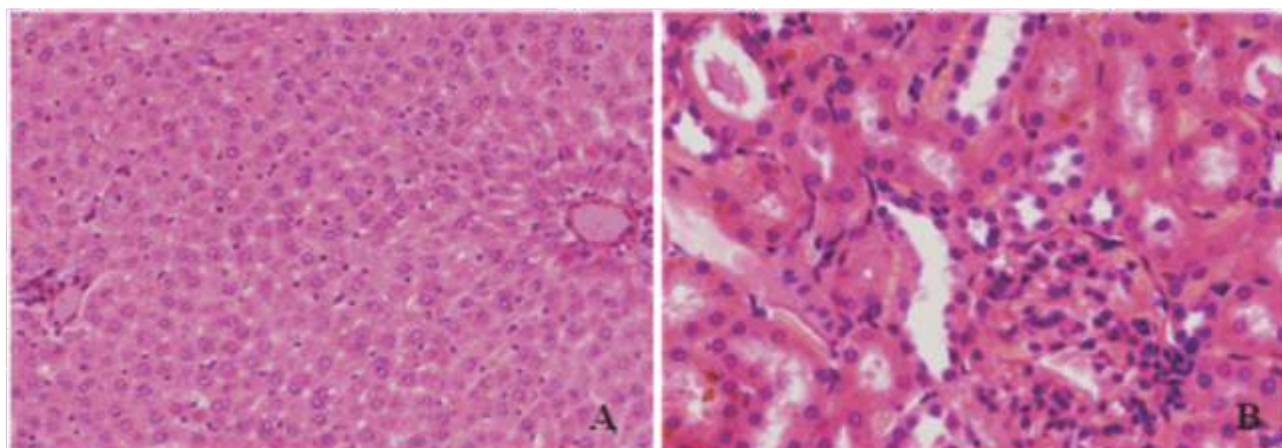


Fig. 100 Histo-pathological analysis of anthocyanins rich black carrot extract on (A) liver; (B) kidney

The formulation was also tested for its antidiabetic activity in Type-1 diabetic rat model by IP injection of streptozotocin a well known chemical inducer of Type-1 diabete, at 50 mg/kg bw. Higher body weight gain (**Fig. 101**) and reduction in blood glucose levels (**Fig. 102**) was recorded after treatment. Improvement in platelet count as well as serum biochemical parameters like alkaline transferase (ALT) and lipid peroxide (**Fig. 103**) were also observed. In contrast, the BCE treated groups had lower intensity of lesions in liver tissues (**Fig. 104 A**). Degenerative changes in kidney tissues were also lower (**Fig. 104 B**). Moreover, cross pathological studies on pancreas revealed proper recovery of Islet of Langerhans (**Fig. 104 C**). BCE was concluded to have anti-diabetic efficacy in streptozotocin induced Type-1 diabetic animals.

Group 1	Normal control rats
Group 2	Diabetic rats (induced by streptozotocin) (50 mg/kg bw) IP
Group 3	Diabetic + glibenclamide 1mg/kg bw orally
Group 4	Diabetic + BCE 100 mg/kg bw pre-treatment
Group 5	Diabetic + Anthocyanin 100 mg/kg bw oral post-treatment

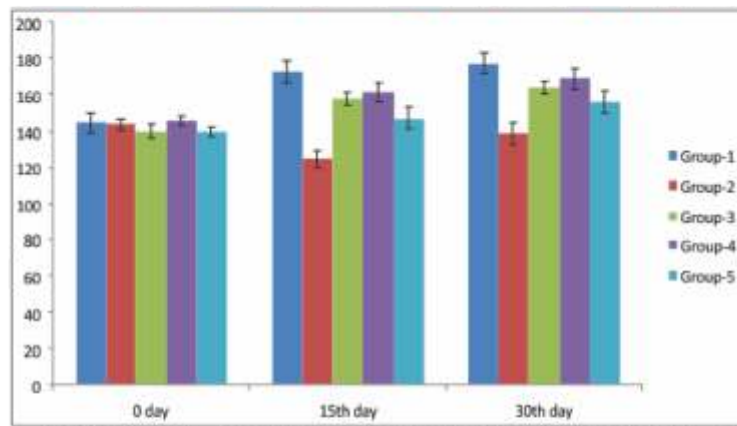


Fig. 101 Mean body weight of animals at different intervals

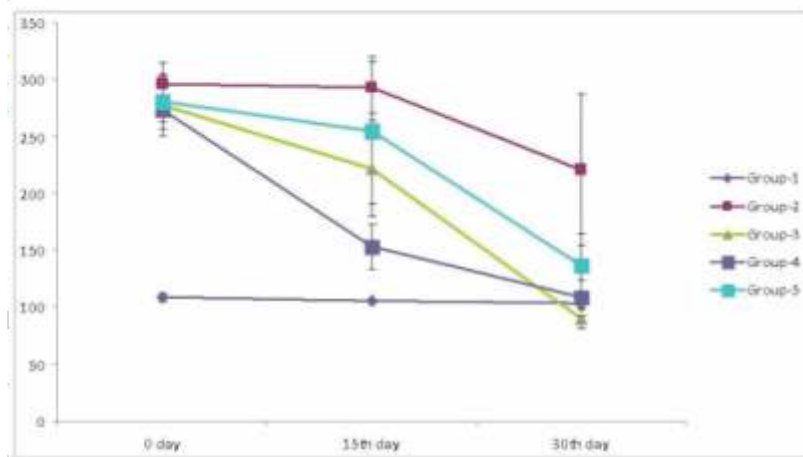


Fig. 102 Mean blood glucose levels at different intervals

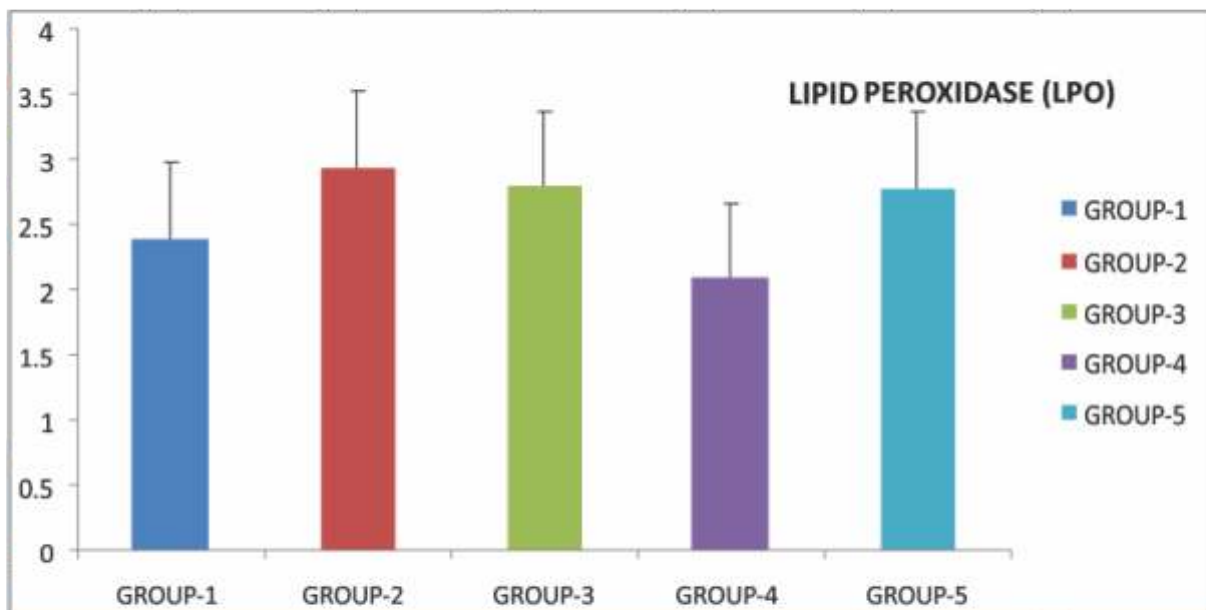


Fig. 103 Levels of lipid peroxidase in blood

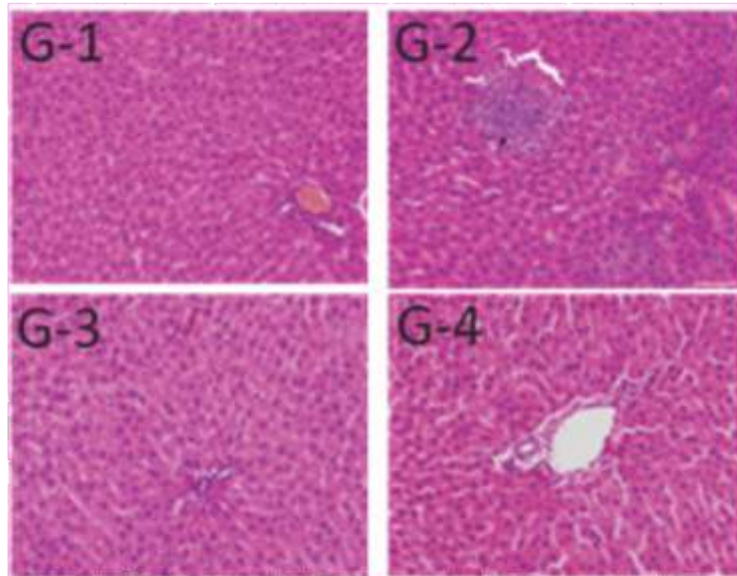


Fig. 104 A Liver tissue showing low intensity lesions

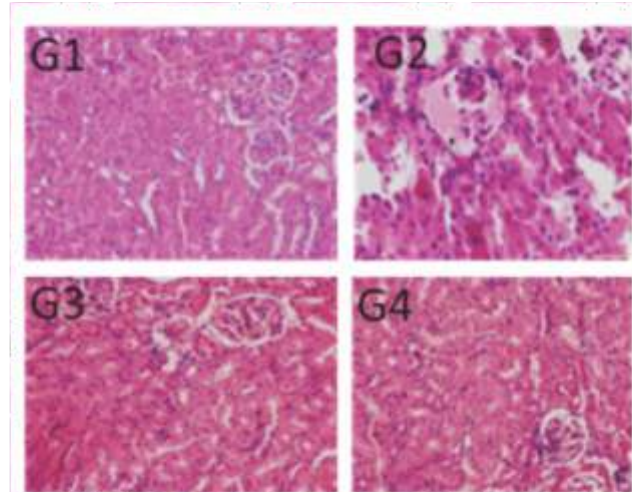


Fig. 104 B Kidney tissue showing lower degenerative changes

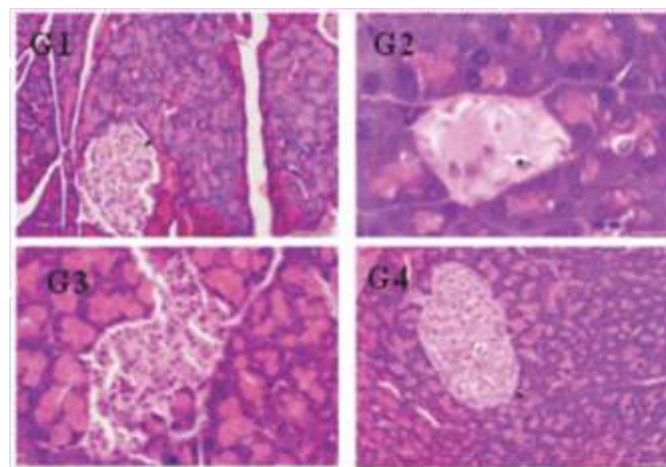


Fig. 104 C Pancreatic Islet of langerhans

INDUSTRIAL DIMENSIONS OF CSIR-IHBT

BUSINESS OUTREACH OF CSIR-IHBT

AN UNIQUE AUTOCLAVABLE SUPER OXIDE DISMUTASE (SOD) ENZYME

The technology developed on the production of an unique autoclavable Super Oxide Dismutase (SOD) enzyme was transferred to M/s Phyto Biotech, Kolkata through an MoU signed on the Transfer of Technology on 3rd April, 2014.

THE AGREEMENT

- **CSIR-IHBT:** Provide the know-how and technical support for large scale production of pure SOD
- **M/s Phyto Biotech, Kolkata:** Commercially manufacture and market the autoclavable SOD

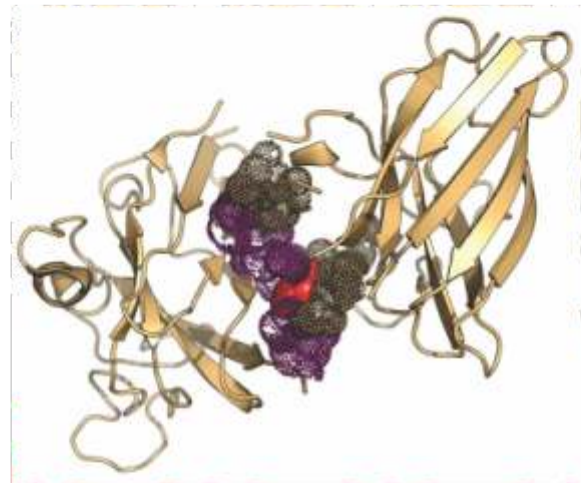


Copies of agreement being exchanged between Mr. Arun Mohita of M/s Phyto Biotech and Dr. P.S. Ahuja at CSIR-IHBT, Palampur

THE UNIQUENESS OF THE SOD ENZYME DISCOVERED AT CSIR-IHBT

- The Cu, Zn SOD was obtained from the plant, *Potentilla atosanguinea* Lodd. var. *argyrophylla* (Wall. ex. Lehm.)
- The plant grows at an altitude of about 4,500 m in the cold deserts at Kunzum Pass (HP).
- Like all SODs, it catalyzes the dismutation of toxic superoxide radicals ($O_2^{\cdot -}$) to molecular oxygen and hydrogen but at temperatures ranging from sub-zero to $>50^\circ\text{C}$.
- It retains its activity even after autoclaving (i.e., heating at temperature of 121°C and pressure of 1.1 kg per square cm for 20 min).
- Crystal structure of the protein showed that unlike all other SODs where Gly is

conserved at position 10, the Gly in the SOD from *P. atrosanguinea* (Pa-SOD) was substituted by Ser. Moreover, the accessible surface area on dimer formation is also the lowest to date (2.16), indicating the smallest gap within the SOD dimer. The percentage of nonpolar atoms in Pa-SOD was also the highest amongst structurally described Cu, Zn SODs.

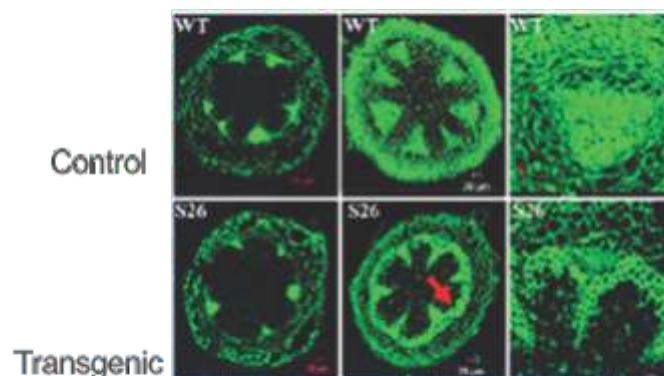


Crystal structure of the SOD enzyme

These intriguing structural features may be responsible for its increased hydrophobicity, thermostability and higher range of Pa-SOD activity.

The journey from discovery to market

- *Pa-SOD* SOD gene was isolated from the cold desert plant, *P. atrosanguinea*; expressed in *E. coli* for its *ex situ* production such that the enzyme thus produced retained the same unique features as that of the native plant.
- Pa-SOD was over-expressed in plant systems such as arabidopsis and potato to show enhanced stress tolerance through the up-regulation of lignin biosynthesis pathway. The potato transgenics showed improved nitrogen content, significantly higher net photosynthetic rate, improved rooting and shoot health, and also better tuber yield as compared to the control.
- The thermostability of the Cu, Zn SOD was increased by modulating the kinetic properties of the enzymes through single amino acid substitution. Cys-95 was replaced with Ala. Subsequent increase in the monomer to dimer ratio to 33 fold in C95A as compared to wild type enhanced the thermostability of the protein significantly. Increased thermostability was due to reduced irreversible denaturation in the mutant as evidenced by CD data.



Increased lignification in transgenic arabidopsis expressing PaSOD

Implications of the technology

SOD enjoys high demand and handsome price in the global market due to its high antioxidant properties and multiple uses. The SOD-based formulation can be used by:

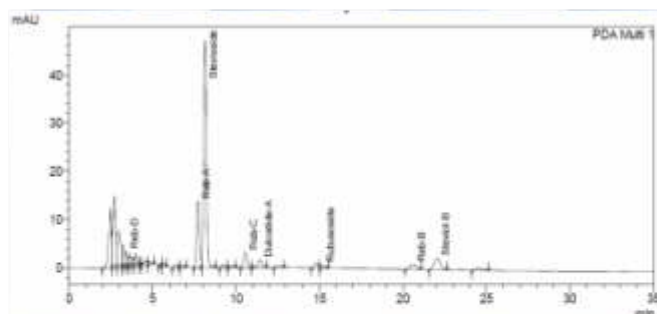
- Cosmetic industry for anti-ageing creams
- Food industry for extending shelf life of fruits and vegetables
- Medical industry during cryo-surgery and preservation of organelles

Other technologies / products ready for transfer

CSIR-IHBT is committed to bridge the gap between academia and industry, and to put its scientific knowledge, expertise and skills for the benefits of different sections of the society. Mostly green processes are being used for the extraction and production of natural products from plants which includes flavours, fragrances, essential oils, hydrosols, high intensity natural sweeteners, natural colours and dyes, rutin, aescine etc. Specific equipments and tools have been also developed for different operations. The infrastructure created in the institute is also being used to serve the needs of the industry by providing scientific and technical backup.

STEVIOL GLYCOSIDES (SGs)

- SGs are low calorie high intensity sweeteners used in food and beverages.
- CSIR-IHBT has developed a simple, eco-friendly green process for extracting total steviol glycosides (SGs) with a purity of $\geq 95\%$ from *Stevia rebaudiana* leaves.



Product containing >95 % SGs and its HPLC characterization

Salient features of the technology

- Green technology where there was no use of hazardous/toxic solvents
- Yield: 9-10 %
- Product meets the JECFA specifications
- Cost effective process
- Process patented in Vietnam and South Korea.

Product developed using SGs as alternate sweetener

- Table top sweetener 'HIM Stevia'
- Ready to drink tea 'Tea Fizz'



**Ready to drink tea (RTD)
sweetened with SGs powder**



**Table top sweetener
'HIM Stevia' sachet**



**Table top sweetener
'HIM Stevia' pouch pack
(30 pouches of 1 g each)**

TEA PRODUCTS

Ready to drink tea (RTDs)

- Developed from secondary grade green and black tea, and contains 50 mg/150 ml and 25 mg/150 ml catechins, respectively.
- The concentrate can be diluted to make hot or cold beverage with water or carbonated water.
- It has more than 6 months' shelf-life at 4 °C.
- It can be sweetened with sugar/low calorie sweeteners, and served chilled with a flavour of choice.
- Tea concentrates can be mixed with fruit concentrates for novelty and value addition.





Tea wines

- Low alcoholic health beverages prepared from secondary/low grade teas with or without seasonal fruits.
- The secondary/low-grade teas are fermented in specially designed food grade HDPE barrels to produce wines containing 12-15 % alcohol.
- These wines aged for 8-12 months in a protected hygienic environment preserve all the health benefits of tea.
- Tea wines have distinct aroma and flavour characteristics.

← Tea wines prepared from secondary grade black tea and locally available wild fruits

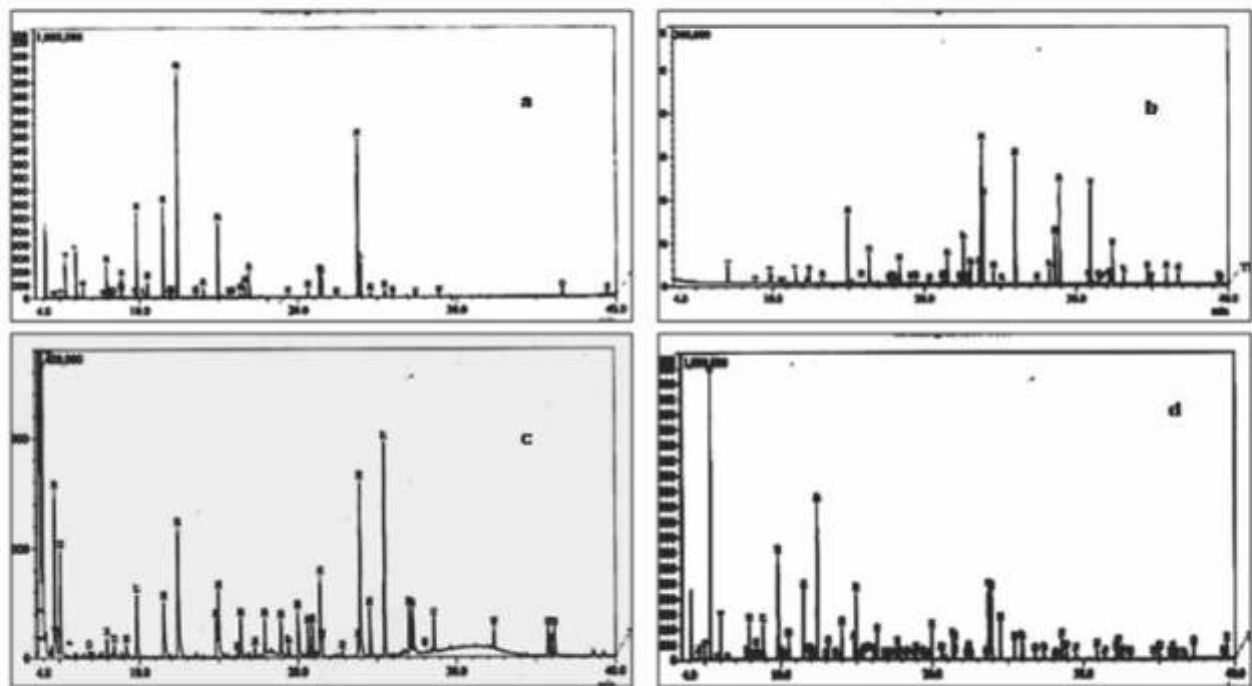
Tea polyphenols and theaflavins

- Wide application as nutraceuticals, food preservatives, and food colorants.
- Extracted from underutilized parts of the tea plant, mainly flowers and mature shoots, using green solvents, concentrated, purified and spray dried.
- Tea polyphenols contain 60-70 % catechins.
- Theaflavins are orange coloured tea pigments formed from polyphenols during black tea manufacture.
- These are dimeric products of catechins with high antioxidant activity.
- The purified tea polyphenols are treated with PPO enzyme to produce theaflavins.
- The theaflavins thus formed are purified and spray dried.



Tea aroma

- The volatile aroma components (up to 0.01 %) were extracted from secondary/low grade orthodox black tea.
- Aroma concentrate from infused leaf was fractionated to give different top notes for use in perfumery, food and beverage flavouring, and personal care products.



GC profiles of different fractions of Kangra orthodox black tea aroma showing volatile components

Tea based herbal mouth freshener

- Mouth freshener is based on tea and Himalayan flora with known anti-dental caries properties.
- The antioxidant activity is due to catechins, 4-terpineol, 1,8-cineole, and linalool, 2-undecanone.

The freshener has a shelf-life of more than 6 months at ambient temperature.



Different products and processes were developed using dietary fibre from apple pomace

- A process for extraction of dietary fibre.
- Extruded snacks from dietary fibre.
- A prototype for mechanical removal of seeds at industrial scale from pomace (Patent publication no. WO/2013/069028).
- Edible apple seed oil with 15-20 % yield. It has good health properties owing to presence of linoleic acid (PUFA).



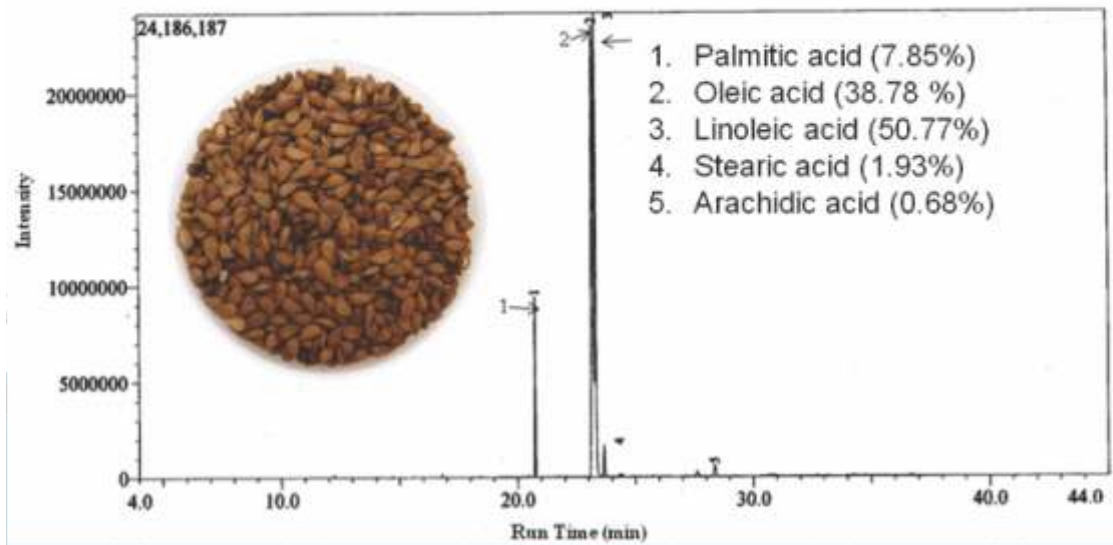
Prototype for seed separation



Dietary fibre



Extruded snacks prepared from developed dietary fibre



GC-MS chromatogram of apple seed oil

Value added food products from buck wheat and mango

- Buck wheat based "Laulipuff"-healthy snacks and nutribar.
- A package for production of buckwheat based extruded snacks.
- Nutritionally enriched- mango bar for combating malnutrition among children and women.



Nutritionally enriched- mango bar



"Laulipuff"-healthy snacks and nutribar

Natural colours using green technology

Product developed employing natural colours



Tea Fizz fortified with anthocynins

A technology for producing highly water soluble, crystalline natural colours with better shelf life was developed using green technology. These colours show better consistency in quality.

Salient features of the technology

- Non-hygroscopic crystalline product
- Readily soluble in water and alcohol
- Improved stability and shelf life
- Green and cost effective process
- Safe for human consumption
- Patented technology (Patent filed: WO/2010/10986)

Essential oils, perfumes and flavouring compounds

- Essential or volatile or ethereal oil was extracted from various plant parts and resinous exudates.
- Each essential oil is a complex mixture of many compounds and in some case it is more than 250 single compounds.
- These can be used in perfumery, aromatherapy, cosmetics, incense, for flavouring food and beverages, health care and household cleaning products.



Essential oils produced on pilot plant at CSIR-IHBT Palampur

- **Rose water and rose oil**

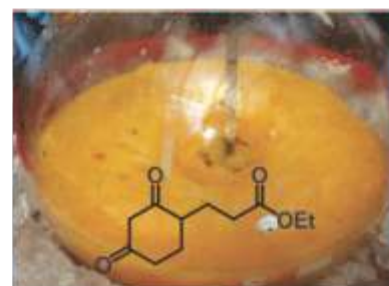
- Rose oil and rose water were produced from freshly plucked flowers of *Rosa damascena* (damask rose)
- Its main constituents are citronellol, geraniol, phenylethyl alcohol, linalool, rose oxides and stearoptenes.
- The products can be used in perfumery, skin care, foods and cosmetics, and are available at competitive prices.
- Complete technology packages on damask rose cultivation and production of rose oil and rose water are available.



Himalayan rose water produced from Damask rose flowers

Large scale production of substituted cyclohexane-1, 3-dione

- A large scale process for substituted cyclohexane-1, 3-dione synthesis from un-substituted or substituted acetone and α, β -unsaturated esters was developed.
- Substituted cyclohexane-1,3-diones are the basic units found in several natural products, bioactive alkaloids and acridine dione type heterocycles, polyphenols and unnatural amino acids.
- Potent herbicidal and pesticidal active molecules contain cyclohexane-1,3-dione derivatives.
- This facile, atom economic and one-pot process for the synthesis of the intermediate is highly important in the area of organic synthesis.



Substituted cyclohexane-1,3-dione

VIRAL DIAGNOSTICS

ELISA based diagnostic

- A rapid cost effective and reproducible ELISA based diagnostic kit was developed for early detection of various apple and cherry viruses (*Apple mosaic virus (ApMV)*, *Apple stem pitting virus (ASPV)*, *Apple stem grooving virus (ASGV)*, *Apple chlorotic leaf spot virus (ACLSV)*, *Prunus necrotic ringspot virus (PNRSV)*, *Cherry virus A (CVA)*, *Cherry necrotic rusty mottle virus (CNRMV)*).
- Facilitates diagnosis of virus infection at nursery level for selection of quality plants with minimal virus titre and infection.



Two step multiplex RT-PCR for simultaneous detection of viruses

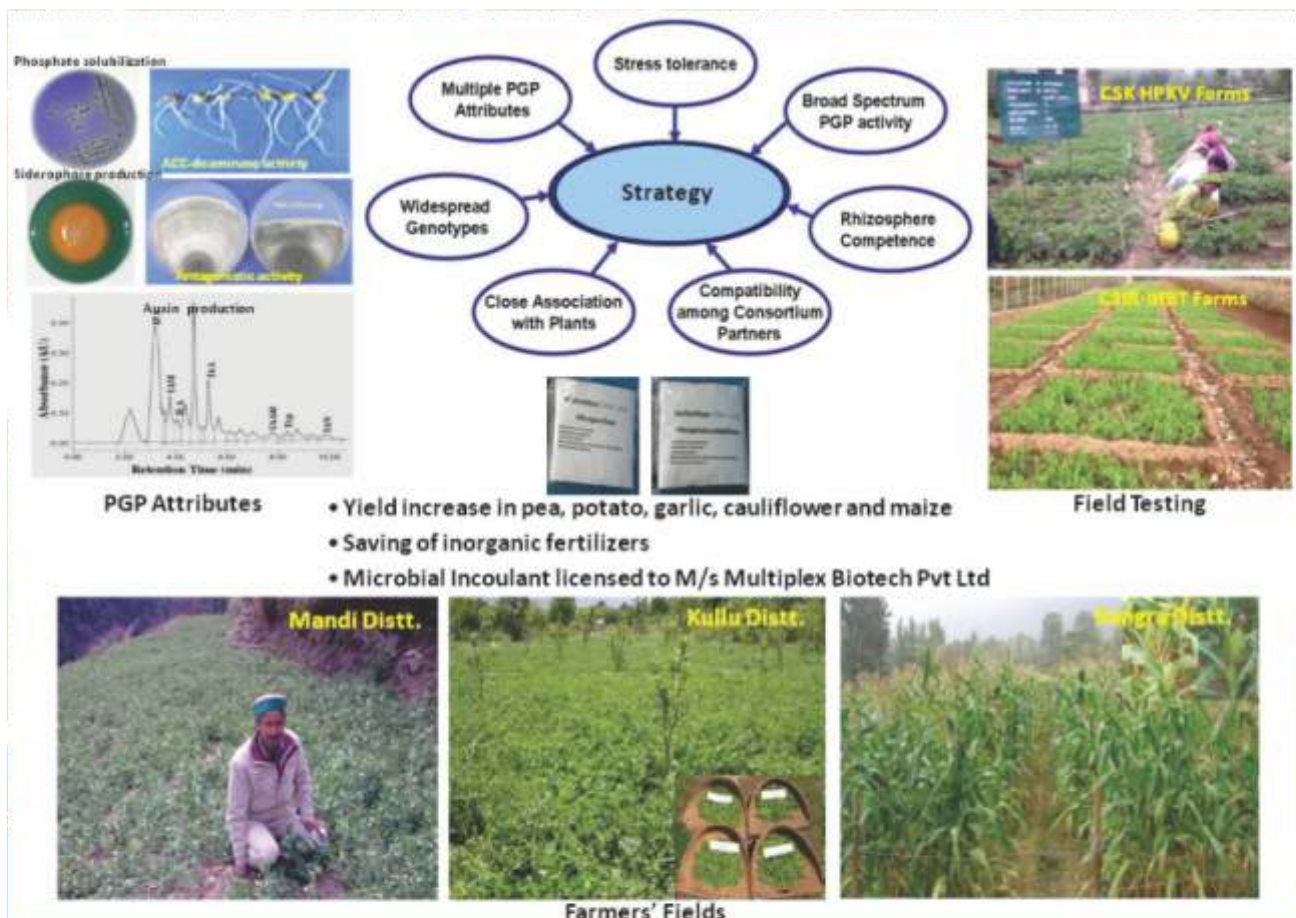
- Simultaneous detection of viruses of apple [*Apple mosaic virus (ApMV)*, *Apple stem pitting virus (ASPV)*, *Apple stem grooving virus (ASGV)*, *Apple chlorotic leaf spot virus (ACLSV)*] and *Apple scar skin viroid (ASSVd)* and four cherry viruses: *Cherry virus A (CVA, Genus; Capillovirus)*, *Cherry necrotic rusty mottle virus (CNRMV, unassigned species of the Betaflexiviridae)*, *Little cherry virus 1 (LChV-1, Genus; Closterovirus)* and *Prunus necrotic ringspot virus (PNRSV, Genus; Ilarvirus)*
- The kit is useful for the detection of viruses from single or multiple infections of stone and pome fruits.
- It has applications in virus indexing, plant quarantine and certification programs.
- Primers for the above assay for apple and cherry viruses are available for anyone who wishes to carry such diagnostics.

MICROBIAL INOCULANTS FOR IMPROVING AGRICULTURE PRODUCTIVITY

The application of plant growth-promoting bacteria has attracted worldwide attention for improving agriculture productivity. The successful outcome of their application depends on the selection of efficient strains with multiple plant growth promoting activities. Solubilization of inorganic phosphates is one of the key mechanisms of rhizobacteria directly affecting the soil fertility. Accordingly, the institute focused on the selection of stress-tolerant and rhizosphere-competent strains with multiple and broad-spectrum plant growth-promoting attributes.

Salient Features

- Efficient phosphate-solubilization
- Production of plant growth hormones
- ACC-deaminase activity for breakdown of ethylene responsible for reduced root growth
- High antagonistic activity to fungal pathogens
- High stress tolerance against desiccation, alkalinity, salinity and calcium salts
- High rhizosphere competence for establishment in the rhizosphere
- High root nodulation and nitrogenase activity by rhizobial strain
- Enhanced growth and yield in different crops-pea, potato, brinjal, tomato and garlic
- Reduced application of inorganic fertilizers





CSIR 800 PROGRAMME FOR RURAL DEVELOPMENT

EXTENSION AND ADVISORY SERVICES

Farmers' Training-cum-Orientation Workshop series: Medicinal, aromatic, cut flower and bamboo plantations offer crop diversification opportunities in the state of Himachal Pradesh. Therefore, dedicated series of Training-cum-Orientation Workshops were organized on the cultivation, value addition, utilization and marketing of medicinal, aromatic, cut flower crops and bamboo plantations at CSIR-IHBT, Palampur. The course module of 3 days was conducted in 9 batches through September 2013 to March 2014 for beneficiaries of District Watershed Development Agency, District Shimla HP. The participating 9 groups of farmers were from Theog, Rampur and Basantpur Development blocks of district Shimla, HP. A total of 156 trainees from rural area participated in the Training-Cum-Orientation workshop.

Farmers field visits series: A total of 153 farmers from Shimla and Kinnaur districts of HP and Reasi, Srinagar and Jammu districts of Jammu & Kashmir (J&K) visited the institute in seven different groups through May 2013 to March 2014. Scientists and technical staff of the institute provided them fully guided access to demonstration fields, nursery facilities, bamboo museum and processing units for exposure and awareness about the subject.

Field training to farmers from Afghanistan: One day training-cum-field demonstration on "Production of perfume from flower crops and commercial floriculture" was conducted on 05.07.2013 at CSIR-IHBT, Palampur for 7 farmers from Afghanistan.

Field survey and advisory services: Eight Village Panchayats (VPs) consisting of 12 villages in 'Bhawarna Development Block' of Kangra district of HP were targeted. Apart from the regular staff, 32 research scholars divided into 8 groups with each group comprising of 4 research scholars participated in the extension activities of the institute. The groups were deployed in these VPs, viz., Bagoda, Kalund, Balla, Rakh, Chachiyan, Gopalpur, Drati, Darognu and Thalla for studying characteristics such as population composition, health, sanitation, agriculture, livelihood options, environment, income source, nutrition, woman and child related issues of the VPs. Base line surveys of the VPs were completed and advisory services were extended on medicinal, aromatic, commercial floriculture, bamboo plantations and utilization of local flora. Afforestation work was also done in these 12 villages and 1000 saplings of *Phyllostachys edulis* (moso bamboo), *Populus deltoides* (800), *Terminatia chebula* (200), *T. bellirica* (200) and *Robinia pseudoacacia* (400) were planted.

Registration of local farmers: Local rural beneficiaries, entrepreneurs and farmers were registered in the CSIR rural technologies and its extension programs as per their willingness, round the year. Entrepreneurs and farmers were registered for trainings; visit to the institute and regular field advisory services. A total of 341 number of rural beneficiaries and farmers were registered during the financial year and about 1800 registrations were completed till date.

Setting up of Demonstration Plots:

Marigold: A demonstration plot was established on the production of marigold (*Tagetes*

erecta) cut flowers at the farmer's field at Gopalpur, Palampur on Sept 20, 2013 on area of 50 m². The planting material and know how was also supplied. All standard package of practices of marigold cultivation were followed till the harvesting. Seeing the success of the project, the farmer was convinced to adopt marigold flower cultivation in future.



Transplanting of marigold plot by farmer's family

Damask rose: Demonstration plot setup on damask rose plantation 3 years back resulted in a good harvest of scented flowers at Kandwari village, near Palampur. The flowers were used for rose water production using the HerboStill[®] developed at CSIR-IHBT. Although CSIR-IHBT had provided the requisite facility for the distillation of rose water during the first year of flowering, the grower installed the mini oil distillation unit on his own at his field.



HerboStill[®] in operation of rose water distillation

Damask rose demonstration field adjoining the Dharamshala Tea Estate, Daddi started producing scented rose flowers which were then used for making blended organic rose tea and herbal tea.



Damask rose field view at Dharamshala Tea Estate Daddi

Wild marigold: *Tagetes minuta* cultivar, Himgold of CSIR-IHBT and its essential oil producing techniques were provided to interested growers. Seeds were also provided to them. One grower from Kannauj district of Uttar Pradesh and Anni village produced a total of 200 kg Tagetes oil during November 2013 to March 2014 using the CSIR-IHBT technology.

Major essential oil compounds of wild marigold cultivated in northern plains

Component	%
Limonene	2.66
(Z)- β -Ocimene	33.89
Dihydrotagetone	13.15
E-Tagetone	3.07
Z- Tagetone	12.29
Z- Ocimenone	4.00
E- Ocimenone	6.34



Field view of *Tagetes minuta* cultivation at farmer's field

Large Cardamom:

About 950 plants of large cardamom were supplied to enthusiastic farmers and growers in Kangra district of HP

Training Programmes

Trainings on various aspects of cultivation, management and value addition of Himalayan Bioresources were imparted by the institute.

- Trainings on "Methods of bamboo propagation and utilization" were imparted to three batches of trainees from Forest Dept. (J&K and HP). Participants: 101.





- Training-cum-workshop on “Bamboo propagation and utilization” was organized for officials of HP State Forest Department on April 26, 2013. Participants: 44, Co coordinator Dr. Anil Sood.
- Training on “Improved production technologies for natural sweetener plant stevia” was organized from May 7-8, 2013. Participants: Two industrialists of Green Korf Pvt. Ltd., Mumbai, India.
- Training on “Technologies for entrepreneurship and rural development” was organized at the Summer Festival at District Administration, Dharamshala, HP, May 26-28, 2013, Faculty: Dr. Markandey Singh and Mr. Sanjay Kumar.
- Training on “Commercially important cut-flower crops” was organized at Kangra, Himachal Pradesh, June 26, 2013, Faculty : Dr. Raja Ram and Mr. Sanjay Kumar.
- Training on “Bamboos” was organized for officials of State Forest Department from Kerala & J&K August 08, 2013. Participants: 29, Co coordinator Dr. Anil Sood.
- Training on “Methods of bamboo propagation” was organized for persons from Forest Department, Sundernagar HP on September 23, 2013. Participants: 27.

Training-cum-orientation workshop on “Medicinal, aromatic and floriculture plant production and utilization techniques” under “Sustainable utilization of regional bioresources for enhancing livelihood options” was imparted to rural community participants from Theog, Rampur, Narkanda and Mashobra Development Blocks of district Shimla (HP) on September 3-5, 2013 and September 11-13, 2013; Sponsored by District Watershed Development Agency, District Shimla (HP).



- A training programme on “Mushroom cultivation, a viable option for supplementing income” was organized on September 6, 2013 at Gopalpur Panchayat. Coordinator & Faculty RK Sud, Virendra Singh and Jitendra Pal.
- A training programme on “Value added edible bamboo products” was organized at the institute on September 10, 2013. Participants: 25 ladies from Gopalpur panchayat were given training for making bamboo candies.
- A training programme on “Making of bamboo candies” was organized at CSIR-IHBT for

women of TECHVIL region. Faculty: RK Sud, Virendra Singh, Anil Sood and Mahesh Gupta. September 10, 2013.



- A training programme on "Management tea plantations for improving their productivity and quality" was organized for small tea growers of HP at Chaugan, Bir on September 27, 2013. Sponsored by Tea Board of India. Faculty: RK Sud.
- Trainings were imparted on "Management tea plantations for improving their productivity and quality for small tea growers of HP in association with Tea Board of India on September 17, 2013, January 22, 2014 and January 24, 2014 at village Chaugan, Deogram and Chobin, respectively. Participants: 40.
- Trainings on "Tissue culture" were imparted to Ms. Sarita Kopra from Chamba (September 23, 2013 to October 05, 2013) and Mr. Ashwani Bhardwaj, JRF from DRDO, Delhi, (September 23, 2013 to October 05, 2013). Co coordinator Dr. Anil Sood.
- Training cum orientation workshop on "Sustainable utilization of regional bioresource for enhancing livelihood options on medicinal, aromatic and floriculture plant production and utilization techniques to rural community" Participants from Theog, Rampur, Narkanda and Mashobra Development Block of District Shimla, HP. Sponsored by District Watershed Development Agency, District Shimla, HP from Oct 03-05, Nov 19-21, Dec 3-5 & 17-19, 2013 and Jan 7-9, 2014. A practical demonstration on essential oil production was given at CSIR-IHBT campus.





(अतिथीय रसगंध एवं युवा चौधा उत्पादन प्रौद्योगिकी)
से फरवरी 2014 के दौरान प्रत्येक 3 दिन के कुल 9 बैच पर
प्रायोजक
श्री. जलाजम विकास अभिकरण, जलपद शिमला (हि.प.)
आयोजक
श्री. एस. आर्. आर.- हिमालय जेवरसंपदा प्रौद्योगिकी संस्थान पालनपुर



- Trainings on "General cultivation practices of commercially important floricultural crops suitable for Bilaspur district, HP" were imparted at Department of Horticulture, HP at Harlog, Bilaspur, October 29, 2013, Faculty : Dr. Raja Ram and Mr. Sanjay Kumar.
- Delivered a lecture on "Bamboos" to the participants from Rampur & Srahan area, Shimla (HP), November 20, 2013. No. of Participants: 14. Co coordinator Dr. Anil Sood.
- Delivered a lecture on 'Bamboo' to the participants from Theog, Rampur, Narkanda & Mashobra area of Shimla hills (HP), December 17, 2013, No. of Participants: 25. Co coordinator Dr. Anil Sood.



- Delivered a lecture to the Officials of Forest Department of Hamirpur and farmers of district Hamirpur, (HP), January 03, 2014. No. of Participants 50. Co coordinator Dr. Anil Sood.
- Training to farmers of Shimla, Theog, Rampur (HP). January 08, 2014. No. of Participants: 30. Co coordinator Dr. Anil Sood.
- Training on "Pruning programme for improving productivity and quality of Kangra tea" was organized for small tea growers of HP by Tea Board of India on January 22, 2014 at village Deogram, Palampur. Faculty: Dr. RK Sud.
- Training on "Pruning and skiffing programme for improving productivity and quality of Kangra tea" was organized for small tea growers of H.P by Tea Board of India on January 24, 2014 at village Chobin, Baijnath. Faculty: Dr. RK Sud.
- Awareness on "Technopreneur promotion programme" as a part of "Training-cum-orientation workshop on sustainable utilization of regional bioresources for enhancing livelihood options" March 11-13, 2014 at CSIR-IHBT, Palampur. Faculty: RK Sud.

Two training-cum-orientation workshops were conducted on "Sustainable utilization of regional bioresource for enhancing livelihood options" from March 11-13 and 25-27, 2014. A



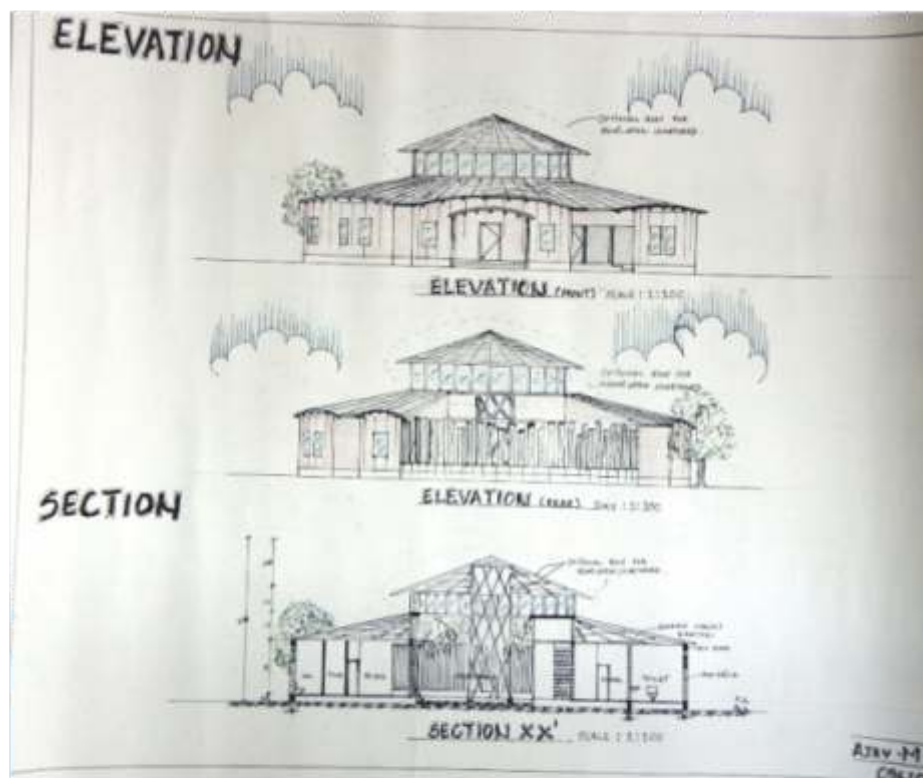
- Three days training workshop on "Bamboo propagation and utilization" for the officials of the J&K Agriculture State Department, March 17-19, 2014. No. of Participants: 28. Co coordinator Dr. Anil Sood.

- Awareness on “Technopreneur promotion programme” as a part of the “Training-cum-orientation workshop on sustainable utilization of regional bioresources for enhancing livelihood options”, March 18-20, 2014 at CSIR-IHBT, Palampur. Faculty: RK Sud.
- Two days training workshop on “Bamboo propagation and utilization” for the officials of the HP Forest Department from Hamirpur (HP), March 21-22, 2014. Participants: 36. Co coordinator Dr. Anil Sood
- Awareness on “Technopreneur promotion programme” as a part of the “Training-cum-orientation workshop on sustainable utilization of regional bioresources for enhancing livelihood options”. March 25-27, 2014 at CSIR-IHBT, Palampur. Faculty: RK Sud.
- Three days training workshop on “Bamboo propagation and utilization for the Officials of the J&K State Forest Department and farmers, March 29-31, 2014. No. of Participants: 33. Co coordinator Dr. Anil Sood.

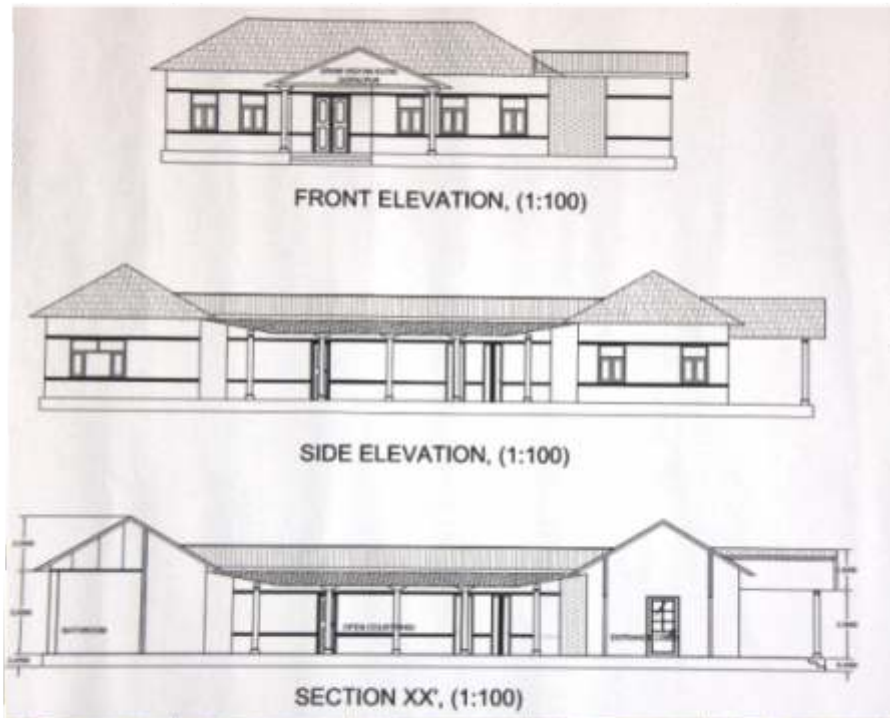
Contest for designing an appropriate Gram Vigyan Kutir

A contest was organized among the architectural students of NIT Hamirpur for proposing a suitable design for a Gram Vigyan Kutir (village science centre). It was desired that the GVK should be built frugally with local resources but in an eco-friendly and innovative manner. The GVK also had to be context-specific in order to blend with its natural environment. .

Forty designs (33 from individuals and 7 in the form of groups, where each group consisted of 4-7 students) were received. The winners of the first, second and third designs were given appreciation certificates and cash awards of Rs. 15,000, Rs. 10,000 and Rs. 5,000, respectively. All participants were given the participation certificates.



First Prize Winner Mr. Ajay. M. Mathai



Second Prize Winner-Mr. Rohit



Third Prize Winner

Group of the following

**Mr. Ajay. M. Mathai, Mr. Manu Yadav, Mr. Prosanta Das, Mr. Sandeep Deb,
Mr. Santosh Kumar, Mr. Vikrant Chauhan, Mr. Sidhant Srivastava**



FACILITIES AND S & T SERVICES

State of the art facility at pilot plant

A pilot scale thin film, spinning cone evaporator particularly suited for the concentration of heat-sensitive, valuable and viscous products was installed at pilot plant of CSIR-IHBT. It offers an exceptionally short residence time, less thermal impact and much greater processing flexibility than traditional rising or falling film evaporators. The other utilities including chiller and boiler were also commissioned.



The pilot scale thin film, spinning cone evaporator installed at CSIR-IHBT

State-of-the-art facility of high throughput DNA sequencing

A third generation DNA sequencing-PacBio RS II System was installed at Biotechnology division. The technology is based on Single Molecule Real Time Sequencing (SMRT). This facility will be used for high throughput sequencing studies on genomes, transcriptomes and methylomes of Himalayan bioresources. The equipment will also benefit other universities/institutes. This third generation sequencing system was commissioned successfully.



PacBio RS II System

S&T services rendered

- Seven potato samples from M/s Mahindra Shubhlabh, Palampur were tested for *Potato virus Y*, *Potato virus X* and *Potato virus S*.
- About 350 kg rose flowers harvested from the garden of a local grower, Mr. B.B.L Butail were processed at Pilot Plant for production of rose water.
- Lemongrass weighing 568.2 kg on fresh weight basis was supplied by a farmer from Jaisinghpur for steam distillation on Pilot scale. This technical service was also rendered to the local farmers to facilitate processing of their harvest for value added products.

- Two batches of fresh ginger rhizomes weighing 19.3 kg and 10 kg were distilled in HerboStill™ and the process was demonstrated to the staff members of DST, Govt. of India.
- *Tagetes minuta* weighing 186 kg supplied by Mr. Ravinder Pal, a local farmer from village Bir, Teh. Baijnath was distilled on mobile distillation.
- Bark of Arjuna (*Terminalia arjuna*) and pericarps of Haritaki (*Terminalia chebula*) supplied by M/s Baijnath Pharmaceuticals (P) Ltd., Paprola were hydro extracted on laboratory scale as per the protocols of Ayurvedic Pharmacopoeia of India (Part-I, Volume-III, First Edition) to optimize the various process parameters.

Establishment of a plant tissue culture lab

A tissue culture lab was established at village Juthed for M/s AK Biotech Pvt. Ltd in a very remote corner of Distt. Chamba. The project included redesigning of the existing infrastructure, providing list of requisite equipments and their suppliers, supply of mother cultures for initiating the work and trouble shooting. The personnel involved in the project were trained in tissue culture procedures and multiplication of the targeted species.



Plant tissue culture lab of M/s AK Biotech Pvt. Ltd at village Juthed, Chamba
(A) autoclave (B) multiplied cultures of targeted species

राजभाषा गतिविधियां

पश्चिमी हिमालय क्षेत्र में आर्थिक महत्व की जैवसंपदा के आधार पर मूल्यवर्धित पौधों, उत्पादों तथा प्रक्रमण विधियों द्वारा औद्योगिक, सामाजिक और पर्यावरणीय लाभ हेतु शोध एवं विकास सेवाएं प्रदान करने के लक्ष्य के साथ-साथ संस्थान भारत सरकार की राजभाषा नीति के कार्यान्वयन एवं हिंदी भाषा के माध्यम से विज्ञान के प्रचार-प्रसार में सतत प्रयासरत है। इस दिशा में संस्थान अपने अनुसंधान एवं विकास से संबंधित विविध आयामों पर हिंदी में संसाधन सामग्री भी तैयार करता है। राजभाषा हिंदी को बढ़ावा देने हेतु संस्थान कई प्रकार के कार्यक्रमों का भी आयोजन करता है। अपने शोध को आम लोगों, किसानों व उद्यमियों तक पहुंचाने के लिए समाचारपत्रों, पत्रिकाओं, रेडियो तथा दूरदर्शन के माध्यम से राजभाषा हिंदी में पहुंचाना भी संस्थान का लक्ष्य है। संस्थान ने जो कृषि तकनीकें विकसित की हैं उनको किसानों एवं उद्यमियों तक पहुंचाने के लिए न केवल प्रदेश अपितु अन्य राज्यों में भी प्रशिक्षण कार्यक्रम राजभाषा हिंदी के माध्यम से किए जा रहे हैं। वर्ष 2013-14 की प्रमुख उपलब्धियां निम्न प्रकार से हैं:

“आई.एच.बी.टी. संवाद” तिमाही ऑनलाइन पत्रिका

संस्थान ने रजत जयंती वर्ष के उपलक्ष्य में एक ऑनलाइन तिमाही न्यूजलेटर शुरू करने का निर्णय लिया था। इसी क्रम में अब तक इसके 20 अंक संस्थान की वेबसाइट में उपलब्ध हैं।

वेबसाइट अद्यतनीकरण

संस्थान की हिंदी वेबसाइट का अद्यतनीकरण किया गया तथा सामग्री को यूनिकोड में करके संस्थान वेबसाइट पर उपलब्ध है।

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 हिंदी में मूल रूप से कार्य करने को प्रोत्साहित करने के लिए हिंदी में प्रकाशित सहायक सामग्रियों जैसे पुस्तकें, कोश, पत्रिकाएं और अन्य संदर्भ साहित्य संस्थान में उपलब्ध करवाया जाता है।

संस्थान में वैज्ञानिक एवं सामान्य विषयों पर विभिन्न हिंदी पत्रिकाओं को उपलब्ध कराया गया है। इसके अतिरिक्त विभिन्न प्रयोगशालाओं/संस्थानों द्वारा प्रकाशित पत्रिकाओं को भी संस्थान में उपलब्ध कराया गया। इस वर्ष संस्थान ने रु. 70000 /- से अधिक मूल्यों की पुस्तकें खरीदी। साथ ही श्री शांता कुमार, माननीय सांसद, राज्यसभा ने संस्थान को रु. 50000 /- मूल्य की पुस्तकें संस्थान को भेंट की।

प्रशासनिक कार्यशाला

19.09.2013 संस्थान के प्रशासनिक कर्मचारियों को राजभाषा में कार्य करने के लिए प्रोत्साहित करने के लिए एक कार्यशाला का आयोजन किया गया जिसमें सीएसआईआर मुख्यालय के वरिष्ठ हिंदी अधिकारी डा. पूरनपाल ने अपने प्रेरणादायी संबोधन से सभी को राजभाषा हिंदी में कार्य करने के लिए प्रेरित किया।

संस्थान में राजभाषा नीति के अनुपालन से संबंधित कार्य के निरीक्षण के लिए संसदीय राजभाषा समिति की दूसरी उपसमिति की 28.5.2013 को मनाली में बैठक हुई। इस बैठक में माननीय सांसद एवं उपाध्यक्ष, संसदीय राजभाषा समिति श्री सत्यव्रत चतुर्वेदी ने संस्थान द्वारा किए गए कार्यों का निरीक्षण एवं समीक्षा की तथा जिन कार्यों में कमी रह गई थी, पर ध्यान देने के लिए कहा। बैठक की समाप्ति पर माननीय सत्यव्रत चतुर्वेदी ने संस्थान के निदेशक को संसदीय राजभाषा समिति के प्रतिवेदन पर राष्ट्रपति के आदेशों की संकलन पुस्तिका को भेंट किया। इस अवसर पर संसदीय राजभाषा समिति के सचिव डा. श्री शुक्ल भी उपस्थित थे। संस्थान की ओर से समिति को 15 आश्वासन दिए गए तथा संस्थान ने



श्री सत्यव्रत चतुर्वेदी (दाँए)
डॉ पी एस आहूजा (बाँए)

उन सभी पर कार्यवाही करके रिपोर्ट परिषद मुख्यालय के माध्यम से संसदीय राजभाषा समिति के सचिवालय में भिजवा दी है। संस्थान की ओर से डा. परमवीर सिंह आहूजा, निदेशक; डा. आर. डी. सिंह, मुख्य वैज्ञानिक; श्री जगदीश पराशर, प्रशासन अधिकारी तथा श्री संजय कुमार, वरिष्ठ अनुवादक उपस्थित थे। निरीक्षण के दौरान परिषद मुख्यालय की ओर से डा. कं. जय कुमार, संयुक्त सचिव (प्रशासन) तथा श्री रविन्द्र मेहमी, हिंदी अधिकारी उपस्थित थे।

लोकप्रिय विज्ञान लेखन तथा प्रकाशन

संस्थान की ओर से इस अवधि में 3 लोकप्रिय विज्ञान लेख "विज्ञान प्रगति" में तथा कुछ लेख दैनिक समाचार पत्रों में प्रकाशित हुए। संस्थान के वार्षिक प्रतिवेदन 2012-13 के लिए शोध एवं विकास गतिविधियों के सारांश का हिंदी में अनुवाद, संपादन एवं टंकण किया।

दूरदर्शन वार्ता

वर्ष के दौरान दूरदर्शन के दिल्ली, शिमला, जालंधर केन्द्र तथा स्थानीय चैनलों से विभिन्न कार्यक्रमों के अन्तर्गत वार्ताएं प्रसारित हुईं।

हिंदी दिवस समारोह

संस्थान में हिंदी दिवस समारोह के अन्तर्गत 14 सितम्बर 2013 को निदेशक महोदय ने अपना संदेश सभी स्टाफ सदस्यों को दिया।

हिंदी दिवस समारोह-2013 का मुख्य समारोह दिनांक 20 सितम्बर 2013 को संस्थान परिसर में आयोजित किया गया।

अपने स्वागत भाषण में संस्थान के वैज्ञानिक डा. आर.डी. सिंह ने हिंदी दिवस के आयोजन के उद्देश्य पर प्रकाश डालते हुए संस्थान की हिंदी संबन्धी गतिविधियों के बारे में विस्तार से बताया।

इस अवसर पर समारोह में मुख्य अतिथि डा. पूरनपाल, वरिष्ठ हिंदी अधिकारी, वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद, नई दिल्ली ने भारत सरकार की राजभाषा नीति के अनुपालन तथा हमारा दायित्व विषय पर विस्तार से जानकारी दी। इसके साथ ही उन्होंने संसदीय राजभाषा समिति के निरीक्षण के दौरान प्रश्नावली पर भी चर्चा की।

संस्थान के निदेशक डा. परमवीर सिंह आहूजा ने अपने संबोधन में संस्थान की गतिविधियों पर प्रकाश डाला तथा बताया कि कैसे संस्थान अपने शोध को सरल राजभाषा हिंदी में विभिन्न माध्यमों से जन-जन तक पहुंचाने का कार्य कर रहा है। उन्होंने वैज्ञानिकों तथा शोध छात्रों से आह्वान किया कि वे आने वाले समय में वैज्ञानिक उपलब्धियों को आम जनता तक पहुंचाने के लिए ज्यादा से ज्यादा हिंदी विज्ञान लेख लोकप्रिय पत्रिकाओं एवं दैनिक समाचारपत्रों में प्रकाशित करें। इस अवसर पर हिंदी टिप्पण प्रोत्साहन योजना के अन्तर्गत भी कर्मचारियों को पुरस्कृत किया गया।

संस्थान के प्रशासन अधिकारी श्री जगदीश पराशर ने धन्यवाद प्रस्ताव प्रस्तुत किया।

अन्य विविध कार्य

संस्थान द्वारा किये जा रहे शोध कार्यों को आम जनता तक पहुंचाने के उद्देश्य से समाचार पत्रों में विभिन्न लेख प्रकाशित किए गये। इसके साथ ही संस्थान द्वारा आयोजित किए जाने वाले विभिन्न समारोहों जैसे सतर्कता जागरूकता सप्ताह, कौमी एकता सप्ताह, सद्भावना दिवस, कार्यशालाओं के आयोजनों, निर्मत्रण पत्र, विज्ञापन, प्रेस नोट आदि को तैयार करने में भी अनुभाग ने सक्रिय योगदान दिया। संस्थान के प्रशासन के स्थापना तथा सामान्य अनुभागों के कार्यों में भी राजभाषा अनुभाग ने सहयोग किया।



श्री सत्यव्रत चतुर्वेदी का संबोधन



SUPPORT SERVICES

PROJECT PLANNING, MONITORING & EVALUATION CELL

- Compiled information on significant achievements of the institute for the CSIR Annual Report, and also submitted monthly reports to CSIR HQ.
- Developed a website for the Indian Fern Society and hosted it on IHBT web server to provide information about the society, its constitution, activities etc. The different issues of the Indian Fern Journal were also made available on the website.



- Information of 11 completed projects was included in the compendium, thereby, totaling the information of projects and their outputs to 162.
- The cell recorded the initiation of 7 new projects funded by various agencies.
- The institutional performance w.r.t publications, ECF, patents, technology transfers etc. were monitored on a regular basis.
- Maintenance of databases and information pertaining to project, staff, publication, patent, ECF, royalty, MoU, resource management etc. were updated on a routine basis.
- The 49th and 50th meeting of Research Council of CSIR-IHBT, Palampur were coordinated on 22nd June 2013 at CSIR Science Center, New Delhi and 11-12th November 2013 at CSIR-IHBT, respectively.
- The queries relating to project trainings were resolved and made necessary arrangements for imparting training to 60 winter and summer trainees.
- In order to encourage and nurture scientific temperament among young children, visits of students from schools and colleges were organized from time to time.
- Information on 13 cases under RTI Act was furnished, and quarterly reports were filed to RTI portal www.rti.gov.in.

- Different institutional functions such as National Technology Day, IHBT Foundation Day, CSIR Foundation Day and National Science Day were organized by the cell.
- CSIR-IHBT website (<http://www.ihbt.res.in>) and intranet portal (<http://ppme>) were regularly updated.
- In a joint activity of the Stores, Finance, Administration and PPME, various tasks were carried out under OneCSIR – Enterprise Transformation Portal for implementation of ERE

COMPUTER CELL

IHBT has campus wide network facilities for more than 350 data nodes over the fiber backbone with a fleet of servers from HP and IEM. A dedicated 1 Gbps leased line was provided under the National Knowledge Network for internet facility throughout the campus including hostel and faculty residences. LAN facility was further extended to the new Academic Block on optical backbone.

A virtual class room was successfully set up to help scholars to attend classes in real time and the faculty to take simultaneous “live” classes on line.

The institute is equipped with network security hardwares like Unified Threat Management Solutions, IDS, IPS, centralized anti-virus on client server based model and SMTP spam/virus protection software etc. Its policies are deployed to protect IHBT resources centrally.

Constant support was lent for in-house management of IHBT DNS (Domain Name Server), WEB, Email and Proxy servers on Linux. Video-conferencing with CSIR and other labs was also facilitated for discussing critical issues and taking decisions.

In addition to the above activities, the cell constantly extends services related to network, computers and peripherals over Local Area Network in the campus.

IHBT-KNOWLEDGE RESOURCE CENTRE (IHBT-KRC)

The Library houses books, e-books, Hindi books, bound volume journals, theses, compact discs and other documents in the field of Science and Technology and some other subject areas. This year, 234 books were added to the collection to make a total of over 14421. The library is fully computerized through the LibSys software which will be soon converted to KOHA software. The library can be easily accessed from anywhere in the world through its portal i.e., <http://library.ihbt.res.in>.

Library OPAC: The Online Public Access Catalogue (OPAC) can be accessed using the site i.e., <http://library.ihbt.res.in:8080/jopacv06/html/SearchForm>.

The institute is a member of the National Knowledge Resource Centre Consortium (NKRC). Thus, it is possible to access 2000+ e-journals of all major publishers, patents, standards, citations and bibliographic databases.

User orientation: The routine activity of orienting new users on the access of online journals and databases was continued for wide and effective use of resources.

Newspapers clippings: The library subscribes 16 newspapers in both Hindi and English, and includes eminent dailies such as Hindustan Times, The Tribune, Dainik Bhaskar, The Economic Times, Punjab Kesari, etc. The library also provides newspaper clippings on a blog



i.e., <http://ihbtinnews.blogspot.in/>.

In the year, the library was visited by 5352 visitors including scientists, students, research scholars and faculty members from several academic and R&D institutions. The library loaned 1285 books and other documents to its members during the year. Research work of scientists, research scholars and staff of the institute was facilitated through photocopying and laser printing services (>4.5. lakhs of pages).



IHBT newspaper clipping Blog (<http://ihbtinnews.blogspot.in>)

PHOTOGRAPHY UNIT

Comprehensive photographic and videographic services were provided for R&D activities of the Institute This included recording of research activities/results both in the labs as well as in the fields. In addition to these, the unit covers the activities of all the official functions, trainings, workshops, conferences and symposia organized in the institute. The highlights of the year include:

Design: The cover pages of the staff club magazine 'Manthan' and the Abstract book of the, Third National Symposium on Emerging Issues in Chitin and Chitosan Research' organized by CSIR-IHBT, Palampur and Indian Chitin and Chitosan Society (ICCS), 7-8th June, 2013 were designed along with the logo and information brochure. Pages on important events as well as the cover page of the Annual Report 2012-13 were conceived and designed. In addition to these, the Institute folder and the certificates of participation for various training programmes were designed.

Videography: Programmes such as those of the 'Third National Symposium on Emerging Issues in Chitin and Chitosan Research' Krishi Darshan of Shimla doordarshan, Plantation/revegetation of closed dumping sites of Parbati Hydro Electric project Stage-II of NHPC (10 in number) were recorded.

Documentary Film: The documentary film on CSIR-IHBT was made under the direction of Dr. Gauhar Raza, SCM-NISCAIR Production, New Delhi.

CSIR-IHBT YouTube: An account was opened on the YouTube for CSIR-IHBT, where seven short films on various research and extension activities of the institute were uploaded and maintained.



PATENTS, PUBLICATIONS, HUMAN RESOURCES AND PUBLICITY

PATENTS FILED

India

Anish Kaachra, Surender Kumar Vats, Paramvir Singh Ahuja and Sanjay Kumar (2014) A new energy efficient process for manufacturing of high quality green tea with enhanced flavor, 0190NF2012/IN dt. 10/02/2014.

Abroad

Rajesh Thakur, Anil Sood and Paramvir Singh Ahuja (2013) A bioreactor vessel for large scale growing of plants under aseptic conditions. 0013NF2012/WO dt. 01/08/2013.

Vijai Kant Agnihotri, Bikram Singh, Garikapati Dyva Kiran Babu, Gopi Chand, Rakesh Deosharan Singh and Paramvir Singh Ahuja (2013) Process for the modification of *Curcuma aromatica* essential oil, 0055NF2011/RU dt. 29/10/2013, 0055NF2011/EP dt. 14/08/2013, 0055NF2011/US dt. 20/08/2013, 0055NF2011/BR dt. 16/09/2013.

Anish Kaachra, Surender Kumar Vats, Paramvir Singh Ahuja and Sanjay Kumar (2013) A method for enhancing status of carbon, nitrogen, biomass and yield of plants, 0057NF2011/JP dt. 18/10/2013, 0057NF2011/AU dt. 18/10/2013, 0057NF2011/NZ dt. 18/10/2013, 0057NF2011/MX dt. 18/10/2013, 0057NF2011/US dt. 19/10/2013, 0057NF2011/PH dt. 21/10/2013, 0057NF2011/EP dt. 12/11/2013, 0057NF2011/KR dt. 18/11/2013, 0057NF2011/CN dt. 06/12/2013.

PATENT GRANTED

India

Srigurupuram Desikachar Ravindranath and Krishna Kumar Singh (2013) A jacket attachment for carrying portable skiffing and shoot harvesting machines, 258005 dt. 27/11/2013.

Sanjay Ghwana, Kashmir Singh, Jyoti Raizada, Arti Rani, Pradeep Kumar Bhardwaj and Sanjay Kumar (2014) A method for rapid isolation of RNA and a kit thereof, 259562 dt. 18/03/2014.

Abroad

Shashi Bhushan, Sakshi Gupta, Garikapati Dyva Kiran Babu, Mohit Sharma and Paramvir Singh Ahuja (2013) Method and apparatus for the separation of seeds from fruit pulp/slurry/pomace. WO 2013/069028A1. dt. 16/05/2013.

Jonnala Kotesh Kumar, Garikapati Dyva Kiran Babu, Vijay Kumar Kaul and Paramvir Singh Ahuja (2013) A process for the production of steviosides from *Stevia rebaudiana* Bertoni. 1-0011187-000/VN; dt. 25/04/2013.

Vijai K Agnihotri, Bikram Singh, Garikapati Dyva Kiran Babu, Gopi Chand, Rakesh Deosharan Singh and Paramvir Singh Ahuja (2013) Process for the modification of *Curcuma*



aromatica essential oil. US 2013/0331467 A1 dt. 12/12/2013.

Sanjay Ghwana, Kashmir Singh, Jyoti Raizada, Arti Rani, Pradeep Kumar Bhardwaj and Sanjay Kumar (2013) A cost effective, less hazardous, two-solution system for rapid isolation of RNA, EP2004822/DE, EP2004822/EE EP2004822/GB dt. 12/06/2013

Saurabh Kulshrestha, Vipin Hallan, Gaurav Raikhy and Aijaz Asghar Zaidi (2013) Development of diagnostic kit against the recombinant coat protein of *Prunus necrotic ringspot virus*, 14704/LK dt. 20/06/2013.

Srigiripuram Desikachar Ravindranath, Garik Dyva Kiran Babu, Arindam Kar and Pankaj Kumar Maji (2013) A mobile tea shoot preconditioning device for withering during black tea manufacture, 1-0011353-000/VN dt. 02/05/2013.

Pardeep Kumar Bhardwaj, Rashmita Sahoo, Sanjay Kumar and Paramvir Singh Ahuja (2013) Superoxide dismutase gene from *Potentilla atosanguinea* and its expression in heterologous system, 2006341292/AU dt. 23/05/2013.

PUBLICATIONS

Journal Articles

Agnihotri VK, Sharma A, Thakur S, Sood S, Kumar R, Pal PK, Gulati A and Singh B (2013) Essential oil composition and antimicrobial activity of leaves and stem of *Stevia rebaudiana* Bertoni cultivated in the Western Himalaya, India. *Indian Perfumer* 57(2): 25-30.

Atri NS, Sharma SK, Joshi R, Gulati Ashu and Gulati Arvind (2013) Nutritional and nutraceutical composition of five wild edible Pleurotus species from North-West India. *International Journal of Medicinal Mushroom* 15(1): 49-56.

Atri NS, Sharma SK, Sharma BM and Gulati A (2013) Comparative study of alkaloid composition in ten wild fungal species from North West India. *African Journal of Basic and Applied Sciences* 5(3): 121-125.

Bajpai PK, Warghat AR, Sharma RK, Yadav A, Thakur AK, Srivastava RB and Stobdan T (2014) Structure and genetic diversity of natural populations of *Morus alba* in the trans-Himalayan Ladakh region. *Biochemical Genetics* 52:137-152.

Bala M, Verma PK, Sharma U, Kumar N and Singh B (2013) Iron phthalocyanine as an efficient and versatile catalyst for *n*-alkylation of heterocyclic amines with alcohols: one-pot synthesis of 2-substituted benzimidazoles, benzothiazoles and benzoxazoles. *Green Chemistry* 15: 1687-1693.

Bandna, Sharma D and Das P (2013) Cyanoalkyl amines: as an efficient reagent to stabilize palladium nano/microparticles for Suzuki and basic media for palladium (II) catalyzed Heck cross coupling reaction. *Nano Bulletin* 2(2): Article No. 130211.

Bhardwaj J and Yadav SK (2013) A common protein extraction protocol for proteomic analysis: Horse gram a case study. *American Journal of Agricultural and Biological Sciences* 8(4): 293-301



Bhardwaj J, Chauhan R, Swarnkar MK, Chahota RK, Singh AK, Shankar R and Yadav SK (2013) Comprehensive transcriptomic study on horse gram (*Macrotyloma uniflorum*): *De novo* assembly, functional characterization and comparative analysis in relation to drought stress. *BMC Genomics* 14: 647.

Bhardwaj P, Kumar R, Sharma H, Tewari R, Ahuja PS and Sharma RK (2013) Development and utilization of genomic and genic microsatellite markers in Assam tea (*Camellia assamica* ssp. *Assamica*) and related *Camellia* species. *Plant Breeding* 132(6): 748-763.

Bhardwaj P, Sharma RK, Kumar R, Sharma H and Ahuja PS (2014) SSR marker based DNA fingerprinting and diversity assessment in superior tea germplasm cultivated in Western Himalaya. *Proceedings of the Indian National Science Academy* 80(1): 157-162.

Bhardwaj PK, Mala D and Kumar S (2014) 2-Cys peroxiredoxin responds to low temperature and other cues in *Caragana jubata*, a plant species of cold desert of Himalaya. *Molecular Biology Reports* 41(5): 2951-2961.

Bhattacharya A, Saini U, Joshi R, Kaur D, Pal AK, Kumar N, Gulati A, Mohanpuria P, Yadav SK, Kumar S and Ahuja PS (2013) Osmotin-expressing transgenic tea plants have improved stress tolerance and are of higher quality. *Transgenic Research* 23(2): 211-23.

Biswas K, Hallan V, Zaidi AA and Pandey PK (2013) Molecular evidence of *Cucumber mosaic virus* subgroup II infecting *Capsicum annuum* L. in the western region of India. *Current Discovery* 2(2): 97-105.

Chand P, Shil AK, Sharma M and Pakade YB (2014) Improved adsorption of Cd²⁺ ions from aqueous solution using chemically modified apple pomace: mechanism, kinetics and thermodynamics. *International Biodeterioration and Biodegradation* 90: 8-16.

Chaudhary A, Sharma U, Vig AP, Singh B and Arora S (2014) Free radical scavenging, antiproliferative activities and profiling of variations in the level of phytochemicals in different parts of broccoli (*Brassica oleracea italica*). *Food Chemistry* 148(1): 373-380.

Das P, Agarwal N and Guha NR (2013) Solid supported Ru(0) nanoparticles: an efficient ligand-free heterogeneous catalyst for aerobic oxidation of benzylic and allylic alcohols to carbonyls. *Tetrahedron Letters* 54: 2924-2028.

Dhir S, Zaidi AA and Hallan V (2013) Molecular characterization and recombination analysis of the complete genome of *Apple chlorotic leaf spot virus*. *Journal of Phytopathology* 161: 704-712.

Dhyani D and Singh S (2014) Potential wild rose germplasm of western Himalayas-Conservation, evaluation and registration. *Indian Journal of Agricultural Sciences* 84(2): 229-235.

Dogra PD, Bir SS and Singh RD (2013) Indian gymnospermous flora: Protecting the forest region of lower Himalaya while countering climate change. *Proceedings of the Indian National Science Academy* 79(2): 265-275.

Dohroo NP, Kansal S, Ahluwalia N and Shanmugam V (2013) First report of *Pantoea ananatis* strain nvgl-01 on ginger. *Plant Disease Research* 28(2): 200-202.

Dua VK, Verma G, Singh B, Rajan A, Bagal U, Agarwal DD, Gupta NC, Kumar S and Rastogi A (2013) Anti-malarial property of steroidal alkaloid conessine isolated from the bark of *Holarrhena antidysenterica*. *Malaria Journal* 12:194.

Gopichand (2013) Species specific changes in chlorophyll fluorescence in deciduous and evergreen tree species growing under short rotation high density energy plantation in north-western Himalaya. *Journal of Medicinal Plant Studies* 1(5): 41-50.

Gopichand, Singh RD and Meena RL (2013) Study of seed germination and agro-techniques of *Asparagus racemosus* Willd. in mid hills of western Himalaya. *The Indian Forester* 139(11): 1040-1045.

Gopichand, Singh RD and Meena RL (2013) Study on seed germination and agrotechniques of *Cheilocostus spectosus* (J. König) C. Specht in mid-hill of western Himalaya. *Global Journal of Research on Medicinal Plants & Indigenous Medicine* 2(8): 562-570.

Gopichand, Singh RD, Meena RL, Kaul VK and Singh B (2013) Influence of manure and plant spacing on growth and yield of *Dioscorea deltoidea* Wall: an endangered species. *Journal of Medicinal Plants Studies* 1(3): 184-190.

Guleria P and Yadav SK (2014) Overexpression of a glycosyltransferase gene SrUGT74G1 from *Stevia* improved growth and yield of transgenic *Arabidopsis* by catechin accumulation. *Molecular Biology Reports* 41(3): 1741-1752.

Hossain MM, Rahi P, Gulati A and Sharma M (2013) Improved *ex vitro* survival of aymbiotically raised seedlings of *Cymbidium* using mycorrhizal fungi isolated from distant orchid taxa. *Scientia Horticulturae* 159: 109-112.

Hossain USK, Dixit D and Sen E (2013) Comparative study of microtubule inhibitors-estramustine and natural podophyllotoxin conjugated PAMAM dendrimer on glioma cell proliferation. *European Journal of Medicinal Chemistry* 68: 47-57.

Jaitak V, Kaul VK and Das P (2013) Environmentally benign Michael and Claisen Schmidt reaction of aromatic carbonyl compounds by alkaline polyionic resin. *Indian Journal Of Chemistry Section B-Organic Chemistry Including Medicinal Chemistry* 52(8): 1137-1145.

Jaryan V, Datta A, Uniyal SK, Kumar A, Gupta RC and Singh RD (2013) Modelling potential distribution of *Sapitum sebiferum* – an invasive tree species in western Himalaya. *Current Science* 105(9): 1282-1288.

Jaryan V, Uniyal SK, Gupta RC and Singh RD (2013) Alien flora of Indian Himalayan state of Himachal Pradesh. *Environmental Monitoring and Assessment* 185(7): 6129-6153.

Jaryan V, Uniyal SK, Kumar A, Gupta RC, Parkash O and Singh RD (2013) Distribution characteristics of *Sapitum sebiferum* (L.) Roxb.- An invasive tree species in Himachal Pradesh, western Himalaya. *Proceedings of the Indian National Science Academy* 79(2): 215-234.

Joshi R, Babu GDK and Gulati A (2013) Effect of decaffeination conditions on quality parameters of Kangra orthodox black tea. *Food Research International* 53: 693-703.

Joshi R, Sood S, Poonam, Mahendru M, Kumar D, Bhangalia S, Pal HP, Kumar N, Bhushan S, Gulati A, Saxena AK and Gulati A (2013) *In vitro* cytotoxicity, antimicrobial and metal



chelating activity of triterpene saponins from tea seed grown in Kangra valley, India. *Medicinal Chemistry Research* 22(8): 4030-4038.

Kant K, Walia M, Agnihotri VK, Pathania V and Singh B (2013) Evaluation of antioxidant activity of *Picrorhiza kurroa* (leaves) extracts. *Indian Journal of Pharmaceutical Sciences* 75(3): 324-329.

Kaur R, Pakade YB and Katnoria JK (2013) Genotoxicity and tumor inducing potential of roadside soil samples exposed to heavy traffic emissions at Amritsar (Punjab), India. *Journal of Applied and Natural Science* 5(2): 382-387.

Kawoosa T, Gahlan P, Devi AS and Kumar S (2013) The GATA and SORLIP motifs in the 3-hydroxy-3-methylglutaryl-CoA reductase promoter of *Picrorhiza kurroa* for the control of light mediated expression. *Functional and Integrative Genomics* 14(1): 191-203.

Kulshrestha S, Hallan V, Sharma A, Seth CA, Chauhan A and Zaidi AA (2013) Molecular characterization and intermolecular interaction of coat protein of *Prunus necrotic ring spot virus*: implications for virus assembly. *Indian Journal of Virology* 24(2): 235-241.

Kumar A, Dhiman R and Deshmukh B (2013) Morphometric analysis of watersheds of Kangra region of Indian Himalaya for assessing its fluvial erosion susceptibility. *Himalayan Geology* 35(1): 47-55.

Kumar A, Lal B, Rajkumar S, Chawla A and Kaushal R (2013) Landscape mapping and tree diversity assessment of Pangri valley: A remote tribal area of Himachal Pradesh in western Himalaya, India. *International Journal of Conservation Science* 4(4): 503-508.

Kumar A, Meenakshi, Kumari CV and Singh RD (2013) KSIS - A web based information system on bioresources of Kangra region of Indian western Himalaya. *Asian Journal of Geoinformatics* 13(2): 1-6.

Kumar H and Kumar S (2013) A functional (E)-4-hydroxy-3-methylbut-2-enyl diphosphate reductase exhibits diurnal regulation of expression in *Stevia rebaudiana* (Bertoni). *Gene* 527(1): 332-338.

Kumar N, Gulati A and Bhattacharya A (2013) L-glutamine and L-glutamic acid facilitate successful *Agrobacterium* infection of recalcitrant tea cultivars. *Applied Biochemistry and Biotechnology* 170(7): 1649-1664.

Kumar R and Sharma S (2013) Simulation and validation of leaf area prediction model for *Picrorhiza kurroa*—an endangered medicinal plant of western Himalaya. *Journal of Medicinal Plants Research* 7(20): 1467-1474.

Kumar R and Singh RD (2013) Integrated weed management in damask rose (*Rosa damascena*) nursery. *Indian Journal of Agronomy* 58(3): 416-420.

Kumar R, Sharma S and Prasad R (2013) Yield, nutrient uptake and quality of stevia (*Stevia rebaudiana* Bertoni) as affected by organic sources of nutrient. *Communication in Soil and Plant Analysis* 44: 3137-3149.

Kumar R, Sharma S, Kulasekaran R and Singh B (2013) Effects of shade regimes and planting geometry on growth, yield and quality of the natural sweetener plant stevia (*Stevia rebaudiana*



- Bertoni) in North-western Himalaya. *Archives of Agronomy and Soil Science* 59(7): 963-979.
- Kumar R, Sharma S, Sood S and Agnihotri VK** (2013) Agronomic interventions for the improvement of essential oil content and composition of damask rose (*Rosa damascena* Mill.) under western Himalayas. *Industrial Crops and Products* 48: 171-177.
- Kumar R, Sharma S, Sood S, Agnihotri VK, Singh V and Singh B** (2013) Evaluation of several *Rosa damascena* varieties and *Rosa bourboniana* accession for essential oil content and composition in western Himalayas. *Journal of Essential Oil Research* 26(50): 147-152.
- Kumar S and Das P** (2013) Solid-supported ruthenium(0): an efficient heterogeneous catalyst for hydration of nitriles to amides under microwave irradiation. *New Journal of Chemistry* 37: 2987-2990.
- Kumar S, Singh L, Rajaram, Zaidi AA and Hallan V** (2014) Simultaneous detection of major pome fruit viruses and a viroid. *Indian Journal of Microbiology* 54(2): 203-210.
- Kumar V and Yadav SK** (2013) Overexpression of CsDFR and CsANR enhanced flavonoids accumulation and antioxidant potential of roots in tobacco. *Plant Root* 7: 65-76.
- Kumar V, Gill T, Grover S, Ahuja PS and Yadav SK** (2013) Influence of human lactoferrin expression on iron homeostasis, flavonoids, and antioxidants in transgenic tobacco. *Molecular Biotechnology* 53(2): 118-128.
- Kumar V, Guleria P, Kumar V and Yadav SK** (2013) Gold nanoparticles exposure induces growth and yield enhancement in *Arabidopsis thaliana*. *Science of the Total Environment* 461-462:462-468. .
- Kumar V, Kumar M, Sharma S and Kumar N** (2014) Highly selective direct reductive amidation of nitroarenes with carboxylic acids using environment friendly cobalt(II) phthalocyanine/PMHS. *RSC Advances* 4: 11826-11830.
- Kumar V, Kumar S, Singh B and Kumar N** (2014) Quantitative and structural analysis of amides and lignans in *Zanthoxylum armatum* by UPLC-DAD-ESI-QTOF-MS/MS. *Journal of Pharmaceutical and Biomedical Analysis* 30(94): 23-29.
- Kumar V, Nadda G, Kumar S and Yadav SK** (2013) Transgenic tobacco overexpressing tea cDNA encoding dihydroflavonol 4-reductase and anthocyanidin reductase induces early flowering and provides biotic stress tolerance. *PLoS ONE* 8(6): e65535.
- Kumar V, Singh C, Sharma U, Verma PK, Singh B and Kumar N** (2014) Silica-supported boric acid catalyzed synthesis of dihydropyrimidin-2-ones, bis(indolyl) methanones, esters and amides. *Indian Journal of Chemistry* 53B: 83-89
- Kumari A and Yadav SK** (2014) Nanotechnology in agri-food sector. *Critical Reviews in Food Science and Nutrition* 54: 975-984.
- Kumari A, Chawla Amit, Lal B and Fraser-Jenkins CR** (2014) *Dryopteris zayuensis* Ching & S.K.Wu and *Pteris biaurita* L. subsp. *fornicata* Fraser-Jenk. - two interesting records in the pteridophyte flora of Himachal Pradesh, India. *Indian Journal of Forestry* 37(1): 115-120.
- Kumari A, Lal B and Parkash O** (2013) Pteridophytic diversity of Barot, Mandi district, Himachal Pradesh, India. *Journal of the Bombay Natural History Society* 110(2): 135-141.

- Mahajan M and Yadav SK** (2014) Gain of function mutation in tobacco MADS box promoter switch on the expression of flowering class B genes converting sepals to petals. *Molecular Biology Reports* 41(2): 705-712.
- Manju A, Brar J and Sood A** (2013) *In vitro* propagation of an edible bamboo, *Bambusa bambuse* and assessment of clonal fidelity through molecular markers. *Journal of Medical and Bioengineering* 2: 257-261.
- Manjunath KR, Kumar A, Mehra M, Renu, Uniyal SK, Singh RD, Ahuja PS, Ray SS and Panigrahy S** (2014) Developing spectral library of major plant species of western Himalayas using ground observations. *Journal of the Indian Society of Remote Sensing* 42(1): 201-216.
- Manu P, Gangola MP, Parkash J, Ahuja PS and Dutt S** (2013) Components of antioxidant system of *Picrorhiza kurroa* exhibit different spatio-temporal behavior. *Molecular Biology Reports* 40(12): 6593-603.
- Mondal KK and Shanmugam V** (2013) Advancements in the diagnosis of bacterial plant pathogens: an overview. *Biotechnology and Molecular Biology Reviews* 8: 1-11.
- Nadha HK, Kumar R, Sharma RK, Anand M and Sood A** (2013) *In vitro* propagation of *Dendrocalamus asper* and testing the clonal fidelity using RAPD and ISSR markers. *International Journal of Current Research* 5(8): 2060-2067.
- Nadda G** (2013) Medicinal and aromatic crops as hosts of *Helicoverpa armigera* Hübner (Lepidoptera: Noctuidae). *Lepcey- The Journal of Tropical Asian Entomology* 02(1): 44-46.
- Noorani, Awasthi R, Sharma MP, Raja Ram, Zaidi AA and Hallan V** (2013) Simultaneous detection and identification of four cherry viruses by two step multiplex RT-PCR with an internal control of plant nad5 mRNA. *Journal of Virological Methods* 193: 103-107.
- Pal PK, Agnihotri VK, Gopichand and Singh RD** (2013) Impact of level and timing of pruning on flower yield and secondary metabolites profile of *Rosa damascena* under western Himalayan region. *Industrial Crops and Products* 52: 219-227.
- Pal PK, Prasad R and Pathania V** (2013) Effect of decapitation and nutrient applications on shoot branching, yield, and accumulation of secondary metabolites in leaves of *Stevia rebaudiana* Bertoni. *Journal of Plant Physiology* 170: 1526-1535.
- Parimoo HA, Sharma R, Patil RD, Sharma OP, Kumar P and Kumar N** (2014) Hepatoprotective effect of *Ginkgo biloba* leaf extract on lantadenes-induced hepatotoxicity in guinea pigs. *Toxicol* 81: 1-12.
- Parkash J, Vaidya T, Kirti S and Dutt S** (2014) Translation initiation factor 5A in *Picrorhiza* is up-regulated during leaf senescence and in response to abscisic acid. *Gene* 542: 1-7.
- Pati AM, Singh S, Ram D and Ahuja PS** (2013) Study on the problems and need of herbal industry in HP. *International Journal of Scientific Research* 2(9): 67-70.
- Praveen G and Yadav SK** (2013) *Agrobacterium* mediated transient gene silencing (AMTS) in *Stevia rebaudiana*: insights into steviol glycoside biosynthesis pathway. *PLoS One* 8(9): e74731.
- Rana A and Singh HP** (2013) Bio-utilization of wild berries for preparation of highly valued



herbal wines. *Indian Journal of Natural Products and Resources* 4(2): 165-169.

Rana A, Rana S, Majeed R, Singh HR, Gulati A, Hamid A, Vyas D and Dhyani D (2014) Comparative studies for screening of bioactive constituents from various parts of *Incarvillea emodi*. *Natural Product Research* 28(8): 593-596.

Randhawa V, Sharma P, Bhushan S and Bagler G (2013) Identification of key nodes of type 2 diabetes mellitus protein interactome and study of their interactions with phloridzin. *OMICS A Journal of Integrative Biology* 17(6): 302-317.

Reddy SGE, Kumari A and Lal B (2013) First report of the aphid, *Amphorophora ampullata* (Homoptera: Aphididae) on the fern, *Hypolepis polypodioides* (Hypolepidaceae) from western Himalayas (India). *American Fern Journal* 103(3):185-187.

Salwan R, Swarnkar MK, Singh AK and Kasana RC (2014). First draft genome sequence of a member from the genus *Planomicrobium*, isolated from the Chandra river, India. *Genome Announcement* 2: e01259-13.

Shanmugam V, Thakur H, Kaur J, Gupta S, Rajkumar S and Dohroo NP (2013) Genetic diversity of *Fusarium* spp. inciting rhizome rot of ginger and its management by PGPR consortium in the western Himalayas. *Biological Control* 66(1): 1-7.

Sharma D, Bandna, Reddy CB, Kumar S, Shil AK, Guha NR and Das P (2013) Microwave assisted solvent and catalyst free method for novel classes of β -enaminoester and acridinedione synthesis. *RSC Advances* 3(26): 10335-10340.

Sharma D, Reddy CB, Shil AK, Saroach RP and Das P (2013) Cyclohexyl iodide promoted approach for coumarin analogue synthesis using small scaffold. *Molecular Diversity* 17(4): 651-659.

Sharma S and Kumar R (2013) Effect of planting time on compositional variation, oil content and growth in clary sage [*Salvia sclarea* L.] under western Himalayan conditions. *Indian Perfumer* 57(3): 31-36.

Sharma S, Kumar M, Kumar V and Kumar N (2013) Vasicine catalyzed direct C-H arylation of unactivated arenes: organocatalytic application of an abundant alkaloid. *Tetrahedron Letters* 54(36): 4868-4871.

Sharma U, Katoch D, Sood S, Kumar N, Singh B, Thakur A and Gulati A (2013) Synthesis antibacterial and antifungal activity of 2-amino-1,4-naphthoquinones using silica-supported perchloric acid (HClO_4 - SiO_2) as a mild, recyclable and highly efficient heterogeneous catalyst. *Indian Journal of Chemistry: Section B* 52: 1431-1440.

Shil AK and Das P (2013) Solid supported platinum (0) nanoparticles catalyzed chemo-selective reduction of nitroarenes to N-Arylhydroxylamines. *Green Chemistry* 15(12): 3421-3428.

Shil AK, Guha NR, Sharma D and Das P (2013) Solid supported palladium (0) nano/microparticles catalyzed ultrasound induced continuous flow technique for large scale Suzuki reaction. *RSC Advances* 3(33): 13671-13676.

Singh C, Kumar V, Sharma U, Kumar N and Singh B (2013) Emerging catalytic methods for



amide synthesis. *Current Organic Synthesis* 10(2): 241-264.

Singh MK, Kumar S and Rajaram (2012) Nutritional studies on cut flower production of gerbera (*Gerbera jamesonii*) under polyhouse conditions in mid hills of western Himalayas. *Journal of Ornamental Horticulture* 15(3-4): 266-270.

Singh O, Gupta M, Mittal V, Kirans S, Nayyar H, Gulati A and Tewari R (2013) Novel phosphate solubilizing bacteria *Pantoea cyripedii* PS1 along with *Enterobacter aerogenes* PS16 and *Rhizobium ciceri* enhance the growth of Chickpea (*Cicer arietinum* L.). *Plant Growth Regulation* 73(1): 79-89.

Singh S, Kumar A and Dhyani D (2013) Inheritance of pigment markers associated with flavonoid and carotenoid pigmentation in flowers of *Gerbera jamesonii*. *Canadian Journal of Plant Breeding* 1(3): 110-114.

Sood A, Anand M, Brar J, Shafi A and Sood P (2014) *In vitro* propagation, biochemical studies and assessment of clonal fidelity through molecular markers in *Bambusa balcooa*: an edible bamboo. *Journal of Tropical Forest Science* 26(1): 115-124.

Sood S, Walia S, Gupta M and Sood A (2013) Quality evaluation of shoots and other edible products of an edible bamboo- *Dendrocalamus hamiltonii*. *Current Research in Nutrition and Food Science* 1(2): 169-176.

Soodan RK, Nagpal A, Pakade YB and Katnoria JK (2014) Analytical techniques for estimation of heavy metals in soil ecosystem: A tabulated review. *Talanta* 125: 405-410.

Srivastava A, Raj SK, Kumar S, Snehi SK, Kulshreshtha A, Hallan V and Pande SS (2013) Molecular identification of *Ageratum enation virus*, betasatellite and alphasatellite molecules isolated from yellow vein diseased *Amaranthus cruentus* in India. *Virus Genes* 47: 584-590.

Uniyal SK (2013). Bark removal and population structure of *Taxus walliichiana* Zucc. in a temperate mixed conifer forest of western Himalaya. *Environmental Monitoring and Assessment* 185(4): 2921-2928.

Uniyal SK (2014) Who will collect and name them. *Biodiversity and Conservation* 23: 511-512.

Verma PK, Kumar N, Sharma U, Bala M, Kumar V and Singh B (2013) Transition metal-free sodium borohydride promoted controlled hydration of nitriles to amides. *Synthetic Communications* 43(21): 2867-2875.

Walia M, Rawat K, Bhushan S, Padwad YS and Singh B (2013) Fatty acid composition, physico-chemical properties, antioxidant and cytotoxic activity of apple seed oil obtained from apple pomace. *Journal of the Science of Food and Agriculture* 94(5): 929-34.

Walia M, Sharma U, Agnihotri VK and Singh B (2014) Silica-supported boric acid assisted conversion of mono- and poly-saccharides to 5-hydroxymethylfurfural in ionic liquid. *RSC Advances* 4(28): 14414-14418.

Walia M, Sharma U, Bhushan S, Kumar N and Singh B (2013) Arabinan-type polysaccharides from industrial apple pomace waste. *Chemistry of Natural Compounds* 49(5): 794-798.

Walia Y, Dhir S, Raja Ram, Zaidi AA and Hallan V (2014) Identification of the herbaceous host



range of *Apple scar skin viroid* and analysis of its progeny variants. *Plant Pathology* 63: 684-690.

Yadav AK, Singh S and Dhiman R (2014) Self-incompatibility evidenced through scanning electron microscopy and pollination behaviour studies in *Stevia rebaudiana*. *Indian Journal of Agricultural Sciences* 84(1): 93-100.

एस.के. यादव, ए. कुमारी, वी. कुमार एवं आर. यादव (2013) नैनोटेक्नोलॉजी का प्रयास : जैव संसाधनों से नैनोमेडिसिन की आस। विज्ञान प्रगति अक्टूबर 62(10), 28 एवं 42।

राकेश कुमार, सौरभ शर्मा, स्वाति सूद एवं विक्रम सिंह (2013) वचा ने रचा महत्वपूर्ण उपयोगों का इतिहास। विज्ञान प्रगति, मई 61(5): 13.17।

सुनील कुमार, अभित कुमार एवं पी.एस.आहूजा (2014) वनस्पतियों एवं वनों के प्रबंधन में सुदूर संवेदन एवं जी.आई.एस. का उपयोग। विज्ञान प्रगति, फरवरी 62(2): 27-30।

एम.के. सिंह, टी. जानकीराम, डी.वी.एस. राजू एवं संजय कुमार (2014) गुलाब की व्यावसायिक खेती, फलफूल, मार्च-अप्रैल, 3-9।

Book chapters

Bhushan S and Gupta M (2013) Apple pomace: source of dietary fibre and antioxidant for food fortification. In: *Handbook of Food Fortification and Health, From Concepts to Public Health Applications Volume-2* (Eds. Victor R. Preedy, Rajaventhana Srirajaskanthan, Vinood B. Patel), Humana Press, ISBN: 978-1-4614-7109-7), Series: Nutrition and Health, p. 21-27.

Kumar S (2013) Divergent strategies to cope up with climate change in Himalayan plants. In: *Climate Change and Abiotic Stress Tolerance*, Vol. -2 (Eds. N. Tuteja and S.S. Gill), Wiley-VCH Verlag GmbH & Co. Weinheim, Germany, ISBN 978-3-527-33491-9, p. 903-931.

Chandel M, Sharma U, Kumar N, Singh B and Kaur S (2014) *In vitro* studies on the antioxidant/ antigenotoxic potential of aqueous fraction from *Anthocephalus cadamba* bark. In: *Perspectives in Cancer Prevention-Translational Cancer Research* (Ed. PR Sudhakaran), Springer India, ISBN: 978-81-322-1533-2-5, p. 61-72.

Brij Lal (2014) Ethnobotany of sal tree (*Shorea robusta* Gaertn. f.): An overview. In: *Ethnobotanical Studies In India* (Ed. Sanjeev Kumar), Deep Publications, New Delhi. ISBN: 978-93-80702-06-3, p. 48-53.

Technical Brochures Released



Conferences and Symposia

Chand P and Pakade YB (2014) Surface modification of apple pomace as low-cost adsorbent for removal of Cd¹² and Pb¹² ions from aqueous solution. In Sixteenth CRSI National Symposium in chemistry, Indian Institute of Technology, Mumbai, February 7-9.

Jaryan V, Uniyal SK and Gupta RC (2014) Production and decomposition of *Sapuntum sebiferum* (L.) Roxb. Litter. Proceedings of the National Symposium on Emerging Trends in Botanical Sciences, Punjabi University, Patiala, February 17-18, pp 117, (Poster B-46).

Kumar H and Kumar S (2013) Molecular basis of steviol glycosides biosynthesis in *Stevia rebaudiana* (Bertoni), a source of non-calorific sweetener. In Proceeding of the EUSTAS (The European Stevia Association) Seventh Stevia symposium, Toulouse (France) June 24-26.

Kumar V (2013) Metal phthalocyanines: biomimetics catalysts for selective and sustainable organic synthesis. In Sixth International Conference on Green and Sustainable Chemistry (GSC-6), The University of Nottingham, United Kingdom, August 04-07, 2013 (oral presented).

Kumari A, Parkash O and Lal B (2014) Epiphytic ferns of Kangra valley, Himachal Pradesh. In 101st Indian Science Congress (Section XIV: Plant Science), Jammu, January 3-7, pp. 221-222.

Mehta M and Bhattacharya A (2013) Improved micropropagation of apple rootstock B9. In XXXIV Annual Meeting of PTCA (I) & National Symposium on Plant Tissue Culture for Food and Nutritional Security, Organized Plant Cell Biotechnology Department, CFTRI Mysore, Karnataka, India, March 11-13, 2013 (Abstract No. MP13).

Reddy SGE (2013) Chitinase as bio-pesticide for insect pest management. In: Third National Symposium on Emerging Issues in Chitin and Chitosan Research, Organized by CSIR-IHBT, Palampur and Indian Chitin and Chitosan Society (ICCS), June 7-8, p36.

Sharma D and Das P (2013) Metal phthalocyanines: biomimetics catalysts for selective and sustainable organic synthesis. In Sixth International Conference on Green and Sustainable Chemistry (GSC-6), The University of Nottingham, United Kingdom, August 04-07, 2013.

Sharma V and Shanmugam V (2013) Purification and characterization of an extracellular 24 kDa chitobiosidase from the mycoparasitic fungus *Trichoderma saturnisporum*. In Third National Symposium on Emerging Issues in Chitin and Chitosan Research, CSIR-IHBT, Palampur, HP, June 7-8.

Shil AK, Reddy CB, Kumar S and Das P (2014) 16th CRSI National Symposium in Chemistry, Feb. 7-9, 2014, IIT Bombay, Mumbai.

टेलीविजन द्वारा प्रसारित कार्यक्रम

PROGRAMMES TELECAST ON TV CHANNELS

विषय	दिनांक	विशेषज्ञ
दूरदर्शन केन्द्र शिमला द्वारा प्रसारित कृषि दर्शन कार्यक्रम के अन्तर्गत		
हि.प्र. के चाय बागानों की उच्च गुणवत्तायुक्त प्रथम फलश का उत्पादन	23.04.2013	डा. आर.के. सूद
विभिन्न जलवायु परिस्थितियों में क्लीनेरी हबर्स उत्पादन की संभावनाएं	26.05.2013	डा. वीरेन्द्र सिंह
लिलियम पुष्प और कंद उत्पादन हेतु खेती एवं फसलोपरान्त प्रौद्योगिकी	18.06.2013	डा. मारकण्डेय सिंह
कृषि-जैवविविधता संरक्षण	24.10.2013	डा. आर.डी. सिंह
सीबकथोर्न-एक कामधेनु पौधा	26.11.2013	डा. बृज लाल
जिन्को बाइलोवा -व्यावसायिक मूल्यवान औषधीय पौधा	28.01.2014	डा. गोपी चन्द
औषधीय पौधों की प्राथमिक प्रक्रमण	14.02.2014	डा. वीरेन्द्र सिंह डा. आर.के. सूद
हिम स्फूर्ति-कांगड़ा चाय की एक नई सुधरित किस्म	24.10.2013	डा. आर.डी. सिंह एवं डा. आर.के. सूद
जालंधर दूरदर्शन से प्रसारित		
सीएसआईआर-आईएचबीटी की प्रमुख शोध एवं विकास गतिविधियां	15.06.2013	डा. पी.एस. आहूजा एवं टीम
सीएसआईआर-आईएचबीटी की प्रमुख शोध एवं विकास गतिविधियां पुनः प्रसारित	30.06.2013	डा. पी.एस. आहूजा एवं टीम
दर्पण टी.वी., पालमपुर द्वारा प्रसारित		
सीएसआईआर-आईएचबीटी स्थापना दिवस	10.06.2013	डा. पी.एस. आहूजा
राष्ट्रीय विज्ञान दिवस	28.02.2014	डा. पी.एस. आहूजा



AWARDS/HONOURS/RECOGNITIONS

Award

CSIR-IHBT won 45th SSBMT outdoors zonal cricket tournament held at CSIR-IIP, Dehradun during October 25-27, 2013

CSIR-IHBT received first prize in the Flower Show for "Bird of Paradise" at HP State Level Holi Festival, Palampur organized by HP Govt., March 14, 2014.

Dr. Paramvir Singh Ahuja honoured with 'Shan-e-Himachal' award by Hon'ble Chief Minister of H.P. Shri Virbhadra Singh on October 27, 2013 for contribution in the area of tea and agriculture.

Dr. Paramvir Singh Ahuja received V. Puri Memorial Award of Indian Science Congress 2014 held at Jammu

Dr. Anil Sood selected for 'Mrs. Usha Vij Memorial award' under the aegis of the Orchid Society of India (TOSI) for the year 2014.

Dr. Vishal Acharya received 'ISCA Young Scientist Award-2014' from Sh. M. Hamid Ansari, Hon'ble Vice President of India in the 101st Indian Science Congress held at University of Jammu during February 3-7, 2014.

Membership

Dr. Vijai Kant Agnihotri: Life time membership of Essential Oil Association of India.

Best Poster Award

Shil AK, Reddy CB, Kumar S and Das P: Best poster award for poster entitled "Development of solid supported platinum(0) nanoparticles as heterogeneous catalyst and its applications in diversified organic transformation" In 16th CRSI National Symposium in Chemistry at IIT Bombay, Mumbai, February 7-9, 2014.

Shanmugam V, Himankshi and Gupta S: Second best paper entitled "Use of chitinolytic *Bacillus atrophaeus* strain S2BC-2 antagonistic to *Fusarium* spp. for control of rhizome rot of ginger" In 3rd National Symposium on Emerging Issues in Chitin and Chitosan Research, CSIR-IHBT, Palampur, HP, June 7-8, 2013.

Evaluator/Judge

Dr. Markandey Singh and Dr. Raja Ram: Judge for "Flower Show" organized by Department of Horticulture, Dharamshala, HP, May 26, 2013.

Dr. Brij Lal and Dr. SK Vats: Judge to evaluate presentations by the students on the theme 'Fostering Scientific Temper' under National Science Day-2014 Celebrations, organized by CSK HP Agricultural University, Palampur, February 26, 2014.

Editor

Dr. Yogesh B. Pakade: Editor-in-chief of the journal "Basic Research Journal of Soil and Environmental Science"

**Ph.D. AWARDED**

Awardees	Title of Thesis	Supervisor	University/Institute
Arun Rana	Bioprospecting thermostable superoxide dismutase from the flora of western Himalayas	Dr. Sanjay Kumar	Guru Nanak Dev University, Amritsar (Pb)
Awadesh Kumar Pal	Introduction of genes for stress tolerance and their expression studies in potato (<i>Solanum tuberosum</i> L. cv. Kufri Sutlej)	Dr. P.S. Ahuja	Guru Nanak Dev University, Amritsar (Pb)
Bandana	Exploration of interface reagent and solid supported palladium catalyst for cross coupling and oxidation reactions	Dr. Pralay Das	Guru Nanak Dev University, Amritsar (Pb)
Damanpreet Singh	Phytochemical and pharmacological investigations of anticonvulsant potential of <i>Ficus religiosa</i>	Dr. Bikram Singh	Punjabi University, Patiala (Pb)
Devinder Kaur	Development of <i>in vitro</i> strategies for conservation of <i>Dendrocalamus hamiltonii</i> Nees et Arn. Ex Munro	Dr. Amita Bhattacharya	Guru Nanak Dev University, Amritsar (Pb)
Dharminder Sharma	Methodology development towards carbon-carbon bond formation and their synthetic applications	Dr. Pralay Das	Guru Nanak Dev University, Amritsar (Pb)
Kiran Devi	Studies on <i>in vitro</i> propagation and genetic transformation in saffron (<i>Crocus sativus</i> L.)	Dr. Madhu Sharma	Guru Nanak Dev University, Amritsar (Pb)
Monika Mahajan	Genetic engineering of flavonoid pathway through gene overexpression and silencing approaches in tobacco (<i>Nicotiana tabacum</i> L.)	Dr. Sudesh Kumar	Guru Nanak Dev University, Amritsar (Pb)
Nisha Sharma	Cytomorphological diversity and chemical characterization of selected anti-diabetic medicinal plants from north India	Dr. Bikram Singh	Punjabi University, Patiala (Pb)
Rahul Kumar	Development and utilization of molecular markers for construction of genetic linkage map in tea [<i>Camellia sinensis</i> (L.) O. Kuntze]	Dr. Ram Kumar Sharma	Guru Nanak Dev University, Amritsar (Pb)
Richard Chalo Muoki	Identification and evaluation of dehydration responsive transcriptome in <i>Camellia sinensis</i> (L.) O. Kuntze	Dr. Sanjay Kumar	Guru Nanak Dev University, Amritsar (Pb)
Rupali Mehta	Development of efficient regeneration systems in economically important edible bamboos	Dr. Anil Sood	Guru Nanak Dev University, Amritsar (Pb)
Vikas	Development of molecular markers for genetic diversity and phylogenetic studies in bamboo	Dr. Ram Kumar Sharma	Guru Nanak Dev University, Amritsar (Pb)
Vineet Kumar	Characterization of silver and gold nanoparticles synthesized using medicinally important plant extracts	Dr. Sudesh Kumar	Guru Nanak Dev University, Amritsar (Pb)
Tabasum Kawoosa	Cloning and characterization of upstream sequences of selected genes of isoprenoid biosynthetic pathway of <i>Picrorhiza kurroa</i> Royle ex Benth	Dr. Sanjay Kumar	Guru Nanak Dev University, Amritsar (Pb)

**M. Sc./M. Pharma / M. Tech**

Awardees	Title of Thesis/ Dissertation/ Project	Supervisor	University/Institute
Aditi Rana	Isolation, screening and characterization of endophytes from roots of <i>Camellia sinensis</i> L. (O) Kuntze for antimicrobial activity	Dr. Arvind Gulati	Gurukul Kangri Vishwavidyalaya, Haridwar (UK)
Aditi Rana	Isolation, screening and characterization of endophytes from roots of <i>Camellia sinensis</i> L. (O) Kuntze for antimicrobial activity	Dr. Arvind Gulati	Kanya Gurukula Mahavidyalaya, Haridwar(UK)
Aditi Ranaut	Establishment of <i>in vitro</i> callus and suspension culture for high biomass production	Dr. Shashi Bhushan	BIS College of Science & Technology, Gagra
Diksha Khajuria	Berberine: anticancer potential, UPLC analysis and dena induced hepatocellular carcinoma model in rats	Dr. Yogendra S Padwad	Baba Ghulam Shah Badshah University, Rajouri (J&K)
Ekta Koundal	Extraction, isolation and characterisation of major alkaloids from <i>Adhatoda vasica</i>	Dr. Neeraj Kumar	Dr. B.R. Ambedkar National Institute of Technology, Jalandhar(Pb)
Gopal Das Bairagi	Identifying triggers for forest fires and their role in predicting forest fire in Kangra district, Himachal Pradesh using remote sensing and GIS.	Er. Amit Kumar	Institute of Environmental Studies, Kurukshetra University, Kurukshetra (Haryana)
Inderpreet Kaur	Cloning of gene in pRT101 vector under the control of CaMV35S promoter	Dr. Anil Kumar Singh	Guru Nanak Dev University, Amritsar(Pb)
Indu Choudhary	Comparative ecology of plantations in the campus of CSIR -Institute of Himalayan Bioresource Technology	Dr. Sanjay Kr. Uniyal	Central University of HP, Shahpur
Jashmanjot Kaur	Techniques in plant biotechnology	Dr. Anil Sood	Punjabi University, Patiala (Pb)
Jeewan Prabha	Changes in some of the photosynthetic components studied in <i>Rumex nepalensis</i> and <i>Trifolium repens</i> under low concentrations of CO ₂	Dr. SK Vats	Central University of HP, Shahpur
Kaiser Ahmed Brat	Engineered multifunctional hybrid nanocomposites for <i>in vitro</i> imaging of targeted cancer cells and related cytotoxicity studies	Dr. Amitabha Acharya	Baba Ghulam Shah Badshah University, Rajouri (J&K)
Khushpreet Kaur	Effect of salt and drought stress on two different wild cultivars of potato (<i>Solanum tuberosum</i>) viz. Kufri sutlej and kufri ba har under <i>in vitro</i> conditions	Dr. Madhu Sharma	Punjabi University, Patiala (Pb)
Lipakshi Awasthi	Isolation and characterization of Stevia Pathogens	Dr. V. Shanmugam	Chandigarh Group of Colleges, Landran Campus, Mohali(Pb)
Manish sharma	Plant virus diagnostic techniques	Dr. Vipin Hallan	Guru Nanak Dev University, Amritsar(Pb)
Navneet Dhillon	Cloning and characterization of genes and analysis of proteome from plants	Dr. Som Dutt	Punjabi University, Patiala (Pb)
Nidhi Walia	Cloning of genes encoding late embryogenesis abundant (lea) group 2 proteins from wild chickpea (<i>Cicer microphyllum</i>)	Dr. Anil Kumar Singh	Chandigarh College of Technology, landran, Mohali (Pb)
Nishant Kashyap	Tools & techniques in microbiology	Dr. RCKasana	Goa University, Goa
Niti Sharma	Extraction and optimization of polyphenols from fresh and preserved wild cheery	Dr. Mahesh Gupta	Punjab Institute of Technology, PTU, Kapurthala(Pb)
Pankaj Verma	Screening and characterization of microorganisms for antimicrobial activity	Dr. ArvindGulati	Panjab University, Chandigarh
Pawandeep Kaur	Gene cloning from plants	Dr. Som Dutt	Guru Nanak Dev University,



Pratibha Sharma	Microwave assisted green approach for the synthesis of novel β -enamionones and acridinediones	Dr. Pralay Das	Dr. B.R. Ambedkar National Institute of Technology, Jalandhar(Pb)
Ramandeep Kaur	Cloning of selected gene from plant	Dr. Sanjay Kumar	Guru Nanak Dev University, Amritsar(Pb)
Rasna	Cloning, characterization and expression analysis of genes from medicinal plants	Dr. Som Dutt	Shoolini University, Solan (HP)
Reeta Jarial	Effect of low temperature stress on catechin biosynthesis in osmotin transgenic of <i>Camilla sinensis</i> (L. (O. Kuntze)	Dr. Amita Bhattacharya	Amity University, Noida (UP)
Rifat Mustafa Malik	Expression analysis of stress responsive genes in horse gram (<i>Macrotyloma uniflorum</i>)	Dr. Sudesh Kumar	Baba Ghulam Shah Badshah University, Rajouri (J&K)
Rohini Keshav	Microbiology laboratory of CSIR-Institute of Himalayan Bioresource Technology	Dr. Ramesh Chand Kasana	Punjab University, Chandigarh
Rupali Mahajan	Compositional, antioxidant and functional characteristics of buckwheat milling fractions and its extrudates	Dr. Mahesh Gupta	Punjab Institute of Technology, PTU main campus, Kapurthala (Pb)
Sampy Duggal	Molecular characterization and in-vitro conservation of selected <i>Gerbera jamesonii</i> hybrids	Dr. Sanatsujat Singh	Shoolini University, Solan (HP)
Sandeep Rana	Characterization and application of Unigene derived microsatellite markers in tea (<i>Camellia sinensis</i>)	Dr. Ram Kumar Sharma	Amity University, Noida (UP)
Savita Sharma	Identification of TDNA insertion in putative mutant <i>Arabidopsis thaliana</i>	Dr. Y Sreenivasulu	Baba Ghulam Shah Badshah University, Rajouri (J&K)
Shifali Mahajan	Comparative studies of proteomes of psychrophilic with mesophilic and thermophilic bacteria	Dr. Vishal Acharya	Central University of HP, Shahpur
Shivangi Sharma	In vitro production of secondary metabolites using plant cell culture technology	Dr. Shashi Bhushan	BIS College of Science & Technology, Gagra (Pb)
Shreshtha Sharma	Evolutionary study of double WRKY domain of high altitude Himalayan plant, <i>Rheum australe</i> with model plants	Dr. Vishal Acharya	Central University of HP, Dharamshala
Shruti Mahajan	Tracking of bills for financial management	Dr. Aparna Maitra Pati & Mr. Jasbeer Singh	Central University of HP, Dharamshala
Sonika Kalia	Evaluation of Expression of novel antioxidant genes (SOD and APX) in transgenic Potato under salt stress	Dr. PS Ahuja & Dr. Anil Kumar Singh	Shoolini University, Solan
Sukhjeet Kaur	Extraction, fractionation and isolation of compounds from <i>Asparagus adscendens</i>	Dr. Bikram Singh	Dr. B.R. Ambedkar National Institute of Technology, Jalandhar(Pb)
Sukriti Sharma	Plant virus diagnostic techniques	Dr. Vipin Hallan	Guru Nanak Dev University, Amritsar(Pb)
Sunaina Walia	Comparative study of plant transcription factor (Stress Associated Protein (SAP) family) in the plant genomes	Dr. Vishal Acharya	School of Life-sciences, Central University of HP
Surbhi	Cloning and expression analysis of genes from plants	Dr. Som Dutt	Banasthali University, Rajasthan
Umar Ghani	Assessing the impact of transgene in imparting abiotic stress tolerance to <i>Arabidopsis thaliana</i>	Dr. Sanjay Kumar	Baba Ghulam Shah Badshah University, Rajouri (J&K)
Vandana	Remote sensing and GIS based forest fire susceptibility mapping in Kangra district of Himachal Pradesh with emphasis on Dharamshala region	Er. Amit Kumar	School of Earth and Environment Science, Central University of HP, Dharamshala

**BE / BTech**

Awardees	Title of Thesis/ Dissertation/ Project	Supervisor	University/Institute
Aakriti Verma	Micropropagation and genetic transformation of <i>Picrorhiza Kurroa</i> Royle Ex Benth	Dr. Madhu Sharma	Beant College of Engineering and Technology, Gurdaspur (Pb)
Aman Mahajan	Molecular characterization of biocontrol fungi and antifungal genes	Dr. V Shanmugam	Beant College of Engineering and Technology, Gurdaspur (Pb)
Aman Pathania	Estimation of catechins and polyphenols from <i>Camellia sinensis</i>	Dr. Ashu Gulati	Amity School of Engineering and Technology, Jaipur(RJ)
Amit Tandon	Power distribution, captive power generation and utility system	Mr. Sandeep Tripathi	NIT, Hamirpur (HP)
Amritpal Singh	Cloning, characterization and expression analysis of genes	Dr. Som Dutt	Beant College of Engineering and Technology, Gurdaspur (Pb)
Anu sharma	Plant virus diagnostic techniques	Dr. Vipin Hallan	NIILM University, Kailthal, Haryana
Dipali Tomar	Screening of transgenic apple for stress tolerance against high temperature	Dr. Amita Bhattacharya	Thapar University, Patiala (Pb)
Inayat Bajwa	Chemical and biological synthesis of biodegradable nanoparticles for biomolecule delivery	Dr. SudeshKumar	Beant College of Engineering and Technology, Gurdaspur (Pb)
Jatinderjot Singh	Validation of <i>cis</i> regulatory elements in seed developing genes of <i>Arabidopsis thaliana</i>	Dr. Y Sreenivasulu	Thapar University, Patiala (Pb)
Manmeet Kahlon	Purification, identification and estimation of catechins from <i>Camellia sinensis</i>	Dr. Ashu Gulati	Beant College of Engineering & Tech, Gurdaspur (Pb)
Monika Chaudhary	Study of gene/protein expression in two different high altitude plants	Dr. Madhu Sharma/ Khirod Sahu	Eastern Institute for Integrated University, Sikkim
Navneet Kaur	Mining and characterization of microsatellite markers from transcriptomic data of <i>Stevia rebaudiana</i>	Dr. Ram Kumar Sharma	Beant College of Engineering and Technology, Gurdaspur (Pb)
Preetika	Anther culture response in <i>Stevia rebaudiana</i> for the development of haploids	Dr. Ashok Kumar	Beant College of Engineering and Technology, Gurdaspur (Pb)
Revathi.T	Cloning of gene and promoter from plants	Dr. Som Dutt	Tamil Nadu Agricultural University, Coimbatore (TN)
Rishabh Kalura	Cloning of senescence -associated genes from <i>Picrorhiza kurroa</i>	Dr. Som Dutt	Manipal Institute of Technology, Manipal University, Karnataka
Sakshi	Standardization of culture media for anther and ovule culture response to induce haploids in <i>Stevia rebaudiana</i>	Dr. Sanat Sujat Singh	Beant College of Engineering and Technology, Gurdaspur (Pb)
Shivani Gupta	Effect of different pre-processing treatment on the extrusion processing of buckwheat and sorghum flour	Dr. Mahesh Gupta	Shoolini University (HP)
Vasudha Sharma	Characterization and evaluation of transcription factor based Microsatellite markers in tea (<i>Camellia sinensis</i>)	Dr. Ram Kumar Sharma	Beant College of Engineering and Technology, Gurdaspur (Pb)
Vimalpreet Kaur	Molecular characterization of bifunctional monodehydroascorbate reductase and carbonic anhydrase nectrin-3 transcription factor from <i>Cucumis sativus</i>	Dr. Vipin Hallan	Beant College of Engineering and Technology, Gurdaspur (Pb)

FOREIGN RESEARCH TRAINING FELLOW

Name	Fellowship	Supervisor	Duration
Mr. Jean Pierre Longue Ekon	Research Training Fellowship for Developing Country Scientists (RTF-DCS)	Dr. Bikram Singh	28 th March to 18 th Sept., 2013

**LECTURES DELIVERED**

Spokesperson	Topic	Occasion with Place	Date
Lectures delivered by the Director, CSIR-IHBT, Palampur			
	Enhancing private sector investments in R&D, technology and innovation	DST-NIPER Brain Storming Conference on Science Technology and Innovation Policy 2013 at CII, Chandigarh	April 16, 2013
	Tea improvement	Tocklai Experimental Station, Tea Research Association (TRA) Jorhat, Assam	April 27, 2013
	Some advances in bio-information-nanotechnology for western Himalaya bioresources	DBT supported brain storming session on "Prioritizing research areas in Nano-Bioinformation Technology for the development of Hill States" at G.B. Pant University of Agriculture and Technology, Pantnagar	July 12/13, 2013
Paramvir Singh Ahuja	My journey through plant sciences	Diamond Jubilee Lecture at CSIR-NBRI, Lucknow	July 30, 2013
	My experiences in plant genetic manipulations	PAU, Ludhiana	September 16 2013
	Biotechnological applications from discoveries at high altitudes	Two days symposium at Delhi University	September 27/28, 2013
	Future in science & biology	INSPIRE Programme, at CSKHPKV, Palampur, HP	October 25, 2013
	Bioresources and biotechnology	Environment, Science & Technology Department, Shimla	October 29, 2013
Lectures delivered by the reputed personnel of CSIR-IHBT, Palampur			
Alka Kumari	Ferns in Fly Ash Management	Fly ash utilization workshop, NTPC, Mouda, Nagpur	January 28, 2014
Amit Chawla	Remote sensing; from sky to earth	Science Day celebrations Government College, Jogindernagar, Mandi District, Himachal Pradesh	September 30, 2014
Amit Kumar	An overview of CSIR-IHBT Activities (Survey, mapping, database development, bioresource conservation and study on adaptation biology)	Alpine ecosystem dynamics and impact of climate change in Indian Himalaya Space Applications Centre (SAC), ISRO, Ahmedabad, Gujarat	June 11, 2013
	Time series analysis of natural vegetation in distinct biogeographical regions of Himachal Pradesh using RS/ GIS techniques in context of climate change	Training on disaster management to district/block level officers and elected representatives of PRIs upto Zila Parishad level	August 8, 2013
Amita Bhattacharya	Conservation and sustainable utilization of two endangered alpine Himalayan plants	National Conference on Plant Bioresource Management and Biotechnology (PMBM) at Department of Botany, University of Rajasthan, Jaipur	January 29-31, 2014
Brij Lal	Scientific techniques of extraction of natural resources of biodiversity	Training and capacity building of teachers in biodiversity conservation & monitoring organisation for social, environmental and rural	April 27, 2013



	Biodiversity of cold deserts: an appraisal	Special summer school on environmental sciences at UGC - Academic Staff College, HPU, Shimla(HP)	June 3, 2013
	Pharmacopoeial standardization of herbal drugs used in Indian system of medicine (AYURVEDA)	Special summer school on environmental sciences UGC - Academic Staff College, HPU, Shimla(HP)	June 4, 2013
	Ethnobotany of cold deserts of Himachal Pradesh- An appraisal	Modern techniques in ethnobotanical research, Institute of ethnobiology, Jiwaji University, Gwalior (MP)	March 13, 2014
	Credibility of plant based traditional knowledge – some success stories	Modern techniques in ethnobotanical research, Institute of ethnobiology, Jiwaji University, Gwalior (MP)	March 14, 2014
Raja Ram	Cultivation and post-harvest technology of commercially important cut-flower crops	Alpine ecosystem dynamics and impact of climate change in Indian Himalaya at Deputy Director of Horticulture of Kangra (HP)	June 26, 2013
SK Vats	Effect of climate change on mountain ecosystem- What is expected?	Training and capacity building of teachers in biodiversity conservation & monitoring organisation for social, environmental and rural development in collaboration with NCSTC, DST, Govt. of India at Dharamshala (HP)	April 27, 2013
Sanjay K. Uniyal	Impact assessment of climate change on Himalayan bioresources	Training on disaster management to district /block level officers and elected representatives of PRIs upto Zila Parishad level Himachal Pradesh Institute of Public Administration (HIPA), Shimla (HP)	August 8, 2013
Sanjay Kumar	Value addition to bioresource of western Himalaya	Workshop on science & technology and sustainable bio-economy for women's welfare organized by Uttarakhand State Council for Science & Technology, Uttarakhand	May 18, 2013
	Harnessing niche specific plant biology in western Himalaya for value addition	Brain storming session on prioritizing research areas in Nano-Bio-Information Technology for the development of Hill states at GBPUAT Pantnagar	July 13, 2013
	Climate change in western Himalaya: response analysis	Training programme on Climate change induced hazards risk management held at Institute of Public Administration	August 8, 2013
	Bioprospecting plant biology at high altitudes in western Himalaya	Indraprastha International Conference on Biotechnology (ICB-2013) at Guru Gobind Singh Indraprastha University, Delhi	October 23, 2013
	Climate change in western Himalaya: biodiversity response	Consultation workshop on climate change and agriculture in Himachal Pradesh organized by the Department of Environment,	November 16, 2013



	Opportunities to biologists in Himalayan niche	Baba Ghulam Shah Badshah University, Rajouri, J&K	November 29, 2013
	How plants adapt at high altitude in western Himalaya? Its fundamentals and application to plant improvement	UGC sponsored National Seminar on Plant Biotechnology: Challenges and Opportunities in 21st Century held on March 3 rd & 4 th , 2014, at Jamia Hamdard, New Delhi.	March 5, 2014
	Bio-prospecting metabolic pathways in Himalayan plants	National Conference on The Science of Omics for Agricultural Productivity: Future Perspectives, held at G.B. Pant University of Agriculture & Technology, Pantnagar (4-6 March, 2014).	March 5, 2014
	Genes and processes from plants of the high altitude Himalayan cold desert region for improving plant productivity	Deakin University/TERI workshop on Bio/nanotechnology applications to improve plant productivity and ecosystems services held at Deakin University, Waurin Ponds Campus, Geelong, Australia (March 12-14, 2014).	March 13, 2014
Sudesh Kumar Yadav	Developing nanoformulations by use of bio-surfactants, biopolymers and bio-molecules	Indo-German Bilateral Workshop, 20-22, March, 2014	March 20 March
	Plant metabolic engineering and its applications	Department of Biochemistry, GGD SD College, Chandigarh	February 21, 2014
	Exploring plant bioresource for better use through nanobiotechnology approach	Symposium on Emerging Trends in Agri-Bioinformatics DWR, Karnal, 16-17 Dec., 2013.	

GUEST LECTURES DELIVERED AT CSIR-IHBT

Spokesperson with Address	Topic	Date
Prof. Ulrich Schurr Institute Director, Forschungszentrum Jülich, IBG-2: Plant Sciences Germany	Plant phenotyping- structure and function of plants in concert with environmental heterogeneity	April 1, 2013
Dr. NK Singh B.P. Pal Chair, NRCPB, IARI, New Delhi	Genomics and GM crops for food security	August 7, 2013
Prof. John D. Hamill Deakin University, Australia	Plant stress and secondary metabolism	November 22, 2013
Drs. Sanjeev Sharma , Himachal Electrohomeopathic Doctors Association Chamba Himachal Pradesh	Electrohomeopathy: concept and relevance	December 10, 2013
St. Mary Eassy , Jivadhara Institute of Neuro Development & Research Ernakulam District, Kerala		
Dr. Bikram Singh Chief Scientist, CSIR-IHBT, Palampur	Dr. Hans Raj Negi Memorial Lecture on Prospecting plant diversity in Himalaya	November 28, 2013
Dr. Ajay Kohli International Rice Research Institute, Manila (Philippines)	Drought tolerance in rice: a new paradigm	November 29, 2013
Dr. Dharam Singh Distinguished Postdoctoral Fellow, Institute of Molecular Biology, Academia Sinica, Taiwan	Post-transcriptional control of gene expression regulated by mRNA decay in <i>E. coli</i>	March 6, 2014

**VISIT ABROAD**

Dr. Anil Sood: Attended training of technology transfer course under the aegis of the Khorana Program by Indo-US Science & Technology Forum (IUSSTF), University of Wisconsin, Madison and DBT(GOI) (IUSSTF and DBT), Wisconsin-Madison (UW) USA, July 20 to August 03, 2013.

Dr. P.S. Ahuja and Dr. Anil Sood: Visited South Africa to assess the feasibility of the utilisation of bamboo and other vegetation as a tool for land remediation and mine rehabilitation, November 11 to December 8, 2013.

Dr. P.S. Ahuja and Dr. Sanjay Kumar: Attended Australia-India strategic research fund workshop of bio/nanotechnology applications to improve plant productivity and ecosystems services at Deakin University and visit to various industry partners while in Victoria, Australia, March 10-21, 2014.

Dr. Ravi Shankar: Awarded INDO-AUSTRALIA S&T visiting fellowship 2012-13, Australia, for a period of one year w.e.f. July 05, 2013.

Dr. Sanjay Kumar: Attended Deakin University/TERI workshop on bio/nanotechnology applications to improve plant productivity and ecosystems services in Deakin University, Waurin Ponds Campus, Geelong, Australia, March 11-15, 2014.

Dr. Ugir Hossain SK: Awarded 6 months Takeda Foundation International Fellowship at Osaka Prefecture University, Japan, March 27 to September 26, 2013.

MEMORANDUM OF UNDERSTANDING (MoU)

Date	Agreement with	Purpose
May 15, 2013	M/s Ensigns Life Sciences Pvt. Ltd. , Pune & M/s Himachal Health Care, Bilaspur (HP)	Transfer of technologies developed at CSIR-IHBT
May 16, 2013	M/s SANTRU ST. Mount Edgecombe, South Africa	To set up turn key projects in South Africa and disseminate technologies developed at CSIR-IHBT for the benefit of the society
August 8, 2013	M/s Phyto Biotech Pvt. Ltd, Bangalore	For introducing the relevant technologies pertaining to SOD.
October 28, 2013	M/s Bajinath Pharmaceuticals, Paprola (HP)	For collaborative research and development related activities.
November 22, 2013	M/s Rich' n' Healthy Life Sciences Pvt. Ltd., Pune	Identifying the plant varieties, and extraction processes
November 22, 2013	M/s Saffron Nutraceuticals Pvt. Ltd., Pune	To develop suitable strategies for marketing the tea related products developed at CSIR-IHBT
February 1, 2014	M/s Breme Developers Pvt. Ltd., Joginder Nagar (H.P)	aseptic mother stocks of apple root stocks of different varieties
January 2, 2014	M/s Breme Developers Pvt. Ltd., Chauntra, Mandi, Himachal Pradesh	Supply of aseptic cultures of apple rootstocks/
February 28, 2014	M/s Phyto Biotech Pvt. Ltd., Kolkata	For isolation, purification, sequencing and cloning of the Super Oxide Dismutase gene in <i>E.coli</i> and to the process to make and purify SOD
March 22, 2014	Indian Council of Agricultural Research, Shimla (HP)	Production of transgenic potatoes with biotic & abiotic stress tolerance



Name	Training/ Workshop/ Conference/ Meeting	Organiser & Venue	Period
Amit Chawla	Regional training workshop on GIS and climate analogue tools for PGR management and enhanced use	NBPGR, New Delhi and Bioversity International, New Delhi	December 2-6, 2013
	Soft computing techniques for optimization	DST sponsored National Programme for Training of Scientists & Technologists Working in Government Sector, ABV -IIITM, Gwalior	February 17-21, 2014
	Probing the changing atmosphere and its impacts in Indo-Gangetic Plains (IGP) and Himalayan regions (AIM-IGPHim).	CSIR-National Physical Laboratories, New Delhi,	April 16, 2013
Amit Kumar	Alpine ecosystem dynamics and impact of climate change in Indian Himalaya	SAC, ISRO, Ahmedabad, Gujarat	June 11-12, 2013
Aparna Maitra Pati	Laboratory for Education and Research in Science amongst School Children and Teachers (LEARNT)	DST, New Delhi	Jan 27, 2014
	National Education Summit	Gandhinagar	Jan 10-11, 2014
Arvind Gulati, Ashu Gulati, KK Singh, RK Sud, Gireesh Nadda, Yogesh B Pakade and SGE Reddy	Tea Board and CII Face Workshop on Food Standards Safety Regulation 2011 New Mandate,	Guwahati and Tezpur Guwahati and Tezpur	September 11-12, 2013
Bikram Singh	Managing innovation and technology for competitiveness	Administrative Staff College of India (ASCI), Bell Vista; Hyderabad	27 th Jan.- 07 th Feb. 2014
	Indo-US symposium on botanical drug development	CSIR-IIIM, Jammu; Medanta, Gurgaon; and NCNPR USA, at The Medicity, Gurgaon, Haryana	December 13-14, 2013
Brij Lal	Discussion meet of UNEP-GEF biodiversity project on strengthening implementation of biological diversity act and rules with focus on access & benefit sharing provisions	HP State Biodiversity Board, Shimla	April 9-10, 2013
	'Traditional Knowledge (TK) and access benefit sharing (ABS)- a national dialogue'	The National Biodiversity Authority (NBA), at Hyderabad	November 29-30, 2013.
Jai Prakash Dwivedi	Participate in Round Table Conference on Challenges and Possibilities for Up-Scaling High Value Products from Himalayas with Focus on Himalayan Nettle	India Habitat Center, Lodhi Road, New Delhi -110003	October 30, 2013
Rakesh Kumar	Mainstreaming agrobiodiversity conservation and utilization in agricultural sector to ensure ecosystem services and reduce vulnerability	ICAR, New Delhi & Bioversity International at NASC Complex, Pusa Campus New Delhi, India	September 3-4, 2013
	Brain storming meeting on Agrometeorological Research for food and Security in India at Assam Agricultural University, Jorhat	Department of Science and Technology, GOI, New Delhi & Assam Agricultural University, Jorhat, Assam	November 15-16, 2013



	Mainstreaming agro-biodiversity conservation and utilization in agricultural sector to ensure ecosystem services and reduce vulnerability	ICAR, New Delhi & Bioersity International at NBPGR, Regional Station, Shimla (HP)	February 20, 2014
RD Singh	Cultivation, value addition and marketing of medicinal and aromatic plants for rural upliftment in Himachal Pradesh	Himachal Pradesh Department of Environment, Science & Technology, Shimla	July 3, 2013
RD Singh and Rakesh Kumar	'Mainstreaming agrobiodiversity conservation and utilization in agricultural sector to ensure ecosystem services and reduce vulnerability'	Bioersity International, NASC Complex, Pusa Campus, New Delhi.	September 3-4, 2013.
Sanat Sujat Singh	Golden jubilee function of National Bureau of Plant Genetic Resources (NBPGR)	Regional Station, Phagli, Shimla, Himachal Pradesh.	April 6, 2013
Sanjay K Uniyal	Review and planning of Bioresource Information Centre (BRIC)	University of Agricultural Sciences, Bengaluru.	May 30, 2013
Sanjay K Uniyal and Amit Kumar	Establishment of ecological site (HIM ADRI site) and its long term regular monitoring	Organized by SAC, Ahmedabad at Tungnath, Uttarakhand,	October 1-4, 2013.
Sanjay Kumar and SK Vats	Brain storming workshop on snow and glaciers and the Himalayan river systems	State Centre on Climate Change, Shimla, Himachal Pradesh during	May 29-30, 2013
SK Vats	Himalayan environment and development – issues and the way forward	GBPIHED, Almora, Uttarakhand	September 8-9, 2013
	Mountain specific research in the context of Himalaya	GBPIHED Almora, Uttarakhand; INSA, New Delhi; and ICIMOD, Kathmandu, Nepal at Indian National Science Academy, New Delhi	November 19-20, 2013

PARTICIPATION IN EXHIBITION

Occasion	Theme	Exhibitor	Date
21 st Himachal Pradesh State Children's Science Congress at Dharmshal	CSIR-IHBT technologies and Products	Er. Jai Prakash Dwivedi	November 20-23, 2013
101 st Indian Science Congress Exhibition India Vision 2020 Mega Expo, Jammu	CSIR-IHBT technologies and products	Er. Jai Prakash Dwivedi	February 3-7, 2014
HP State Level Holi Festival, Palampur	CSIR-IHBT technologies and products for farmers and entrepreneurs	Er. Jai Prakash Dwivedi and Mr. Sanjay Kumar	March 14-17, 2014
Kisan Mela, Flower Show and Entrepreneurship Programme at CSIR-IIM, Jammu	CSIR-IHBT technologies and products	Er. Jai Prakash Dwivedi and Mr. Sanjay Kumar	March 23, 2014

**DISTINGUISHED VISITORS**

Prof. Ulrich Schurr, Institute Director, Forschungszentrum Jülich, IBG-2 Germany, April 1, 2013

Sh. Brij Behari Lal Butail, Hon'ble Speaker, HP Vidhan Sabha, May 11, 2013

Prof. TA Gonsalves, Director, IIT Mandi, May 11, 2013

Prof. Furqan Gamar, Vice chancellor, Central University Himachal Pradesh, May 11, 2013

Dr. P.L. Gautam, Vice- Chancellor, Career Point University, Hamirpur (HP), June 10, 2013

Dr. NK Singh, B.P Pal Chair, NRCPB, IARI, New Delhi, August 7, 2013

Dr. Nagendra Kumar Singh, Professor, NRCPB, IARI, New Delhi, August 8, 2013

Dr. Srinivasan, Project Director, National Research Center on Plant Biotechnology, IARI, New Delhi, September 26, 2013

Prof. John D. Hamill, Deakin University, Australia, November 22, 2013

Dr. Ajay Kohli, International Rice Research Institute, Manila (Philippines), November 29, 2013

Drs. Sanjeev Sharma, Himachal Electrohomeopathic Doctors Association, Chamba, Himachal Pradesh, December 10, 2013

St. Mary Eassy, Jivadhara Institute of Neuro Development & Research, Ernakulam District, Kerala, December 10, 2013

Mr. Avtar Singh Dhindsa, Beauscape Farms, Amargarh Punjab, February 28, 2014

Prof. Dr. Ingolf Kühn, Professor the Martin-Luther University Halle-Wittenberg, / Germany, March 27, 2014

Prof. Banasri Hazra, Jadavpur University, Kolkata, March 28, 2014

GROUP VISITORS

Visitors	No. of Visitors
Students from Educational Institutes	1180
Farmers, NGOs, and Govt. Officials	609
Total Visitors	1789



IMPORTANT EVENTS

National Technology Day

National Technology Day was celebrated on May 11, 2013. Sh. Brij Behari Lal Butail, Hon'ble Speaker, HP Vidhan Sabha was the Chief Guest on this occasion. Prof. TA Gonsalves, Director, IIT Mandi delivered the Technology Day lecture on "Fostering Innovation for India in IITs".



Prof. Furqan Qamar, Prof. SK Sharma, Prof. TA Gonsalves, Hon'ble Sh. Brij Behari Lal Butail and Dr. PS Ahuja (from left to right) on National Technology Day



Prof. Furqan Qamar, Prof. SK Sharma, Prof. TA Gonsalves, Hon'ble Sh. Brij Behari Lal Butail, Dr. PS Ahuja and Dr. Anil Sood (from left to right) releasing book "Science of Tea Technology" on National Technology Day

CSIR-IHBT Foundation Day

CSIR-IHBT Foundation Day was celebrated on June 10, 2013. Dr. PL Gautam, Vice-Chancellor, Career Point University, Hamirpur (HP) delivered the Foundation Day lecture on "Biodiversity and Society". On this occasion, Dr. Gautam released the Annual Report 2012-13 and a technical brochure "Ornamental Rose (*Rosa Hybrid*) Cultivars" an unique thorn less red Himalayan Wonder Rose. CSIR-IHBT documentary made by NISCAIR was screened on the occasion



Dr. Anil Sood, Mr. Gauhar Raza, Dr. PL Gautam and Dr. PS Ahuja (from left to right) releasing a folder "Ornamental Rose (*Rosa Hybrid*) Cultivars" on the event of CSIR-IHBT Foundation Day



Dr. Anil Sood, Mr. Gauhar Raza, Dr. PL Gautam and Dr. PS Ahuja (from left to right) releasing "CSIR-IHBT Annual Report 2012-13" on the event of CSIR-IHBT Foundation Day



CSIR Foundation Day

CSIR Foundation Day celebrated on September 26, 2013. Dr. Srinivasan, Project Director, National Research Center on Plant Biotechnology, IARI, New Delhi delivered Foundation Day lecture on "Relevance of Promoters in Transgenic Research". Prof. SK Sharma, Former Vice-Chancellor, CSK HPKV, Palampur and Research Council Member, CSIR-IHBT presided over the function



Dr. Anil Sood, Prof SK Sharma, Dr. Srinivasan and Dr. PS Ahuja (from left to right) releasing a folder "Ginseng (Panax ginseng cultivation and Agrotechnology)" on the event of CSIR Foundation Day



Dr. PS Ahuja and Prof. SK Sharma presenting 1st prize to Mr. Ajay M. Mathai for designing "Gram Vigyan Kutir (Village Science Center)" on the event of CSIR Foundation Day

National Science Day

National Science Day celebrated on February 28, 2014 at CSIR-IHBT. Sh. Avtar Singh, CEO, Buescape Farm, Ludhiana (PB) delivered keynote lecture on the topic entitle "Science for Every Farmer". Dr Naresh Kumar, Former Head, RDPD CSIR HQ was the Guest of Honour. Prof. S.K. Sharma, Former Vice Chancellor, CSK HPKV, Palampur presided over the function



Dr. Anil Sood, Dr Naresh Kumar, Prof SK Sharma, Sh. Avtar Singh and Dr. PS Ahuja addressing (from left to right) on National Science Day



Dr. Anil Sood, Dr Naresh Kumar, Prof SK Sharma, Sh. Avtar Singh and Dr. PS Ahuja (from left to right) on National Science Day



Symposium

Third National Symposium on Chitin and Chitosan Research at CSIR-IHBT in association with the Indian Chitin and Chitosan Society, during June 7-8, 2013. Participants: 50.



Awareness programme

An awareness programme on "Food Safety and Standards Regulations, 2011 – The New Mandate" sponsored by Tea Board, 31 October, 2013.



Workshop

Workshop on "Standardization and quality control of herbal medicine" on 10-11th December, 2013.





RESEARCH COUNCIL

CHAIRMAN

Prof. Samir Bhattacharya

Former Director, CSIR-IICB, Kolkata
Emeritus Professor NASI and Sr. Scientist
School of Life Sciences, Visva Bharati (A Central University) Santiniketan-731 235

MEMBERS

Prof. Bharat B Chattoo

Professor & Coordinator
Biotechnology Programme, Genome
Research Centre Dept. of Microbiology and
Biotechnology Centre
MS University of Baroda, Baroda - 390002

Prof. Alok Bhattacharya

Professor
School of Life Sciences & Computational and
Integrative Sciences Jawaharlal Nehru University,
New Delhi- 110067

Dr. N Sathyamurthy

Director
Indian Institute of Science Education
& Research Mohali, Knowledge City, Sector 81,
SAS Nagar Mananli PC - 140306

Dr. Renu Swarup

Adviser,
Ministry of Science & Technology,
Department of Biotechnology,
Government of India Block-2, 7th Floor, CGO
Complex, Lodhi Road, New Delhi-110003

Dr. Imran Siddiqi

Chief Scientist
CSIR-Centre for Cellular and Molecular Biology
Uppal Road, Hyderabad - 500007

Dr. Jai Rup Singh

Vice Chancellor
Central University of Punjab,
City Campus, Mansa Road, Bathinda-151001

PERMANENT INVITEE

Head or Nominee

Planning & Performance Division (PPD)
Council of Scientific & Industrial Research
New Delhi-110 001

Prof. SK Sharma

Former Vice Chancellor
CSK -H.P. Krishi Vishwavidyalaya
Shanti Kunj, Ghuggar Tanda,
Palampur- 176061

Prof. Narpinder Singh

Professor
Dept. of Food Science & Technology
Guru Nanak Dev University,
Amritsar - 143005

Prof. Sandeep Verma

Department of Chemistry
Centre for Environmental Sciences
and Engineering
Indian Institute of Technology
Kanpur - 208016

Dr. Ram A Vishwakarma

Director
CSIR-Indian Institute of Integrative Medicine,
Canal Road, Jammu - 180001

Prof. Siddhartha Roy

Director
CSIR-Indian Institute of Chemical
Biology 4, Raja SC Mullick Road,
Jadavpur Kolkata - 700032

Dr. PS Ahuja

Director
CSIR-Institute of Himalayan Bioresource
Technology, Palampur-176 061 (HP)

MEMBER SECRETARY

Dr. Aparna Maitra Pati

Principal Scientist, PPME
CSIR-Institute of Himalayan Bioresource
Technology, Palampur-176 061 (HP)



MANAGEMENT COUNCIL

Chairman

Dr. PS Ahuja

Director

CSIR-IHBT, Palampur, HP

Members

Dr. Ram A Vishvakarma

Director

CSIR-IIIM, Jammu, J&K

Dr. Aparna Maitra Pati

Principal Scientist

CSIR-IHBT, Palampur, HP

Dr. Sudesh Kumar

Sr. Scientist

CSIR-IHBT, Palampur, HP

Sh. Mukhtiar Singh

Principal Technical Officer

CSIR-IHBT, Palampur, HP

Member Secretary

Sh. JK Parashar

Administrative Officer

CSIR-IHBT, Palampur, HP

Dr. Sanjay Kumar

Sr. Principal Scientist

CSIR-IHBT, Palampur, HP

Er. GD Kiranbabu

Principal Scientist

CSIR-IHBT, Palampur, HP

Dr. Yogendra Padwad

Scientist

CSIR-IHBT, Palampur, HP

Sh. Ishwar Dass

Finance & Accounts Officer

CSIR-IHBT, Palampur, HP

**STAFF****SCIENTIFIC****Director**

Dr. PS Ahuja

Chief Scientist

Dr. Anil Sood

Dr. RD Singh

Dr. Arvind Gulati

Dr. Bikram Singh

Dr. Virendra Singh

Sr. Principal Scientist

Dr. Sanjay Kumar

Sh. D Dhyani

Er. KK Singh

Dr. Ashu Gulati

Dr. Brij Lal

Dr. RK Sud

Principal Scientist

Dr. Aparna Maitra Pati

Er. GD Kiran Babu

Dr. Amita Bhattacharya

Dr. Gopi Chand

Dr. SK Vats

Dr. Vipin Hallan

Senior Scientist

Dr. Sanjay K Uniyal

Dr. RK Sharma

Er. Amit Kumar

Dr. Y Sreenivasulu

Dr. Sudesh Kumar

Dr. Sanat Sujat Singh

Dr. Rakesh Kumar

Dr. Som Dutt

Dr. Shashi Bhushan

Scientist

Dr. Gireesh Nadda

Dr. Neeraj Kumar

Dr. Pralay Das

Dr. Vijai Kant Agnihotri

Dr. Ravi Shankar

Dr. Probir Kumar Pal

Dr. Anil Kumar Singh

Dr. Amit Chawla

Dr. SGE Reddy

Dr. Partha Ghosh

Dr. Mahesh Gupta

Dr. Yogendra S Padwad

Er. Mohit Sharma

Dr. Ashok Kumar

Dr. Yogesh B Pakade

Dr. Amitabha Acharya (21-11-13)*

Dr. Dinesh Kumar (21-11-13)*

Dr. Vikram Patial (21-11-13)*

Dr. Manoj Kumar (03-12-13)*

Dr. Damanspreet Singh (13-12-13)

TECHNICAL**Principal Tech. Officer**

Dr. Raja Ram

Sh. Mukhtiar Singh

Sr. Technical Officer (3)

Sh. Om Prakash

Dr. Kiran Kaul

Sh. RS Shekhawat

Sr. Technical Officer (2)

Sh. Sukhjinder Singh

Sh. Robin Joshi (10-01-14)*

Sr. Technical Officer (1)

Dr. Avnesh Kumari

Sh. Sandeep Tripathi

Sh. Vikrant Gautam

Sh. Jai Prakash Dwivedi

Dr. Kiran Singh Saini

Sh. Ramdeen Prasad

Sh. JS Bisht

Dr. Rajneesh (11-04-13)*

Dr. Khirod K Sahoo(22-04-13)*

Dr. Pankaj K Markand (12-02-14)*

Sh. Shiv Kumar (01-04-13)*

Technical Officer

Sh. Rakesh Kumar

Sh. Anil Kumar

Sh. Vivesh Sood

Sh. Mahesh S

Sh. Ramjeelal Meena

Sh. Sanjay Kumar

Sh. Mohit K Swarnkar

Sh. Jasbeer Singh

Sh. Mukesh Gautam

Sh. Om Prakash

Sh. Prashanta K Behera

Technical Assistant

Ms. Vijay Lata Pathania

Sh. Pabitra Gain

Ms. Meenakshi

Sh. Arvind Kumar Verma

Sh. Anil K Choudhary

Sh. Dharmesh Kumar

Sh. Pawan Kumar (18-04-13)*

Sr. Technician(2)

Sh. Gian Chand

Sh. Janak Singh

Sh. VS Dhadwal

Sh. Khushal Chand

Sh. Dhruv Kumar

Sh. Ajay Parmar

Sh. Karandeep

Technician(2)

Sh. Bhushan Kumar

Sh. Harmesh Chand

Sh. Ramesh Kumar

Sh. Parveen Kumar

Sh. Kuldip Singh

Sh. Sanjay Kumar

Sh. Avinash C Rana

Technician (1)

Sh. Sandeep Sood

Sh. Ranjeet Singh

Sh. Ajay Kumar

Sh. Surjeet Singh

Sh. Arvind Kant

Sh. Vikas Kumar

Ms. Jasveer Kaur

Lab Assistant

Sh. Naresh Kumar

Sh. Anar Singh

Lab Attendant Gr. I(2)

Sh. Baldev Singh

Ms. Rajni Devi Chettri

Sh. Rakesh Chand

Lab Attendant Gr. I(1)

Sh. Yam Bahadur Chettri

Sh. Uttam Chand

Sh. Balak Ram

Sh. Girja Nand

Sh. Deepak Sood

Sh. Kuldip Singh

Sh. Balwant Raj

Ms. Anupama Saini

Sh. Shamsheer Singh

ADMINISTRATION**Administrative Officer**

Sh. JK Prashar

Section Officer (G)

Sh. SD Rishi

Sh. Amarjeet

(Transfer from CBRI 03-06-13)*

Assistant (GEN) Gr. I

Sh. Shanti Kumar

Sh. Raj Kumar

Sh. Parveen Singh

Sh. Devraj Nagina (11-12-13)*

Sh. Ved Prakash (13-12-13)*

Sh. Keerti Raj (30-12-13)*

Assistant (GEN) Gr. II

Ms. Santosh Kumari

Sh. Baldev

Sh. Kiran Kumar

Ms. Pooja Awasthi

Private Secretary

(Vacant)

Senior Stenographer

Sh. Didar Singh Patial

Senior Hindi Translator

Sh. Sanjay Kumar

**Security Assistant**

Sh. Trilok Nath

Coupon Clerk

Sh. Anand Sharma

Staff Car Driver

Sh. Om Prakash

Sh. Kewal Chand

Sh. Pratap Chand

Sh. BrahmDass

Cook

Sh. Oman Singh

Sh. Karan Singh

Chowkidar

Sh. Baleshwar Prasad

Sh. Jagat Ram

Sh. Bahadur Ram

Sh. Ramesh Kumar

Sh. Kuldip Singh

Sh. Bhawani Ram (17-02-14)*

Tea/Coffee Maker

Sh. Bipan Gurang

Others

Sh. Thaman Bahadur

Sh. Nand Lal

Ms. Krishna Devi

Ms. Rujala Devi

Sh. Shankar

Sh. Bipan Kumar

FINANCE & ACCOUNTS**Finance & Accounts Officer**

Sh. Ishwar Dass

(Transfer from CSIO 06-05-13)*

Section Officer (F&A)

(Vacant)

Assistant (F&A) Gr. I

Sh. Manoj Kumar

Sh. Vipin Kumar

Sh. Vikas Pattiaya (19-12-13)*

Assistant (F&A) Gr. II

Ms. Aruna Kumari

STORE & PURCHASE**Store & Purchase Officer**

Sh. SP Prabhakar

(Transfer from NPL 01-01-13)*

Section Officer (S&P)

(Vacant)

Assistant (S&P) Gr. I

Ms. Vinla Devi

Sh. Rajeev Sood

Assistant (S&P) Gr. II

Sh. Puneet Kumar

Transferred to CSIR Laboratories and Other Establishment :

Dr. AK Sinha: Chief Scientist, transferred to CSIR-CDRI, Lucknow on 12.06.2013

Dr. Markandey Singh: Principal Scientist, transferred to IARI, New Delhi on 06.08.2013

Sh. Inderjit Singh: Section Officer (F&A), transferred to CSIR-IMTech, Chandigarh
12.08.2013

Sh. Parshotam Lal: Chowkidar, transferred to CSIR-IIIM, Jammu on 20.09.2013

Er. RK Bindal: Principal Scientist, transferred to CSIR-NPL, New Delhi on 04.10.2013

Dr. Ramesh C Kasana: Scientist, transferred to IARI, Jodhpur on 15.10.2013

Sh. Lakshmi N Pandey, Assistant (G) Gr.I, transferred to CSIR Headquarters on 24.12.2013

Dr.V Shanmugam: Senior Scientist, transferred to IARI, New Delhi on 26.12.2013

Sh. Sunil Kumar, Finance & Accounts Officer, transferred to CSIR HQ, New Delhi on 10-04-
2013Sh. Surender Kumar, Store & Purchase Officer, transferred to CSIR HQ, New Delhi on 10-
04-2013**Retired****Dr. Madhu Sharma,**
Sr. Principal Scientist
(18-02-2014)**Sh. Prem Parkash,**
Lab Assistant
(31-08-2013)**Resigned**

Dr. Bagler Ganesh B (08-04-2014)

*Newly joined staff during 2013-14

**Emeritus Scientist/ CSIR TWAS Postdoctoral Fellow/ Principal Investigators/ Scientist Fellow/ Research Associate/Apprentice/ Sr. Research Fellow/ Jr. Research Fellow****Emeritus Scientist**

Prof. SK Sharma

CSIR TWAS Postdoc. Fellow

Dr. Adebiso Oloisakin

Principal Investigators

Dr. (Ms.) Tanuja Rana

Dr. Ugir Hossain SK

Scientist Fellow

Dr. Vishal Acharya

Dr. (Ms.) Alka Kumari

Research Associate

Dr. (Ms.) Abha Chaudhary

Ms. Pratibha Vyas

Dr. Ashok

Ms. Kiran Devi

Senior Research Fellows

Mr. Hamarshu Sharma

Ms. Ruchi Sharma

Mr. Vivek Dogra

Mr. Sunil Kumar Singh

Mr. Amit Sharad

Mr. Piar Chand

Mr. Rajesh Kumar

Mr. Rahul Mohan Singh

Mr. Anish Kaachra

Mr. Ram Dhan

Ms. Praveen Guleria

Ms. Amrita Shafi

Ms. Rimpdy Dhinan

Mr. Arun Kumar Shil

Mr. Surender Kumar

Mr. Nitul Ranjan Guha

Ms. Pritu Pratibha

Ms. Mrigaya Mehra

Ms. Sushila Sharma

Mr. Aditya Kulshrestha

Ms. Vandna Chawla*

Mr. Ashish Kumar

Mr. Sunny Dhir

Mr. Saurabh Sharma

Ms. Anita Kumari

Mr. Sandeep Kumar

Ms. Parul Goel

Ms. Poonam Roshan

Ms. Indu Gangwar

Ms. Shivalika Pathania*

Mr. Surender Pal

Mr. C Balreddy

Mr. Manoranjan Kumar

Mr. Jai Parkash

Mr. Sumit Dhadwal

Mr. Vishal Sharma

Ms. Preeti

Ms. Monika Bhuria

Ms. Shikha*

Ms. Kiran Mansingh Rawat*

Junior Research Fellows

Ms. Madhu Kumari

Ms. Vandna Thakur

Mr. Ajya Kumar #

Ms. BL Barsain

Mr. Saurabh Sharma

Mr. Vinod Bhatt

Mr. Gulshan Kumar

Mr. Kuldip

Mr. GP Panzade*

Mr. Dinesh Thakur

Ms. Richa Hans*

Mr. Saurabh Soni

Ms. Rubbel Singla

Mr. Roushan Kumar

Mr. Maheshwar Singh

Ms. Tanvi Sharma

Ms. Nisha Dhinan

Mr. Arindam Ghosh Mazumder*

Apprentice

Mr. Jiwan Kumar

* INSPIRE Fellow

DBT-JRF

Tenure Completed

Dr. (Ms.) Jyoti Bhardwaj, PI.

04.10.2013

Ms. Parul Gahlan, SRF

11.02.2014

Ms. Richa Salwan, SRF

31.03.2014

Ms. Hena Dhar, SRF

31.03.2014

Mr. Vineet Kumar, SRF

30.04.2013

Ms. Karnika Thakur, SRF

30.04.2013

Ms. Reenu Kumari, SRF

30.06.2013

Mr. Praveen Kumar, SRF

31.03.2014

Ms. Shammi Bhatti, SRF

23.07.2013

Ms. Rupali Jandrotia, SRF

24.08.2013

Mr. Vishal Kumar, SRF

22.12.2013

Mr. Longue Ekon JP, NAM

Research Fellow -

19.09.2013

Resigned

Dr. Lakshmir Singh, PI.

02.08.2013

Dr. Vikram Patial, Sci. Fellow

20.11.2013

Dr. Amitabha Acharya, Sci. Fellow

20.11.2013

Dr. (Ms.) Aditi Saurabh, Sci. Fellow

11.10.2013

Mr. Rahul Kumar, SRF

19.11.2013

Mr. Dharminder Sharma, SRF

13.09.2013

Ms. Prachi Awasthi, SRF

14.04.2013

Mr. Ashish Kumar Verma, JRF

20.06.2013

Ms. Monika Mahajan, SRF

20.01.2014

Mr. Rajnish Kumar, DBT-BINC (JRF)

31.03.2014

Fellowship transferred to CSIR-CDRI, Lucknow :

Mr. A.G Lavekar, JRF (UGC)

Mr. A.N. Hauserao, SRF (UGC)

Mr. Yogesh Abaso Thopate, SRF (UGC)

सी.एस.आई.आर.—हिमालय जैवसंपदा प्रौद्योगिकी संस्थान, पालमपुर—हि.प्र.
शोध एवं विकास गतिविधियां तथा प्रमुख उपलब्धियां

हिमालय जैवसंपदा का लक्षणचित्रण एवं प्रबन्धन

वर्ष 2013-14 के दौरान संस्थान ने पश्चिमी हिमालय की पुष्पीय संपदा एवं पादपीय संरक्षण के प्रलेखन के उद्देश्य से प्रदेश के चम्बा, कांगड़ा, कुल्लू एवं लाहौल-स्पीति, जनपद के दूरदराज, आरक्षित एवं गैर-आरक्षित वन क्षेत्रों के करीबन 30 वानस्पतिक सर्वेक्षण किये गये हैं। इन सर्वेक्षणों के दौरान पुष्पित पौधों के साथ-साथ पर्णों (फर्न) समुदाय का भी अध्ययन किया गया। इसके अलावा पौधों के 1000 नमूने भी एकत्रित किए गए, जिसमें से करीबन 200 नमूनों को छांटकर विधिवत पादपालय में संचित किया गया। करीबन 15 प्रजातियों ऐसी हैं जिनके नमूने पहली बार इकत्रित किए गए।

स्थायी निगरानी प्रखंड/प्लॉट की स्थापना

हिमालय के उच्च तुंगता वाले क्षेत्रों में फैले भूखंडों, वनों में 'स्थायी निगरानी भूखंड/प्लॉट' लगाए गए। लाहौल-स्पीति में एक हेक्टेअर वर्ग के क्षेत्र में समुद्र तल से 3800 मीटर ऊँचाई पर 'अल्पाइन जोन भोजपत्र वृक्षों के प्रभुत्व वाले जंगलों में 103 जगहों पर प्लॉट लगाए गए हैं। इनका उद्देश्य यहाँ की पारिस्थिकी एवं इस प्रकार के जंगलों के इकोसिस्टम में होने वाले जलवायु परिवर्तन का प्रभाव समझना है।

हिमाचल प्रदेश के चम्बा जिले में भूमि उपयोग/भूमि आवरण का मानचित्रिकरण

हिमाचल प्रदेश के चम्बा जिले का भू-आवरण/भू-उपयोग का मानचित्रण सुदूर संवेदन तकनीक द्वारा किया गया। उपग्रह के प्रतिबिंबों के वर्गीकरण से इस क्षेत्र को मुख्यतः 9 भू-आवरण/भू-उपयोग उपयोग वर्गों में विभाजित किया गया। परिणाम प्रदर्शित करते हैं कि इस जिले का 54.2 प्रतिशत क्षेत्रफल वन आवरण एवं अलपाइन घास है। झाड़ियों और बंजर भूमि 9.65 प्रतिशत क्षेत्र में पाया गया। इसके अलावा 9.71 प्रतिशत कृषि एवं जलीय इकाई के अंतर्गत पाया गया।

कांगड़ा के भू-स्थानीय सूचना तंत्र (KSIS) का विकास

कांगड़ा का भू-स्थानीय सूचना तंत्र (KSIS) एक वेब पर आधारित अनुप्रयोग है, जो हिमाचल प्रदेश के कांगड़ा जिले के लिए संस्थान द्वारा तैयार किया गया है। इसके माध्यम से जिले में उपलब्ध जैव संसाधनों एवं इनके वितरण से संबंधित जानकारी इंटरनेट के माध्यम से प्राप्त की जा सकती है।

कांगड़ा क्षेत्र के वाटरशेड की भू-क्षरण की संभावना का मूल्यांकन

कांगड़ा क्षेत्र के वाटरशेड की भू-क्षरण की संभावना का मूल्यांकन भौगोलिक सूचना तंत्र द्वारा किया गया। इस विश्लेषण से कांगड़ा जिले में 10 वाटरशेड पाये गए जिनमें 1बी 1ए 2(चक्की जब्बन) एवं 1बी1बी5 (देहार) वाटरशेड में प्रवाह अपरदन की संभावना अधिक पायी गई है।

ग्रेट हिमालयन राष्ट्रीय उद्यान (जीएचएनपी) की नेट प्राइमरी प्रोडक्टिविटी (एनपीपी) का आंकलन

ग्रेट हिमालयन राष्ट्रीय उद्यान (जीएचएनपी) कुल्लू, हि. प्र. की नेट प्राइमरी प्रोडक्टिविटी (एनपीपी) का आंकलन 2013 के MODIS उपग्रह के आँकड़ों से किया गया। विश्लेषण से यह ज्ञात हुआ कि इस क्षेत्र की वार्षिक औसत NPP का 523.81 ग्राम कार्बन/मीटर²/वर्ष है।

पौधों के अतिक्रमण का अध्ययन

हिमाचल प्रदेश में पाई जाने वाली अजनबी पौध प्रजातियों पर अध्ययन करने से पता चला है कि राज्य कि 15% वनस्पतियाँ विदेशी हैं। इन प्रजातियों में बहुतायत (73% जातियाँ) वनस्पतियाँ शाकीय हैं, जो एस्ट्रेसी (60 जातियाँ), पोएसी (48 जातियाँ) तथा लेग्युमिनेसी (43 जातियाँ) कुल से संबंधित हैं। समस्त जातियों में यूकेलिप्टेस एवं आइपोमियाँ (9) तथा यूफोरबिया (8) सर्वाधिक प्रभावी हैं।

प्रजातियों के वितरण का प्रतिमान

सेपियम सेबीफेरम विश्व में सर्वाधिक अतिक्रमक प्रजाति है, तथा पश्चिमी हिमालय में इसका आक्रामक रूप फैलना संरक्षण का एक गंभीर विषय है। इसके मदेनजर से, सेबीफेरम के पश्चिमी हिमालय में संभावित वितरण की विषयवाणी करने हेतु मैक्सैन्ट-अधिकतम एन्ट्रापी आधारित कार्यक्रम को प्रयोग में लाया गया। मॉडेलिंग से यह ज्ञात हुआ है कि से. सेबीफेरम के संभावित वितरण का कुल क्षेत्रफल 11920 वर्ग किमी है। इसका संभावित विस्तार उत्तरी आक्षांश 30°14'43" से 32°50'40" तक पूर्वी देशांतर 74°52'25" से 79°23'28" तथा 349मी. से 2390मी. की तुंगता तक आँकी गयी है। समस्त संभावित क्षेत्र के कुल 15% क्षेत्र में इन प्रजातियों की पाये जाने की अत्यधिक संभावना पायी गयी।

पर्णागों की जैव-विविधता का अध्ययन एवं संरक्षण

मंडी जनपद के बरोट एवं शिकारी देवी वन्यजीव संरक्षण क्षेत्रों में पाये जाने वाले पर्णागों की जैव विविधता के अध्ययन फलस्वरूप करीब 90 प्रजातियाँ (85 फर्न एवं 5 फर्न-एलिस) बरोट से एवं 105 प्रजातियाँ (100 फर्न एवं 5 फर्न एलिस) शिकारी देवी वन्यजीव संरक्षण क्षेत्र से सूचिवद्ध की गई हैं। इनमें करीबन 30 प्रजाति संकटाग्रस्त हैं। पादप संरक्षण को ध्यान में रखते हुए कुछ संकटाग्रस्त प्रजातियों को मिलाकर वर्तमान में करीबन 140 पर्णागों की प्रजातियाँ संस्थान के फर्नरी में सफलतापूर्वक स्थापित की गयी हैं।

नवीन रिकार्ड

उपरोक्त वानस्पतिक सर्वेक्षणों के परिणामस्वरूप एवं एकत्रित पादप नमूनों के गहन अध्ययन के आधार पर दो प्रजातियाँ जैसे झायोप्टेरिस जेयूएन्सिस एवम टेरिस बाइउरीटा सबस्पीसीज़ फोर्निकेटा हिमाचल प्रदेश से पहली बार रिपोर्ट की गई।

नूतन वानस्पतिक अध्ययन

कालाटोप क्षेत्र जनपद चम्बा के सर्वेक्षण के दौरान लगभग 25 ऐसे औषधिय पौधों के बारे में जानकारी प्राप्त की जिन्हें स्थानीय लोग विभिन्न प्रकार की व्याधियों को ठीक करने में प्रयोग करते हैं, जिसमें कुछ प्रमुख वनस्पतियाँ हैं ऐन्सिलया (जलन तथा छाले), अजूगा (घाव भरने में), एस्प्लेनिथम (खुजली में), बेरगिनिया (घाव भरने में), जीरेनिअम (दंत-पीड़ा), तथा सोर्वेरिया (अतिसार रोग) आदि।

पादप प्रजातियों का प्रमाणीकरण

विगत वर्ष में विभिन्न संस्थाओं के शोध-छात्रों एवं वैज्ञानिकों द्वारा भेजी गयी ऐसे 50 पादप प्रजातियों के नमूनों की पहचान की गयी है जो मूल रूप से उक्त संस्थाओं के शोध-छात्रों एवं वैज्ञानिकों के शोध कार्यों से संबंधित थीं।

इंडियन फर्न सोसाइटी' के वेबसाइट का विकास

संस्थान के जैव-विविधता प्रभाग द्वारा 'इंडियन फर्न सोसाइटी' के लिए एक वेबसाइट विकसित की गयी है जो संस्थान के वेबसाइट से लिंकड है तथा इसे सीधे <http://www.ihbt.res.in/IFS/index.html> द्वारा देखा जा सकता है।

उच्च तुंगता जीवविज्ञान और जलवायु परिवर्तन

उच्च तुंगता कठोर जलवायु युक्त क्षेत्रों में केरागाना जुवाटा उत्तरजीविता के लिए आश्विक उपाय

हिमाचल प्रदेश के लाहौल व स्पीति जिले के शुष्क मरुस्थल स्पीति घाटी के कठोर और प्रतिकूल पर्यावरण को उच्च विकिरण, तापमान और जल की अत्यधिक कमी में लक्षणचित्रण किया गया। इस क्षेत्र की चिरस्थायी झाड़ी केरागाना जुवाटा की उत्तरजीविता को जानने के लिए आश्विक उपायों को खोजा गया और जीन की प्रभुता पाई गई। इस वर्ष केरागाना जुवाटा के जीन के गुणों का अध्ययन किया गया। विश्लेषण से पाया गया कि कथित जीन, मिथाईल जैसमोनेट की उपस्थिति में सबसे ज्यादा प्रतिक्रिया दर्शाती है।

भारतीय ट्रांस-हिमालय से सूक्ष्मजीवों का बिलगन और पहचान

भारतीय ट्रांस-हिमालय के ऊंचे उच्चतम शीलों एवं ग्लेशियरों से सूक्ष्मजीवों की विश्लेषण विविधता एवं पहचान का कार्य शुरू किया गया है। *Camellia sinensis*, *Cedrus deodara*, *Dactylorhiza hatagirea*, *Ephedra gerardiana*,

Ginkgo biloba, *Hippophae rhamnoides*, *Juniperus communis*, *Picrorhiza kurroa*, *Pinus roxburghii*, *Populus alba*, *Potentilla anserina*, *Taxus baccata* and *Salix satcifolia* से कुल मिलाकर 701 बैक्टीरिया, 72 एक्टिनोमाइसिटी एवं 209 फफूंद निकाले गए।

भारतीय ट्रांस-हिमालय से सूक्ष्म जीवों का अलगाव एवं लक्षणचित्रण

पिछले काम की निरंतरता में विविधता विश्लेषण तथा लक्षणचित्रण, सूरज ताल और चन्द्र ताल झीलों से अलगाव किए गए सूक्ष्म जीवों के अनुवांशिक परिवर्तनशीलता का परीक्षण एरिक-पोलिमिरेज शृंखला अभिक्रिया द्वारा किया गया। एरिक-फिंगरप्रिंट से जीवों की बहुरूपता को देखा गया। 16 sRNA जीन क्रम के आधार पर बैक्टीरिया ने निम्न वंशक्रम आश्रीवेक्टर, बेसिलस, बोसेया, ब्रेबुडीमोनास, फ्लेबोबैक्टीरियम, जेनवेक्टर, कोकुरिया, मिथाइलोबैक्टीरियम, माक्रोबैक्टीरियम, पेनिबेसिलस, पीडोवेक्टर, सूडोमोनास, रॉडोकोकस, सालिनीबैक्टीरियम, सांगुइवेक्टर, स्फिंगोमोनास तथा स्टेफाइलोकोकस के साथ संबंध दर्शाया।

माइक्रोवियल एंजायम

एसीनिटोवेक्टर से सिरिन प्रोटीएस को ई. कोलाई में व्यक्त किया गया। आइपीटीजी से 5 घंटे बाद सबसे ज्यादा प्रोटीन का उत्पादन ई. कोलाई में देखा गया। 35 किलो डालटन माप का प्रोटीन निकल-एनटीए से परिष्कृत किया गया। पीनिबेसिलस से दो एंडोग्लूकानेस जीन को ई. कोलाई में व्यक्त किया गया। इनमें से एक जीन 63 किलो डालटन माप एवं दूसरा 59 किलो डालटन माप के पाये गए। सक्रिय पुनःसंयोजक एंजायमस को निकल-एनटीए से परिष्कृत किया गया। परिष्कृत प्रोटीन को आदर्श तापमान, पीएच और विभिन्न सबस्ट्रेट्स के लिए परीक्षण किया गया।

हिमाचल प्रदेश स्थित चंद्रा नदी से प्राप्त जीवाणु प्लानॉमिक्रोवियम जीनस के प्रथम स्पीशीज का जीनोम अनुक्रम किया गया। प्लानॉमिक्रोवियम *glaciel* CHR43 जीवाणु में तापमान की एक विस्तृत रेंज पर protease एंजाइम उत्पादन की क्षमता है। PaSOD जीन की उच्च अभिव्यक्ति से ट्रांसजेनिक एरॉबिडोप्सिस पादप में कैलस विकास, पौधों के विकास और नमक तनाव सहिष्णुता में सुधार पाया गया।

जिनोमिक्स एवं प्रोटियोमिक्स

अरबिडोप्सिस में स्टीविआ रेबडिआना के स्टेविओल ग्लाइकोसाइड जैवसंश्लेषण पथ के जीनों का अतिप्रकटन जिबबरेलिन संग्रहण व पौधों पर इसके विकास मापदंडों का प्रभाव देखने के लिए SrUGT85C2 पराजीनिक क्रमों का अरबिडोप्सिस थेलिआना द्वारा विकास किया गया। विकसित पराजीनिक क्रम में जिबबरेलिन तत्व की 78-83 % तक गिरावट के साथ-साथ इसके आंतरिक पददंडों जैसे कम लम्बाई वाले हड्ढोकोटिल, तने के विकास में कमी व सम्बंधित जल की कमी भी पायी गयी। स्टेविओल ग्लाइकोसाइड व जिबबरेलिन की \square भांति क्लोरोफिल तत्व में भी कमी पायी गयी, पराजीनिक क्रमों में 17-37 % क्लोरोफिल ए व 64-76 % क्लोरोफिल बी की कमी पायी गयी इन दोनों की भांति क्लोरोफिल का जैवसंश्लेषण एम.इ.पी. पथ द्वारा किया जाता है। संभवतः SrUGT85C2 जीनों के अतिप्रकटन के कारण क्लोरोफिल संश्लेषण पथ भी प्रभावित हो रहा है।

एराबिडोप्सिस के ROS1 जीन का तम्बाकू में लवण तनाव की स्थिति में फ्लेवोनॉयड व ऑक्सीकरणरोधी प्रणालियों के पश्चजनन नियंत्रण का मूल्यांकन

तम्बाकू में लवण तनाव के समय फ्लेवोनॉयड व ऑक्सीकरणरोधी प्रणालियों के अध्ययन व इस पथ के जीनों के पश्चजनन नियंत्रण को समझने के लिए अरबिडोप्सिस के ROS1 जीन को तम्बाकू के पौधों में निवेशित कर ROS1 अतिप्रकटित पराजीनिक पौधों को विकसित किया गया है। फ्लेवोनॉयड व ऑक्सीकरणरोधी प्रणालियों के किण्वकों को कोडित करने वाले जीनों के प्रतिलिपि स्तरों का विश्लेषण किया गया है इन परजीनिक पौधों के आकारिकी व आणविक स्वरूपों का अभी विश्लेषण किया जाना है।

चाय का अभिकलनात्मक पश्चजीनोमिक व पश्चजनन सम्बन्धी अध्ययन

चाय की जागृत व सुसुप्त अवस्था के अंकुरों व पुरानी पत्तियों को चाय (कैमेलिया सिनेन्सिस) के विभिन्न सम्बन्धी जैसे-कम्बोड, असमिका तथा हिमस्फुर्ती (चाइनेरी) से एकत्रित किया गया। प्रदीप्त जीनोम विश्लेषक GALLX द्वारा चाय के विभिन्न नमूनों की प्रतिलिपिक सामग्री को उत्पन्न किया गया। प्रदीप्त अनुक्रमण तकनीक का प्रयोग करके अनुमानतः

192, 820, 752 आरएनए अनुक्रमित रीड प्राप्त किये गए।

सूखे के तनाव के प्रति कुल्थी की प्रतिक्रिया का प्रतिलेखन व सूक्ष्म आर एन ए तकनीक द्वारा विश्लेषण

पौधों में सूखे के प्रति बचाव के गुण विभिन्न चयापचयी क्रियाओं द्वारा संधृत किए जाते हैं। परंतु कुल्थी के जिनोंम के अनुक्रमित न होने के कारण सूखे के प्रति इसके व्यवहार को समझाना अत्यंत कठिन है। अतः सूखे के प्रति साहिष्णु इस फलीदार पौधे के अनुवांशिक रूप को समझने हेतु एक नए सीरे से इसका प्रतिलेखन व संबंध विश्लेषण किया गया। जिसमें कुल्थी के दो जीनोंटाइप्स (सूखे से संवेदनशील; एम-19) व (सूखे से सहनशील; एम-249) के तने व जड़ के आठ नमूनों का सामान्य व पॉलीएथाईलीन ग्लाइकोल आधारित परीक्षण किया गया। प्रदीप्त अनुक्रमण तकनीक का प्रयोग कर के 229,297, 89 ; युग्मों व रीड युग्मों को उत्पन्न किया गया। 26, 045 प्रतिलिपियां हेतु महत्वपूर्ण ब्लास्ट हिट्स प्राप्त किए गए व कुल 21887 एकल जीनों की पहचान की गई। सूखे के तनाव की स्थिति में जीन ऑटोलोजी प्रतिक्रिया में किण्वक गतिविधि अत्यधिक व्यक्त की गई थी व जिनोंम विश्लेषण व जीनों के क्योटो एन्साइक्लोपेडिया में सयन्त्र रोगजनक व हॉर्मोन संकेत परागम अनुग्रहित राइबोसोम चयापचयी पथ में प्रमुख रूप से सम्मिलित थे। इस खोज ने सुझाया कि वेलीन में गिरावट, ग्लूकोनेओजेनेसिस व प्युरीन न्यूक्लेओटाइड में गिरावट अत्यंत सूखे से प्रभावित है। एन. ए. सी., मिब संबंधित व डब्लू.आर.के.वाई. वंशों से संबंधित ट्रांसकृपशन तथ्य तनाव कि स्थिति में वर्णित पाए गए। इस अध्ययन द्वारा पहचाने गए जीनों व पथों द्वारा कुल्थी के सूखे के तनाव के प्रति रक्षा प्रतिक्रिया व कुशल विनियमन के सक्रिय अनुकूलन का प्रमाण दिया गया।

तंबाकू के मेड बॉक्स प्रमोटर में उत्परिवर्तन की अभिव्यक्ति के फलस्वरूप फूल वर्ग-बी के जीनों द्वारा सेपल का पंखुडियों में परिवर्तन

सेपल के पंखुड़ी व अन्य समलक्षणी असमानताओं वाले एक उत्परिवर्तित परजीनिक क्रम का आणविक विश्लेषण किया गया। जिस में ये पाया गया कि वर्ग बी जीनों, ग्लोबोसा व डेफैसीन एवम एंथोसाइयनिन सिन्थेज का कोडन करने वाले जीनों के प्रकटन के कारण सम्भवतः इसके पेटिलाइड अंगों के होमोयोटिक परिवर्तन हेतु उत्तरदायी हैं। जब जीन कि अवस्थिति जानने हेतु इस क्रम का आलंकरण किया गया तो यह पाया गया कि टी-डीएनए वर्ग बी के मेडस बॉक्स जीन ग्लोबोसा के प्रमोटर के खंड में निवेशित था जो संभवतः इस जीन के प्रकटन को नियंत्रित कर रहा है।

जीन गुप्तता व अतिप्रकटन के सम्मिलित दृष्टिकोण द्वारा स्टीविया रेबाडडियाना के स्टेवियोल ग्लायकोसाइड के जैवसंश्लेषण से संबंधित जीनों का क्रियात्मक मूल्यांकन।

स्टेवियोल ग्लायकोसाइड जैवसंश्लेषण पथों के आणविक नियंत्रण को समझने हेतु इस पथ को जीनों का स्टीविया रेबाडडियाना व अरेबिडोप्सिस थालियाना में गुप्तता व अतिप्रकटन किया गया जिसमें एंट-कोरिनोईक अम्ल की शाखा के रूप में स्टेवियोल ग्लायकोसाइड जैवसंश्लेषण पथों का व जिब्वरेलिन जैवसंश्लेषण में मेथिल एरिथ्रीट्रोल फास्फेट पथ के नेतृत्व की भूमिका प्रकट हुई।

स्टीविया रेबाडडियाना में स्टेवियोल ग्लायकोसाइड पथों के जैवसंश्लेषण संबंधित जीनों की साइलेंसिंग।

आरएनएआई माध्यम व एग्रोबैक्टीरियम माध्यम द्वारा SrKA13H व अन्य तीन जीनों SrUGTs (SrUGT85C2, SrUGT74G1, SrUGT76G1) को गुप्त किया गया। SrKA13H व तीन SrUGTs ने संपूर्ण स्टीवियोल ग्लाइकोसाइड के संग्रहण को कम कर दिया जबकि SrUGT85C2 व SrKA13H के एमटी ने जिब्वरेलिन की मात्रा को बढ़ा दिया। यह पाया गया की स्टीवियोल ग्लाइकोसाइड चयापचयी पथ की बाध्यता ने इसे जिब्वरेलिन के संश्लेषण की ओर परिवर्तित कर दिया। इसके अतिरिक्त SrUGT76G1 आणविक दस्तावेजों द्वारा SrUGTs के प्रोटीनों से सम्बन्ध स्थापित किया गया। यह प्रमाणित हुआ की स्टीवियोल ग्लाइकोसाइड के न्यून अंश का SrUGT76G1 की गुप्तता से सम्बन्ध है इस अध्ययन द्वारा स्टीवियोल ग्लाइकोसाइड जैवसंश्लेषण के एक अन्य पथ को भी प्रमाणित किया गया है।

नैनोतकनीक

निर्धारित कैंसर कोशिकाओं का बहुपयोगी नैनोकॉम्पोजिट द्वारा प्रत्योक्षकरण

फोलिक एसिड संयुग्मित नैनोकॉम्पोजिट की साईटोटॉक्सिसिटी और सेल अपटैक की जाँच के लिए उन्हें विभिन्न सेल लाईंस के साथ परखा गया। इस अध्ययन में पाया गया की यह नैनोकॉम्पोजिट सी-6 कोशिकाओं के लिए विषाक्त थे।

परन्तु ए-549 कोशिकाओं पर इनका कोई प्रभाव नहीं था। अधिक अध्ययन के लिए इस नैनोकम्पोजिट को चूहे में इंजेक्ट किया गया और चूहे के फेफड़ों के ऊतकों में इनकी उपस्थिति पाई गयी। इन नैनोकम्पोजिट की स्थिरता को बढ़ाने के लिए इन पर और शोध कार्य चल रहा है।

नैनोकणों पर आधारित कीटनाशक संसंर

एक और गतिविधि में नैनोकणों के एक नए वर्ग को रासायनिक कीटनाशकों का पता लगाने के लिए संश्लेषित किया गया था। विभिन्न कीटनाशकों के अध्ययन द्वारा पाया गया की केवल डाईकोफॉल (Dicofol) ही नैनोकम्पोजिट की प्रतिदीप्ति तीव्रता fluorescence intensity में वृद्धि करने में सक्षम है।

प्राकृतिक पादप व संश्लेषण रासायनिकी

बेंजइमिडाजोल, बेंजोक्साजोल एवं बेंजोथायाजोल का उत्प्रेरक एवं क्षार रहित संश्लेषण:

विभिन्न एराइलबेंजाजोल के संश्लेषण के लिए एक कुशल एवं उन्नत विधि स्थापित की गई। यह विधि उत्प्रेरक एवं क्षार रहित होते हुए भी विभिन्न अभिक्रियाशील समूहों की उपस्थिति में प्रयोग है।

नाइट्रोएरीना के अवकरण के लिए लौह एवं पैलाडियम थैलोसायनिन उत्प्रेरक:

विभिन्न नाइट्रोएरोमैटिक एवं हेटेरोएरोमैटिक के अवकरण के लिए लौह एवं पैलाडियम थैलोसायनिन को उत्प्रेरक के रूप में स्थापित किया गया। यह विधि ग्राम स्तर के अभिक्रिया के उत्पादकता के लिए भी उपयुक्त है।

मोनो एवं पोलिसेकेराइड का सिलिका आधारित बोरिक एसिड से हाइड्रोक्सीमिथाइल में रूपांतरण:

इस विधि में सिलिका समर्थित बोरिक एसिड उत्प्रेरक की उपस्थिति में फक्टोज, ग्लूकोज, सूकोज, इन्जुलिन एवं सेल्यूलोज को हाइड्रोक्सीमिथाइल फरफ्यूरल में सफलतापूर्वक रूपांतरित किया गया।

कोबाल्ट(II) थैलोसायनिन एवं पी.एम.एच.एस. का उपयोग करके नाइट्रोएरीना का कार्बोक्जिलिक अम्ल से प्रत्यक्ष अवकरित अमाइडेसन:

विकसित प्रोटोकाल में कोबाल्ट थैलोसायनिन का उपयोग करके विभिन्न तरह के अमाइड का संश्लेषण किया गया। यह विधि विभिन्न अभिक्रियाशील समूहों की उपस्थिति में भी अमाइड संश्लेषण के लिए उपयुक्त एवं सक्षम है।

अभिक्रियाशील एरीन का बैसिसीन उत्प्रेरित प्रत्यक्ष सी.एच. एराइलेसन:

अधातोका वैसिका से एक पृथक उपक्षार वैसिसीनका उपयोग कार्बनिक के रूप में विभिन्न प्रकार के बाइएराइल संश्लेषण के लिए किया गया।

ईस्टर अमाइड एवं डाइहाइड्रोपिरिमिडिनोन का सिलिका आधारित बोरिक अम्ल उत्प्रेरित संश्लेषण:

इस विधि में सिलिका आधारित बोरिक अम्ल का उपयोग रिसायकलेबल उत्प्रेरक के रूप में अल्कोहल, फेनाल, एमिन तथा थयोल के एसिटाबलेन के लिए किया गया।

अल्कोहल के उपयोग से एराइल एवं हेटेरोएराइल एमिन का लौह थैलोसायनिन उत्प्रेरित एन-अल्कोइलेसन:

इस विकसित विधि में लौह थैलोसायनिन को उत्प्रेरक के रूप में उपयोग करने दमीनोबेंजोथायाजोल, एमीनोपिरिडीन एवं एमीनोपिपिडिन का एन-अल्कोइलेसन किया गया।

संकमण धातु मुक्त नाइट्राइल से अमाइड का संश्लेषण:

सोडियम बोरोहाइड्राइड का उत्प्रेरित मात्रा में उपयोग करते हुए विभिन्न सगंध, सिग्म (एलिफैटिक) एवं असमलैंगिकसगंध नाइट्राइल को बनुरूप अमाइड में परिवर्तित किया गया।

जीवाणुरोधी एवं फफूंदरोधी सक्रिय अणुओं के रूप में 2-एमीनो-1, 4-नेफथाक्वीनोन का संश्लेषण:

हाइड्रोक्लोरेट-सिलिका उत्प्रेरित 2-एमीनो-1, 4-नेफथाक्वीनोन का संश्लेषण प्राथमिक एवं माध्यमिक एमिन तथा 1, 4-नेफथाक्वीन से किया गया।

एल्कोहल तथा एमिन से इमिन की कुशल आक्सीकृत संश्लेषण

लौह थैलौसायनिन उत्प्रेरक की उपस्थिति में विभिन्न सगंध और स्निग्ध एल्कोहल से इमिन का संश्लेषण किया गया।

छोटे स्कैफाल्ड का उपयोग करके विभिन्न कौमेरिन का संश्लेषण:

सायक्लोहेक्सेन के विभिन्न यौगिकों को नये स्कैफाल्ड के रूप में उपयोग करके कौमेरिन के यौगिकों का संश्लेषण किया गया।

माइक्रोवेव की सहायता से इनामिनोईस्टर और एक्सीडिनडायोन के नये वर्गों के संश्लेषण के लिए विलायक और उत्प्रेरक मुक्त विधि:

इस विधि में β -इनामिनोईस्टर एवं एक्सीडिनडायोन के साथ-साथ पेप्टाइड मिमिक अणुओं का संश्लेषण भी किया गया है।

माइक्रोवेव की सहायता से टोस आधारित रूथेनियम नैनोकण उत्प्रेरित नाइट्राइल का अमाइड में परिवर्तन:

टोस आधारित रूथेनियम का विजातीय उत्प्रेरक के रूप में उपयोग करके नाइट्राइल एवं उनके विभिन्न यौगिकों से अमाइड का संश्लेषण किया गया।

टोस आधारित पैलेडियम नैनोकणों से उत्प्रेरित बड़े पैमाने पर सुजुकी अमिक्रिया के लिए अल्ट्रासाउंड प्रेरित सतत प्रवाह तकनीक:

इस विधि में टोस आधारित पैलेडियम नैनोकणों का उपयोग विभिन्न हैलोएरिन एवं फेनाइल बोरानिक अम्ल के सुजुकी कास कपलिंग के लिए किया गया है। यह विधि ग्राम स्तर अभिक्रिया के लिए अत्यधिक उपयुक्त है।

टोस आधारित प्लैटिनम नैनोकण उत्प्रेरित नाइट्रोएरिन का हाइड्राक्सील एमिन में अवकरण:

इस विधि में विभिन्न नाइट्रोएरिन के यौगिकों को सफलतापूर्वक हाइड्राक्सील एमिन में परिवर्तित किया गया। यह विधि दूसरे अभिक्रिया शील समूहों की उपस्थिति में भी उपयुक्त है।

टोस आधारित रूथेनियम नैनोकण : बेंजाइलिक एवं एलाइलिक एल्कोहल की वायुजीवी आक्सीकरण से कार्बोनिक रूपांतरण के लिए एक सक्षम विजातीय उत्प्रेरक

इस विधि में टोस आधारित रूथेनियम नैनोकणों का उपयोग विभिन्न एलाइलिक एवं बेंजाइलिक एल्कोहल को आंशिक आक्सीजन की उपस्थिति में अनुरूप कार्बोनाइलिक यौगिकों में परिवर्तित किया गया है।

फसल सुधार के लिए बहुवर्षीय पद्धति

हिमाचल प्रदेश स्थित चंद्रा नदी से प्राप्त जीवाणु प्लानॉमिक्रोबियम जीनस के प्रथम स्पीशीज का जीनोम अनुक्रम किया गया। प्लानॉमिक्रोबियम *glaciei* CHR43 जीवाणु में तापमान की एक विस्तृत रेंज पर protease एंजाइम उत्पादन की क्षमता है। PaSOD जीन की उच्च अभिव्यक्ति से ट्रांसजेनिक एरॉबिडॉप्सिस पादप में कैल्स विकास, पौधों के विकास और नमक तनाव सहिष्णुता में सुधार पाया गया।

चाय में माइक्रोसेटेलाइट चिन्हक की पहचान तथा प्रयोग:

चाय के अनुवांशिकी को समझने तथा चाय के अनुवांशिकी गुणों को उत्तम बनाने हेतु माइक्रोसेटेलाइट चिन्हक पहचाने गये। माइक्रोसेटेलाइट चिन्हक चाय के संकरण में बहुत ही उपयोगी है। माइक्रोसेटेलाइट चिन्हक की उपयोगिता विभिन्न चाय की प्रजातियों के पहचानने में किया जाता है। हमारे द्वारा पहचाने गए माइक्रोसेटेलाइट चिन्हक चाय के विभिन्न जो चाय की गुणवत्ता को संकरण के माध्यम से बढ़ाने में उपयोगी सिद्ध होंगे।

स्टीविया:

माइक्रोसेटेलाइट चिन्हक का उपयोग स्टीविया पौधे का द्वितीयक उत्पाद रीबोडियोसाइट स्वीटनर की तरह प्रयोग होता है। यह उत्पाद मधुमेह रोगियों के लिए लाभकारी होता है। स्टीविया का द्वितीयक उत्पाद बढ़ाने हेतु उसके आनुवांशिक गुणों का समझना आवश्यक है। हमने स्टीविया से भी माइक्रोसेटेलाइट चिन्हक पहचाने तथा उसकी विविधता को

पहचानने का अध्ययन किया। इस प्रकार हमारे द्वारा पहचाने गये माइक्रोसेटेलाइट चिन्हक स्टीविया की द्वितीयक उत्पाद क्षमता को बढ़ाने में विषय में सहायक सिद्ध होंगे।

उत्तरी भारत के एक्वेलेरिया के जीनोम का अध्ययन:

एक्वेलेरिया पौधों में बहुत से औषधीय गुण विद्यमान है। प्रकृति में विभिन्न एक्वेलेरिया की विविधता तथा जैवविज्ञान के अध्ययन हेतु हमने एएफएलपी चिन्हक की सहायता से पौधों की जीनोटाइपिंग की। जिससे हमें ज्ञात हुआ कि इसके पौधों में बहुत विविधता है जो विश्व में एक्वेलेरिया तथा नजदीकी पौधों की गुणवत्ता के सुधार में उपयोग में लाए जा सकते हैं।

बांस का तुलनात्मक मानचित्र :

हमने बांस में माइक्रोसेटेलाइट चिन्हक पहचाने तथा इन चिन्हक का प्रयोग चावल के पौधों पर किया। अध्ययन से इनके सिनेटनी अध्ययन से हम एक पौधे में बनाने गये चिन्हक की उपयोगिता को उसके नजदीक पौधे में प्रयोग कर सकते हैं। इस प्रकार हमारे द्वारा बनाये गये चिन्हक बांस और चावल के आनुवांशिकी को समझने तथा उनकी उपयोगिता को बढ़ाने में सहायक होंगे।

गुलाब फूल कटाई चरण का संगंध तेल की मात्रा और रचना पर प्रभाव

गुलाब फूल (रोजा डेमसिना) की कटाई चरण का संगंध तेल की मात्रा और रचना पर प्रभाव का अध्ययन करने के लिए अप्रैल से मई 2013 के दौरान प्रयोग किए गए। नतीजे बताते हैं कि तोड़े गए फूलों में संगंध तेल की मात्रा अधिक दर्ज की गई। परन्तु उच्च तेल सीआईएस गुलाब ऑक्साइड, citronellol + nerol, geraniol और अन्य चरणों की तुलना में कम पाई गई।

फूलों का भंडारण की स्थिति का जामदानी गुलाब (रोजा Damascena मिल.) के आवश्यक तेल की मात्रा और रचना पर पश्चिमी हिमालय में प्रभाव

गुलाब के फूलों को geraniol की दर 4 ± 0.5 डिग्री सेल्सियस पर 10 से 30 दिनों तक भण्डारण से अवधि में वृद्धि के साथ $2.29 \pm 1.79\%$ से $19.07 \pm 1.25\%$ से कमी आई है। अधिकतम तेल और घटकों की प्राप्ति हेतु तोड़े गए फूलों को 20 डिग्री सेल्सियस पर संग्रहित करना उत्तम पाया गया।

वैलेरियाना जटामांसी और हाइपरकेटम के उत्पादन विकास और बायोमास पर ऊंचा CO² और तापमान का प्रभाव

चल रहे वैश्विक परिवर्तन के साथ संयोजन के रूप में वायुमंडलीय कार्बन डाइऑक्साइडके प्रभाव को समझना स्ट्रेस शमन और फसल उत्पादन के लिए अनुकूलन के लिए तैयार करने के लिए महत्वपूर्ण है। उच्च कार्बन डाइऑक्साइड और उच्च तापमान की प्रतिक्रिया दो औषधीय पौधों में जांची गई। हाइपरकेटम की कुल शुष्क बायोमास उच्च कार्बन डाइऑक्साइड में अधिक था। वैलेरियाना जटामांसी में ऊंचे तापमान से परिवेश (Ambient) और उच्च कार्बन डाइऑक्साइड की तुलना में फ्लादागमिकी (Phenological stages) छोटा था।

हिप्पोफी जर्मप्लाज्म संसाधन केन्द्र

संस्थान ने लाहौल में हिप्पोफी जर्मप्लाज्म संसाधन केन्द्र (हिमाचल प्रदेश) की स्थापना की है। वर्तमान में रूस और चीन से 143, हिमाचल से Hippophae के accessions, लेह क्षेत्र (जम्मू एवं कश्मीर) से 60 accessions अक्टूबर 2013 में जोड़ी गई।

औषधीय और सुगंधित पौधों पर प्रदर्शन

लाहौल एवं स्पीति के ठंडे रेगिस्तान क्षेत्र में औषधीय और सुगंधित पौधों को लोकप्रिय करने के लिए, phaphra (*Fagopyrum esculentum*) काली गाजर (गाजर subsp. sativus), *Salvia* (*Salvia sclarea*), ginseng (*Panax ginseng*), केसर (कुमकुम), कुटकी (पिकोरिजा) और फूल फसल लिलियम पर प्रदर्शन प्लॉट अप्रैल 2013 से अक्टूबर 2013 के दौरान रिबलिंग में किसानों के खेतों में लगाए गए।

लाहौल घाटी में जिनसेंग का परिचय

लाहौल घाटी में ginseng लगाने का प्रयास 2008 के बाद से सीएसआईआर IHBT के वैज्ञानिकों द्वारा किया गया था। घाटी के विभिन्न स्थानों पर प्रदर्शन प्लाट तैयार किए जा रहे हैं।

लाहौल घाटी में केंसर (*Croues sativus*) की खेती

केंसर दुनिया की सबसे महंगी मसाला फसल में से एक है। किसानों के क्षेत्र में और केंलांग, जिला लाहौल एवं स्पीति (हिमाचल प्रदेश) लाहौल घाटी पर केंसर प्रदर्शन प्लाट, में विभिन्न स्थानों पर फसल के प्रदर्शन हेतु लगाया गया है।

विभिन्न कृषि जलवायु स्थितियों में स्टीविया के पौधों की सघनता का मानकीकरण

स्टीविया की पत्ती की उपज तथा पत्तियों में स्टेवियोल ग्लाइकोसाइड का संचय आम तौर पर सस्य वैज्ञानिक पद्धतियों पर निर्भर करते हैं। इष्टतम पौधों और उचित फसल ज्यामिति उच्च पत्ती उपज के लिए महत्वपूर्ण कारक है। अतः संस्थान और पंजाब कृषि विश्वविद्यालय (पीएयू), लुधियाना स्टीविया की सूखी पत्ती की उपज दोनों स्थानों पर रोपण ज्यामिति से प्रभावित नहीं था। परन्तु पौध सघनता (111100 पौधे / हेक्टेयर) तथा (4000 पौधे / हेक्टेयर) में, क्रमशः विरल आबादी की तुलना में 94 और 78 % की सूखी पत्ती उपज की वृद्धि हुई। स्टेवियोल ग्लाइकोसाइड (स्टीवियोसाइड के Reb 1 एवं 2) संचय ज्यामिति संयंत्र और आबादी रोपण से प्रभावित नहीं थे।

पत्ती उपज की अवधि में PGPR की दक्षता का मूल्यांकन करने के लिए में स्टीविया पर एक अन्य प्रक्षेत्र में प्रयोग किया गया। PGPR संयंत्र पोषक तत्व की solubilization और पौधों को पोषक तत्व उपलब्ध कराने और पौधों की वृद्धि और विकास को प्रभावित कर सकते हैं। PGPR कार्बनिक और अकार्बनिक उर्वरकों के विभिन्न खुराक के साथ अकेले और संयोजन में लागू किया गया था। एकमात्र PGPR का उपयोग रासायनिक उर्वरक के बदले बायोमास उत्पादन की दृष्टि से प्रभावी नहीं था। अधिकतम सूखी पत्ती उपज (360ग्राम/ पौधा) PGPR जैविक खाद और रासायनिक उर्वरकों के संयुक्त उपयो के साथ दर्ज की गई थी।

रोजा डेमसिना

दमस्क गुलाब में छंटाई प्रणाली पोषक तत्वों की खुराक का मानकीकरण

दमस्क गुलाब में संगंध तेल की उच्च उपज और गुणवत्ता प्राप्त करने के लिए छंटाई प्रणाली और $MgSO_4$ के आदर्श खुराक मानकीकृत करने के लिए एक प्रक्षेत्र प्रयोग किया गया। फूलों की संख्या (प्रति झाड़ी) और फूल उपज (ग्राम/ झाड़ी) छंटाई प्रणाली और विभिन्न सांद्रता के साथ $MgSO_4$ प्रभावित पाए गए। अधिकतम फूलों की संख्या प्रति (झाड़ी 350.5) और फूल उपज (1,0987 ग्राम/ झाड़ी) आंशिक छंटाई प्रणाली के साथ दर्ज की गई थी

चाय के मूल परिवेश से पौध-वृद्धि उत्प्रेरक सूक्ष्म जीवों का अलगाव, आवरण तथा लक्षणचित्रण

कांगड़ा घाटी में चाय के मूल परिवेश से 370 बैक्टेरिया का अलगाव किया गया तथा उनको विभिन्न पौध-वृद्धि उत्प्रेरक गुणों के लिए जांचा गया। 45 बैक्टेरिया ने फॉस्फेट उत्पादन, 52 ने एसीसी-डीएमानेस उत्पादन तथा 45 बैक्टेरिया ने ईडोल एसीटिक एसिड उत्पादन दर्शाया। 16srRNA जीन क्रम के आधार पर बैक्टीरिया ने बेसिलस, एनटेरोबेक्टर, सिट्रोबेक्टर, सूडोमोनास, सिरेशीआ, लाइसिनीवेसिलस, कुपरियाविड, हाफनीया, क्लूडवेरा, पेनटोइ तथा विरीडीबेसिलस के साथ संबंध दर्शाया।

एसीसी-डीएमानेस इंजयाम गतिविधि की परख करने की प्रक्रिया

कुल 238 एसीसी-डीएमानेस उत्पादक बैक्टीरिया हिप्पोफी रम्नोइडस, पोपुलस अल्बा, पाइसम स्टाइवम, सैलिक्स सैलिसीफोलिया, सोलेनम टयूबररोसम और टैरेकसेकम ओफिसिनेकम के मूल परिवेश से विलगित किए गए। 69 बैक्टीरिया ने एसीसी-डीएमानेस गतिविधि तथा नियंत्रण की तुलना में बैक्टीरिया ने मक्की और मटर के अधिक जड़ बढ़ाव में वृद्धि का प्रदर्शन किया। 16srRNA जीन क्रम के आधार पर बैक्टीरिया ने एसीनेटोबेक्टर, आथोबेक्टर, बेसिलस, सेलुलोमोनास, एंटीरोबेक्टर, फ्लेवीमोनास, माइक्रोबेक्टीरियम पैनटोइ, सूडोमोनास, राइजोबियम, स्टेनोट्रोफोमोनास तथा जीहेंगलीउएला के साथ संबंध दर्शाया।

भारतीय ट्रांस हिमालय से कुछ औषधीय पौधों से अंतः पादपी सूक्ष्म जीवों और उनके प्राकृतिक उत्पादों को बढ़ावा देना।

परियोजना का उद्देश्य अंतः पादपी सूक्ष्म जीवों का अलगाव, लक्षणचित्रण, रोगाणु रोधी गतिविधि और पौधों के यौगिकों का जैव स्थानांतरण करना है।

कुल 980 अंतः पादपी सूक्ष्म जीव, 701 बैक्टीरिया, 209 फफूंदी तथा 72 एक्टिनोमाइसीटस का अलगाव कैमिलिया साइनेनसिस, सिडरस देवदार, डेक्टाइलोराइजा हेटागीरया, एफेडरा जेरासडीआना, जिंको वाइलोबा, हिप्पोफी रम्नोइडस, जूनिथेरस कम्यूनिस, पिक्रोराइजा कुरुआ, पाइनस रोक्सवर्धी पोपुलस अल्बा, पोटेन्टिला अनसेरिन, टेक्सस बकाटा तथा सेलिकस सेलिसीफोलिया के मूल परिवेश से किया।

रोगाणु रोधी गतिविधि के परीक्षण में 607 अंतः पादपी सूक्ष्म जीवों ने एक से अधिक जीवों के विपरीत प्रतिरोधी गतिविधि दर्शायी। 53 बैक्टीरिया तथा 7 फफूंदी ने विस्तृत श्रेणी में दो और दो से अधिक सूक्ष्म जीवों के विपरीत गतिविधि दर्शायी। विस्तृत श्रेणी दर्शाने वाले सूक्ष्म जीवाणु बेसिलस, पेनीवेसिलस, माइक्रोमोनोस्पोरा, निग्रोस्पोरा, नोकार्डिया, सिरेशीआ, स्ट्रेप्टोमाइसिस तथा वरिओवोरस के साथ संबंधता दर्शायी।

इथाइलामिन एचसीएल तथा ग्लूटामिन से थीयनिन के जैव स्थानांतरण के लिए कुल मिलाकर 185 बैक्टीरिया का परीक्षण किया गया। 7 बैक्टीरिया ने 40–50% थीयनिन की परिवर्तन क्रम दर्शाया। 16S rRNA जीन क्रम के आधार पर बैक्टीरिया ने बेसिलस, एनटेरोबैक्टर, सिट्रोबैक्टर, सूडोमोनास, स्टेफाइलोकोकस तथा लाइसिनीवेसिलस के साथ संबंधता दर्शायी।

सूक्ष्मजैविकी एवं फसल रक्षण

पौधों पर आधारित कीटनाशकों का विकास

पौधों पर आधारित कीटनाशकों का विकास हेतु विभिन्न पौधों के एक्सट्रेक्ट्स को कीड़ों प्लूटैला जाइलोस्टैला व एफिडस के नियंत्रण के लिए जांचा गया। टेरिडोफाइटस के 10 एक्सट्रेक्ट में से IHB-PED-M001 ने प्लूटैला जाइलोस्टैला के प्रति अच्छे परिणाम दिखाए। 72 घण्टे के ट्रीटमेंट के बाद इन कीड़ों का 67%, 40% और 33% नियंत्रण 2.0%, 1.5%, और 1.0% सांद्रता पर पाया गया।

इसी प्रकार मैथा, करकुमा एरोमेटिका, सित्रामोमम कैम्फोरा, हिंडीचियम और लेमनग्रास ने प्लूटैला जाइलोस्टैला के प्रति विभिन्न कीटनाशक गतिविधि दिखाई।

ट्रांसजैनिक तम्बाकू के पौधों का कीटनाशक परिणाम के लिए अध्ययन

ट्रांसजैनिक तम्बाकू के पौधों जिनमें डाइहाइड्रो-फ्लैवोनॉल 4-रिडक्टैज(डीआरएफ) और एंथोसाइनिडिन रिडक्टैज (एएनआर) था और सामान्य जंगली तम्बाकू को स्पॉडोप्टैरा लिटूरा के कीड़ों के प्रति परीक्षित किया गया। सी.एस.डी. एफ.आर. और सी.एस.ए.एन. आर. ट्रांसजैनिक लाइन्स को स्पॉडोप्टैरा लिटूरा के प्रति प्रतिरोधक पाया गया।

क्षेत्र प्रयोग

सेब के पौधों में लगने वाली माइट को नियंत्रित करने के लिए अलग-अलग प्रकार के अकैरिसाइड्स को कुल्लू जिला, हिमाचल प्रदेश के सेब बागानों में जांचा गया। स्पाइरोमैसीफेन, हैक्सीथाइजोक क्लोरफैनपाइनर व फैनपाईरोक्सामैट ने स्टैंडर्ड चैक डाइकोफोल से अच्छे परिणाम दिखाए।

आज के परिपक्ष में, जब नवीकरणीय संसाधनों की कमी हो रही है, सेब-पोमेस जैसे जैव-संसाधनों का प्रबंधन एवं लाभदायक उपयोग समाज के विकास में महत्वपूर्ण योगदान दे सकता है। अभी तक, कृषि या बागवानी उद्योग से उत्पन्न होने वाली जैवसंहति (बायोमास) का लाभदायक एवं उपयुक्त उपयोग, वैज्ञानिक और औद्योगिक समुदायों के आगे एक बड़ी चुनौती बना हुआ है।

सीएसआईआर - आईएचबीटी के प्रयास से सेब की खली से आहार फाइबर निकालने की प्रक्रिया को प्रयोगशाला स्तर पर विकसित करने में सफलता मिली है। संभावित मानव स्वास्थ्य लाभ के कारण, आहार फाइबर की वैश्विक बाजार में भारी वाणिज्यिक मांग (लगभग 3 अरब डॉलर, 2011) है। सेब खली से औद्योगिक पैमाने पर बीज अलग करने के लिए एक प्रोटोटाइप (पेटेंट दायर) भी विकसित किया गया है। एक सह-प्रतिफल के रूप में, बीज खाद्य तेल (15–20% तक की तेल मात्रा) की निकासी के लिए भी प्रयोग किए जा सकते हैं। इसमें लिनोलिक एसिड (PUFA) की ज्यादा मात्रा होने

के कारण, यह मानव सेहत के लिए बहुत ही लाभकारी हो सकता है।

जंगली गुलाबों की गृहीकरण, मूल्यांकन एवं उपयोग

मध्य हिमालय क्षेत्रों में पाये जाने वाले जंगली गुलाबों को एकत्रित कर उनको संरक्षित करके उनकी आकृतिक विभिन्नता का अध्ययन किया गया। गुलाबों के विभिन्न नस्लों को उनकी आकृतिक विभिन्न जैसे रंग, कलियों का आकार व माप, फूलों की किस्म जैसे सिंगल या डबल, आकार एवं पौधों की बढ़वार के आधार पर एकत्रित किया गया। संग्रहित किये गये गुलाबों में जीवित 21 नस्लों को उनकी आकृतिक विभिन्नता व वर्गीकरण विज्ञान के आधार पर 5 किस्मों जैसे रोज़ा ब्रुनोनी, रोज़ा कैथाएंसिस, रोज़ा मोस्चाटा, रोज़ा मल्टीपलोरा तथा रोज़ा अल्बा में वर्गीकृत किया गया। समस्त मूल्यांकन प्रयोगों के लिये इन नस्लों की तुलना गुलाब के प्रमुख मूलदण्ड रोज़ा इंडिका किस्म ओडोरटा (IHBT-0) से एक आदर्श नियंत्रक के रूप में किया गया। संरक्षित किये गये गुलाबों में मूल्यवान जनन द्रव्य की छंटाई चार मुख्य अनुवीक्षण मापदंडों के आधार पर की गयी जैसे विंटर एक्टिव ग्रोथ के मूल्यांकन के लिये तुलनात्मक अध्ययन, नस्लों पर कलमों की सुसंगति, अनुकूल ग्राफिटिंग विधि एवं समय का सुसंगति पर प्रभाव तथा सुसंगत पौधों पर पुष्प दंडों की लम्बाई एवं संख्या के आधार पर। सुसंगति के आधार पर पहले प्रयोग में सात स्ट्रेनों जैसे IHBT-WR-21 (रोज़ा अल्बा), IHBT-WR-16 (रोज़ा ब्रुनोनी), IHBT-WR-24 (रोज़ा मल्टीपलोरा) IHBT-WR-27 (रोज़ा कैथाएंसिस), IHBT-WR-01 (रोज़ा कैथाएंसिस) IHBT-WR-26 (रोज़ा कैथाएंसिस), IHBT-WR-23 (रोज़ा कैथाएंसिस) को चुना गया तथा उन्हें खेत में लगा दिया गया ताकि दूसरे प्रयोग में उनकी पुष्प उत्पादन क्षमता का मूल्यांकन किया जासके।

प्रत्येक किस्म के 4 पौधों पर विभिन्न ग्रेड के मारकेटेबल पुष्प दंडों (A>60 cm; B = 45-60 cm and C = 30-45 cm) के उत्पादन हेतु 4 वर्षों तक परीक्षण किये गये। आँकड़े कुल उत्पादित पुष्प दंडों, औसत लम्बाई (सें मी) तथा औसत त्रिज्या के भी लिये गये। प्रत्येक नस्ल की औसत वैल्यू का परिकलन किया गया तथा आपस में विभिन्नता का विश्लेषण F-test द्वारा किया गया। गुलाब के प्रभेदों की क्षमता पर वातावरण के प्रभाव को जानने के लिये चार वर्ष के आंकणों को पुनरावृत्ति के तौर पर प्रयोग किया गया। इस प्रयोग के आंकणों को अलग-अलग विशेषकों के प्रसरण-विश्लेषण के लिये उपयोग किया गया।

इस अध्ययन में चार विभिन्न प्रभेदों को, जो सुसंगति, विंटर एक्टिव ग्रोथ व पुष्प उत्पादन क्षमता में नियंत्रक से अच्छे या समान थे उन्हें गुलाब के उपयुक्त जनन द्रव्य के रूप में पहचान कर मातृ पौधों के रूप में सुस्थापित किया गया। इन प्रभेदों को जनन द्रव्य रजिस्ट्रेशन कमेटी, नेशनल ब्यूरो ऑफ़ प्लांट जेनेटिक रिसोर्स (NBPGR), ICAR, न्यू दिल्ली द्वारा गुलाब के नये जनन द्रव्य के रूप में पंजीकृत किया गया। इन संभावित उपयुक्त जनन द्रव्य प्रभेदों की सूत्रगुणता स्तर जानने के लिए कोशिकाविज्ञान द्वारा सूत्रगुणता का अध्ययन भी किया गया। चारों संभावित उपयुक्त स्ट्रेनों IHBT-WR-24, IHBT-WR-16, IHBT-WR-23 और IHBT-WR-21 के कोशिकीय अध्ययन से सपष्ट हुआ की ये सभी द्विगुणित गुणसूत्र (2n=2x=14) वाले हैं।

सजावटी, सुगन्धित व जंगली गुलाबों में नये परिवर्तित उत्पन्न करने के लिये उन में अंतर-जातीय व अंतर-प्रजाति संकरण बनाये गये। संकरण कार्य क्रम में 6 विभिन्न किस्मों जैसे रोज़ा ब्रुनोनी, रोज़ा डेमासीना, रोज़ा मल्टीपलोरा, रोज़ा सेंटीफोलिया, रोज़ा रुगोसा, तथा रोज़ा इंडिका को फूलों, फलों व सगंध तैलों में वांछित विभिन्नता उत्पन्न करने के लिये उपयोग किया गया। रोज़ा डेमासीना व रोज़ा हाइब्रिडा में भी अंतर-प्रजाति एवं व्युत्क्रम संकरण बनाये गये। कुल 717 बीज 305 परागणों से अंतर-जातीय संकरणों से, 109 बीज सजावटी गुलाबों के 57 परागणों से, 87 बीज प्रतीक संकरण के 165 परागणों द्वारा तथा 23 बीज रोज़ा डेमासीना की अंतर-प्रजातीय संकरणों से उत्पन्न हुये।

जरबेरा प्रजनन

जरबेरा के नियंत्रित संकरण द्वारा उत्पन्न परिग्रहणों में दो वर्णक चिन्हकों (एंथोसायानिन पुष्प दंड के आधार पर तथा पीले रंग के वर्णक का लीगुल्स के आधार पर) अध्ययन किया गया। पुष्प के रंग में दोनों रंग फलाबोनाइड और कैरोटिनाइड के अनुरूप हैं तथा इस अध्ययन के द्वारा पीले व सफ़ेद रंगों के एसायनिक पौधों की पहचान हो सकी। इस शोध से यह भी पता चला कि जब लाल अथवा गुलाबी रंग के फूलों वाले पौधों का संकरण सफ़ेद तथा पीले रंग के फूलों वाले पौधों से किया जाता है तो अगली पीढ़ी में लाल अथवा गुलाबी रंग के फूल प्रमुख रूप से 3:1 के अनुपात में उत्पन्न होते हैं। सफ़ेद रंगों के एसायनिक पौधों को लाल, गुलाबी तथा पीले रंग के फूलों की वर्ण रचना को समझने के लिए

उपयोग में लाया जा सकता है।

संकरण द्वारा उत्पन्न प्ररूपों से, उन्नत विशेषताओं वाले जसवेरा के पौधों का चयन किया गया तथा इन संकर पौधों में पुष्प की विभिन्न प्रकार की विशेषताओं (जैसे कि फूलों का रंग, आकार, बनावट, लम्बाई इत्यादि) का अध्ययन किया गया। अध्ययन किए गए पौधों में से चयनित तीन पौधों (आइएचबीटी-जीआर-23, आइएचबीटी-जीआर-24-6 एवं आइएचबीटी-जीआर-ई-3) को बढ़ाने के लिए उनका उत्तक संवर्धन किया जा रहा है।

चाय प्रजनन

चाय में ब्लिस्टर ब्लाइट प्रतिरोध के लिए श्रृंखला मैपिंग करने हेतु संस्थान में एक बाइक्लोनल पॉप्युलेशन विकसित की है जिसे दो किस्मों के संकरण द्वारा तैयार किया गया है। एक किस्म एस ए-6 है जो ब्लिस्टर ब्लाइट प्रतिरोधी है तथा दूसरी किस्म कांगड़ा आशा है जो उच्च गुणवत्ता की चाय है परन्तु ब्लिस्टर ब्लाइट बीमारी के लिए अति संवेदनशील है। बाइक्लोनल पॉप्युलेशन का कृषिक्षेत्र में तीन वर्षों तक बीमारी के लिए मूल्यांकन किया गया एवं कुछ प्रतिरोधी पौधों की पहचान की गयी जिन्हें आण्विक मार्कर के साथ श्रृंखलाबद्ध करने के उपयोग में लाया जाएगा। चाय के प्रतिरोधी पौधों का प्रवर्धन पौधशाला में किया जा रहा है तथा उन्हें गुणवत्ता एवं उत्पादकता के लिए भी मूल्यांकित किया जाएगा।

स्टीविया प्रजनन

स्टीविया में स्कैनिंग इलेक्ट्रॉन माइक्रोस्कोप द्वारा पुष्प विकास के 9 चरणों की पहचान की गई। टेट्राड चरण दो में तथा पराग चरण पाँच में सबसे ज्यादा दर्ज किया गया। चरण चार एवं पाँच को पराग एकत्रित करने के लिए उपयुक्त पाया गया जिसे संकरण में उपयोग किया जा सकता है। बीज उत्पादन एवं अंकुरण क्षमता के आधार पर विभिन्न परागण व्यवहारों का मूल्यांकन किया गया जिससे पता चला कि हवा के माध्यम से कम पराग का प्रसार होता है, परागण मुख्यतः कीटों द्वारा होता है तथा स्टीविया में स्वपरागण नहीं होता। इस में परागण व्यवहार से हमें सुझाव मिलता है कि यह फसल स्वविरोधी है।

यन्त्रीकरण

कृषि व्यवसाय में यन्त्रीकरण (Mechanization of Farm Practices) एवं उन्नत किस्म के तीन पंक्तियों समचतुर्भुजाकार उपकरण समायोजन (हो) का परिकल्पना एवं निर्माण किया गया है, जो कतारों की मध्य की भूमि की जुताई कर सके। इसमें मूलतः एक पहिया, हरिस, मूढ एवं समचतुर्भुजाकार ढांचा है, जिस पर उपकरण के फालों को मजबूती से निर्धारित किया जा सके। इसे मृदा किस्म फसल के अंतरण एवं कार्यकता के बल के अनुरूप फालों को अपेक्षित स्थान पर सुसज्जित करने की पूरी व्यवस्था है। इसे ढांचे में दोनों तरफ एवं अतःलम्ब दिशा में बागवानी/फसल को विना किसी बाह्य विघन के अतःकृषि संचालन करने की व्यवस्था है। इसके अतः कृषि संचालन की न्यूनतम दूरी 25 मि.मी. एवं अधिकतम दूरी 600 मि.मि. हो सकती है। इसे फसल के अंतरण के अनुरूप विस्तार कर इसके फालों को नियत स्थान पर निर्धारित किया जा सकता है। इसे स्थानीय उपलब्ध सामग्री से स्थानीय कारीगरों द्वारा निर्माण।

ग्रामीण विकास

एक कृषि उद्यमी द्वारा संस्थान द्वारा विकसित जंगली गेंदे की एक कृषोपजाति की उत्पादन पद्धति को अपनाया गया। उत्तर प्रदेश के जिला कन्नौज और हिमाचल प्रदेश के कुल्लू जिले में खेती और आसवन करके लगभग 200 कि.ग्रा. टैजेटिस तेल का उत्पादन करने में सफलता पायी। इस पद्धतियों से हिमाचल प्रदेश और देश के अन्य भागों से लगभग 4 टन/प्रतिवर्ष टैजेटिस तेल का उत्पादन होता है। भवारना विकास खण्ड के गोपालपुर गांव पंचायत क्षेत्र में गेंदा फूल की खेती को प्रक्षेत्र प्रदर्शन लगाकर बढ़ावा दिया गया। इसके साथ ही मशरूम की खेती के लिए प्रशिक्षित किया गया।

वैज्ञानिक एवं नवीकृत अनुसंधान अकादमी के 32 अध्येताओं ने सीएसआईआर-800(ग्रामीण विकास पाठ्यक्रम) हेतु 8 पंचायतों का अध्ययन किया। इन अध्येताओं ने अपने सर्वेक्षण द्वारा पारिवारिक जनसंख्या, स्वास्थ्य, स्वच्छता, कृषि आजीविका के विकल्प, पर्यावरण, पोषण, महिलाओं एवं बच्चों से संबन्धित विषयों पर आकंठे एकत्रित कर विश्लेषण किया। साथ ही लाभदायक वृक्षों का उन ग्राम पंचायतों में पौधारोपण का कार्य भी पूरा किया। ग्राम पंचायतों की आवश्यकता आधारित परियोजनाओं के प्रस्तुतिकरण भी तैयार किए गए।

बड़ी इलाइची के 950 पौधे कांगड़ा जिले के किसानों को दिए गए।

समय समय पर छोटे चाय उत्पादकों को प्रशिक्षण प्रदान किया गया।

बॉस से मूल्यवद्धित उत्पाद तैयार करने के लिए एक प्रशिक्षण कार्यक्रम का आयोजन किया गया जिसमें 25 महिलाओं को प्रशिक्षित किया गया।

ग्राम विज्ञान कुटीर के डिजाइन को तैयार करने के लिए राष्ट्रीय प्रौद्योगिकी संस्थान, हमीरपुर के छात्रों के लिए एक प्रतियोगिता का आयोजन किया गया। इसमें 33 छात्रों ने प्रतिभागिता की तथा अच्छे डिजाइन वाले छात्रों को पुरस्कृत भी किया गया।

उद्योग के लिए सीएसआईआर-आईएचबीटी का योगदान

संस्थान शैक्षणिक और उद्योग के बीच की खाई को पूरा करने के लिए कृत संकल्प है तथा अपने वैज्ञानिक ज्ञान, विशेषज्ञता और कुशलता को समाज के विभिन्न समुदायों के लाभ के लिए लगा रहा है। कई हरित प्रौद्योगिकी का प्रयोग पौधों से प्राकृतिक उत्पाद जिसमें स्वाद, सुगंध, सगंध तेल, हाइड्रोसोल, प्राकृतिक मीठाकारक और रंजक, रुटिन और ऐसिन आदि हैं। प्रमुख प्रौद्योगिकियां निम्नलिखित हैं

आटोक्लेवेबल सुपरॉक्साइड डिस्म्यूटेज (सौंड़)

स्टीवियाल ग्लाइकोसाइड्स निष्कर्षण तकनीक

स्टीवियाल ग्लाइकोसाइड्स निर्मित उत्पाद – शीतल पेय-टी फिज, हिम स्टीविया शीशे, हिम स्टीविया पाउच

हरित प्रौद्योगिकी का उपयोग करते हुए प्राकृतिक रंग व रंजक

सगंध तेल

गुलाब जल

मूल्य वर्धित उत्पाद

बक व्हीट से लौली पफ व स्नेक्स

पोषकता से भरपूर आमपापड़

सेब से बीज अलग करने की मशीन

सेब के बीज से खाद्य तेल

सेब की खली से स्नैक्स या व्यंजन

चाय से निर्मित उत्पाद

चाय शीतल पेय

टी वाइन

चाय थियाफ्लेविन और पॉलीफिनॉल

चाय आधारित माउथ फ्रेशनर

विषाणु नैदानिक किट

योजना, परियोजना, अन्वेषण और मूल्यांकन इकाई सी.एस.आई.आर. तथा आई.एच.बी.टी. के वार्षिक प्रतिवेदन के लिए सूचना को एकत्रित किया तथा प्रतिमाह परिषद मुख्यालय को उपलब्ध कराया गया। इंडियन फर्न इंटरनेट तथा इन्ट्रा नेट पर सामग्री को अद्यतन किया। पूरी हुई 11 परियोजनाओं की सूचना को संकलित किया। अब 162 परियोजनाओं की जानकारी उपलब्ध है। 49वीं एवं 50वीं अनुसंधान परिषद बैठक का आयोजन। संस्थान परिसर में विभिन्न संस्थानों के 60 छात्रों को प्रशिक्षण दिलाया गया। संस्थान की गतिविधियों को बताने तथा स्कूली छात्रों में विज्ञान के लोकप्रियकरण के लिए समय-समय पर संस्थान में शैक्षणिक भ्रमण कराया गया। सूचना के अधिकार अधिनियम के अन्तर्गत 13 मामलों की जानकारी प्रदान की तथा उक्त जानकारी को आरटीआई पोर्टल पर लगाया।

इन्सपायर इन्टरशिप कॅम्प का आयोजन किया गया। विभिन्न सी.एस.आई.आर. स्थापना दिवस, आई.एच.बी.टी. स्थापना दिवस, राष्ट्रीय विज्ञान दिवस, राष्ट्रीय प्रौद्योगिकी दिवस सहित कई प्रकार के समारोहों का आयोजन किया। संस्थान में चल रही परियोजनाओं का मूल्यांकन किया। प्रकाशन, पेटेंट आदि से संबंधित जानकारियों को संग्रहित किया। भण्डार, वित्त एवं प्रशासन के साथ मिलकर एक-सीएसआईआर के लिए सामग्री का संकलन किया।

कम्प्यूटर इकाई

350 से अधिक कम्प्यूटरों को फाइबर बैकबोन एवं वाई-फाई नेटवर्क, वीडियोकॉन्फ्रेंसिंग सुविधा, एच.पी., आई.बी.एम. सरवर के माध्यम से प्रदान की जाती है। राष्ट्रीय ज्ञान नेटवर्क के अन्तर्गत सारे संस्थान परिसर में 1Gbps लीज्ड लाइन की सुविधा प्रदान की गई है। नए अकादमी ब्लॉक में लेन सुविधा प्रदान की गई तथा वर्चुअल क्लास रूम की सुविधा प्रदान की गई है, जिससे स्कालर एक अच्छे वातावरण में ज्ञान अर्जत कर पाएंगे। नेटवर्क सिम्योरिटी के लिए यूनिफाइड थ्रेट मैनेजमेंट सिस्टम, आईडीएस, आइपीएस, सेंट्रलाइज्ड नेटवर्क सिम्योरिटी सिस्टम, एन्टीवायरस आन क्लाइट सरवर मोडम तथा एसएमटीपी स्पेम/वायरस प्रोटेक्शन सॉफ्टवेयर को संस्थान के इ रिसोर्स को संरक्षित करने के लिए लगाया गया। डोमेन नेम सरवर, डीएनएस, वेब, इमेल प्रोक्सी आफलिनेक्स को प्रबन्धित किया गया।

आई.एच.बी.टी. ज्ञान संसाधन केन्द्र

आई.एच.बी.टी. का ज्ञान संसाधन केन्द्र में विज्ञान एवं प्रौद्योगिकी से संबंधित 14421 दस्तावेज जैसे की पुस्तकें, इबुक्स, हिंदी पुस्तकें, साप्जिल्ड वाल्यूम जर्नल, शोध प्रबन्ध, सीडी आदि हैं, जो कि संस्थान ज्ञान संसाधन केन्द्र के वैज्ञानिकों तथा तकनीकी कर्मियों तथा पालमपुर के आस-पास के शैक्षणिक केन्द्रों को लगातार सेवाएं प्रदान कर रहा है। लिबसिस का उपयोग करते हुए ज्ञान संसाधन केन्द्र पूरी तरह से कम्प्यूटरीकृत है तथा जल्द ही कोहा में परिवर्तित कर दिया जाएगा। इसे <http://library.ihbt.res.in> द्वारा देखा जा सकता है। पुस्तकालय में 16 समाचार पत्र मंगवाए जाते हैं तथा मुख्य वैज्ञानिक समाचारों को <http://ihbtionews.blogspot.in/> द्वारा देखा जा सकता है। वैज्ञानिकों तथा तकनीकी स्टाफ के लिए साइटेशन रिपोर्ट को एकत्रित किया गया तथा विषय विशेष पर बिब्लियोग्राफी उपलब्ध कराई गई। प्रत्येक सप्ताह केन्द्र में आने वाले नवीनतम पुस्तकों, पत्रिकाओं आदि की जानकारी सभी को उपलब्ध कराई जाती है। 200 से अधिक इ-जर्नल और डेटाबेस को देखा जा सकता है। इसके साथ ही 155 प्रकाशित जर्नल भी उपलब्ध हैं। 5352 उपयोगकर्ताओं ने केन्द्र की सेवाओं का लाभ उठाया। 1285 पुस्तकें इस वर्ष पाठकों को जारी की गईं। 4.5 लाख से अधिक पृष्ठों की फोटोकॉपी प्रदान की गईं। ऑनलाइन जर्नल को देखने के लिए पाठकों को प्रशिक्षण भी प्रदान किया गया।

पेटेंट

वर्ष के दौरान संस्थान ने भारत में 1 तथा विदेशों में 3 पेटेंट फाइल किए तथा 2 पेटेंट भारत तथा 7 विदेश में प्राप्त/पंजीकृत हुए।

प्रकाशन

वर्ष के दौरान संस्थान ने स्तरीय जर्नल में 105 शोध पत्र प्रकाशित कराए। चार लोकप्रिय विज्ञान लेख विज्ञान प्रगति तथा फल-फूल में प्रकाशित हुए। पुस्तकों में 4 लेख/पाठ प्रकाशित हुए। 2 तकनीकी ब्रोशर भी प्रकाशित हुए।

संगोष्ठी/सेमिनार में प्रतिभागिता

संस्थान के वैज्ञानिकों ने तथा 22 बैठकों, संगोष्ठियों तथा कार्यशालाओं में प्रतिभागिता की।

संस्थान ने 4 प्रदर्शनियों में अपने उत्पादों तथा प्रौद्योगिकी को प्रदर्शित किया।

व्याख्यान

संस्थान के निदेशक ने 8 तथा वैज्ञानिकों ने 21 स्थानों में व्याख्यान दिए।

संस्थान में 8 आमंत्रित व्याख्यान आयोजित किए गए।

दूरदर्शन कार्यक्रम

संस्थान के वैज्ञानिकों ने वर्ष के दौरान 8 दूरदर्शन शिमला केन्द्र से कृषि दर्शन कार्यक्रम के अन्तर्गत, 2 कार्यक्रम दूरदर्शन जालंधर तथा 2 कार्यक्रम अन्य चैनलों से प्रसारित किए।

विदेश यात्रा

वर्ष के दौरान संस्थान के निदेशक तथा 5 वैज्ञानिकों ने विदेश दौरा किया

पुरस्कार, सम्मान

संस्थान के निदेशक को हिमाचल प्रदेश के मुख्यमंत्री श्री वीरभद्र सिंह ने 27 अक्टूबर को शान-ए-हिमाचल पुरस्कार से सम्मानित किया गया।

डा. अनिल सूद, मुख्य वैज्ञानिक को ऑर्किड सोसायटी ऑफ इंडिया की ओर से श्रीमती उषा विज पुरस्कार से सम्मानित किया गया।

डा. विशाल आचार्य, साइंटिस्ट फेलो को जम्मू में आयोजित भारत विज्ञान कांग्रेस में उपराष्ट्रपति ने युवा वैज्ञानिक-2014 के रूप में पुरस्कृत किया।

संस्थान के संबन्ध

6 अन्तरराष्ट्रीय व 22 राष्ट्रीय स्तर के सरकारी संस्थानों, 18 निजी संस्थानों तथा 2 स्वयंसेवी संस्थाओं के साथ संबन्ध हैं

छात्रों को प्रशिक्षण

संस्थान ने 14 विश्वविद्यालयों/ संस्थानों के 38 छात्रों को प्रशिक्षण प्रदान किया।

संस्थान के वैज्ञानिकों को इस वर्ष कई महत्वपूर्ण पुरस्कार/सम्मान प्राप्त हुए।

इस वर्ष संस्थान के 15 शोध छात्रों ने पी.एच.डी. प्राप्त की, 44 छात्रों ने स्नातकोत्तर तथा 19 ने बी.टेक. डिग्री के लिए शोध-प्रबन्ध विभिन्न विश्वविद्यालयों में जमा किए। एक विदेशी छात्र को भी प्रशिक्षित किया गया।

अनुबन्ध

संस्थान ने अपनी प्रौद्योगिकी के ज्ञान के प्रसार के लिए 10 संस्थानों से अनुबन्ध किए।

विशिष्ट अतिथि

इस वर्ष 15 विशिष्ट अतिथियों ने संस्थान में यात्रा की।

संस्थान का शैक्षणिक भ्रमण

शैक्षणिक संस्थानों से छात्र	1180
किसान, स्वयंसेवी संस्थाएं तथा सरकारी अधिकारी	609

OBITUARY



Sh. Rajendra Kumar Tandon
Sr. Technical Officer (3)
(12-07-1964 – 15-06-2013)

Sh. Rajendra Kumar Tandon was born on July 12, 1964 in Village- Ustechar, PO-Deogran, Teh.- Palampur (HP). He joined CSIR-IHBT on July 28, 1986 as Technical Assistant Gr. VIII. He contributed significantly in Instrumentation Unit of the Institute and catered to routine instrumentation activities of the Institute. He will be remembered for his devotion, dedication and diligence. He departed for his heavenly abode on June 15, 2013. He is survived by his wife Ms. Reeta Tandon, daughter Ms. Shalini Tandon and son Sh. Sumit Kumar Tandon and Sh. Amit Kumar Tandon.

CSIR-IHBT family prays for eternal peace to the departed soul and extends heartfelt condolences to the bereaved family.

Scientists discuss methods for value addition to chitin

ALL INDIA
The chitinase and chitinase inhibitors are being used to enhance the value addition to chitin. The chitinase inhibitors are used to enhance the value addition to chitin. The chitinase inhibitors are used to enhance the value addition to chitin.

रिबलिंग में वनस्पति उद्यान स्थापित करेगा आई.एच.बी.टी.

संस्थान में प्रयाग उद्यान विभाग, द हिमालयन जैव विज्ञान संस्थान की प्रारम्भिक कार्यवाही शुरू
प्रयाग, 23 मार्च (भा.सं.) - हिमालयन जैव विज्ञान संस्थान (आई.एच.बी.टी.) ने प्रयाग में वनस्पति उद्यान स्थापित करने की प्रारम्भिक कार्यवाही शुरू की है। उद्यान में विभिन्न प्रजातियों के वनस्पतियों को बोया जा रहा है।

Rose without thorns developed by Himalayan institute

डिहालवा, 23 मार्च - रोज़ों को अनामक और बिना छालों के रूप में विकसित करने में हिमालयन जैव विज्ञान संस्थान (आई.एच.बी.टी.) ने सफलतापूर्वक प्रयाग में एक नए किस्म की रोज़ विकसित की है। यह रोज़ बिना छालों के और अनामक है।



आई.एच.बी.टी. के संस्थापक और प्रमुख प्रोफेसर डॉ. अशोक कुमार शर्मा (बाएं) और डॉ. राजेश कुमार शर्मा (दाएं) के साथ प्रयाग में विकसित की गई नए किस्म की रोज़ का प्रदर्शन।

आईएचबीटी ने मनाया स्थापना दिवस

डिहालवा, 23 मार्च - हिमालयन जैव विज्ञान संस्थान (आई.एच.बी.टी.) ने अपनी स्थापना दिवस मनाया। संस्थापक और प्रमुख प्रोफेसर डॉ. अशोक कुमार शर्मा ने संस्था के विकास और भविष्य के प्रति आशा व्यक्त की।

अलख राष्ट्रीय विज्ञान दिवस कार्यक्रम में विशेषज्ञों ने पुष्प क्षेत्री पर दिवा बल

प्रयाग, 23 मार्च - राष्ट्रीय विज्ञान दिवस कार्यक्रम में विशेषज्ञों ने पुष्प क्षेत्री पर दिवा बल दिया। वे पुष्पों के विकास और उनके उपयोग के बारे में जानकारी दी।

ये हैं कांटे रहित गुलाब

डिहालवा, 23 मार्च - आई.एच.बी.टी. के प्रयाग में विकसित की गई नए किस्म की रोज़ों में कांटे नहीं हैं। ये रोज़ें अनामक और बिना छालों के हैं।

फूल उगाकर मजबूत करें आर्थिकी

प्रयाग, 23 मार्च - फूल उगाकर मजबूत करें आर्थिकी। फूलों की खेती एक लाभकारी व्यवसाय है। इसे बढ़ावा देने के लिए सरकारें प्रयास कर रही हैं।

एक सप्ताह तक जली करने फूल

डिहालवा, 23 मार्च - एक सप्ताह तक जली करने फूलों की खेती में आई.एच.बी.टी. के प्रयाग में सफलता मिली है। फूलों की खेती में जलीकरण एक प्रभावी तकनीक है।

आई.एच.बी.टी. बाजार में उतारेगा उत्पाद

अपने द्वारा विकसित उत्पादों की करेगा आई.एच.बी.टी. विक्री, एक कंपनी की स्थापना की प्रस्तावना
प्रयाग, 23 मार्च (भा.सं.) - हिमालयन जैव विज्ञान संस्थान (आई.एच.बी.टी.) ने अपने द्वारा विकसित उत्पादों की बाजार में उतारने का प्रस्ताव रखा है।

बास को सावध पदार्थ के रूप में विकसित किया

संस्थापक ने प्रयाग में प्रस्तावित
बास को सावध पदार्थ के रूप में विकसित किया। बास को खाने के लिए सुरक्षित बनाने के लिए आई.एच.बी.टी. के प्रयाग में प्रयास किया जा रहा है।

रंग के उपयोग से बनाए जा रहे उत्पाद

प्रयाग, 23 मार्च - रंग के उपयोग से बनाए जा रहे उत्पादों की खेती में आई.एच.बी.टी. के प्रयाग में सफलता मिली है। रंगों की खेती एक लाभकारी व्यवसाय है।

विज्ञान के क्षेत्र में सुविधाओं के अनुपात में उपलब्धियां कम

पालमपुर, 28 फरवरी (धनु-नानपाल) - हिमालयन जैव विज्ञान संस्थान (आई.एच.बी.टी.) ने विज्ञान के क्षेत्र में सुविधाओं के अनुपात में उपलब्धियों का आकलन किया।

कागज़ चाय की आधार बनाई टी-कोटा

संस्थापक ने प्रयाग में प्रस्तावित
कागज़ चाय की आधार बनाई टी-कोटा। कागज़ चाय को खाने के लिए सुरक्षित बनाने के लिए आई.एच.बी.टी. के प्रयाग में प्रयास किया जा रहा है।

कैवल प्रमुख विभाग

प्रयाग, 23 मार्च - कैवल प्रमुख विभाग में प्रयाग में आई.एच.बी.टी. के प्रयाग में सफलता मिली है। कैवल प्रमुख विभाग की खेती एक लाभकारी व्यवसाय है।

अनुपात में उपलब्धियां कम

पालमपुर, 28 फरवरी (धनु-नानपाल) - हिमालयन जैव विज्ञान संस्थान (आई.एच.बी.टी.) ने विज्ञान के क्षेत्र में सुविधाओं के अनुपात में उपलब्धियों का आकलन किया।

UNIQUE MUSEUM

Bamboo-the wonder grass

THE BAMBOO MUSEUM AT PALAMPUR IS A MUST VISIT PLACE. THE MUSEUM IS BUILT WITH VARIOUS SPECIES OF THIS 'WOODY GRASS', GIVING AN INSIGHT INTO THE VARIOUS USES THAT BAMBOO CAN BE PUT TO

66 Making handicrafts, food items and cloth from bamboo will give employment to the local people.

-Anil Sood, senior advisor, IISCT

THE PROGRESS INDEX
The Bamboo Museum at Palampur is a must visit place. The museum is built with various species of this 'woody grass', giving an insight into the various uses that bamboo can be put to. The museum is a great place to visit for anyone who is interested in bamboo. It is a great place to visit for anyone who is interested in bamboo. It is a great place to visit for anyone who is interested in bamboo.

अफगानिस्तान के प्रशिक्षणार्थियों ने सीखा फूलों की खेती करना

अफगानिस्तान के प्रशिक्षणार्थियों ने सीखा फूलों की खेती करना। प्रयाग में आयोजित कार्यक्रम में अफगानिस्तान के प्रशिक्षणार्थियों को फूलों की खेती के बारे में जानकारी दी गई।

अफगानिस्तान के प्रशिक्षणार्थियों ने सीखा फूलों की खेती करना। प्रयाग में आयोजित कार्यक्रम में अफगानिस्तान के प्रशिक्षणार्थियों को फूलों की खेती के बारे में जानकारी दी गई।



CSIR-IHBT, a constituent laboratory of CSIR India, is located at the picturesque town of Palampur perched in the lap of majestic snow clad mountain of Dhauladhar.

