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Annual Report 2011-12

सी.एस.आई.आर.–हिमालय जैवसंपदा प्रौद्योगिकी संस्थान
CSIR-Institute of Himalayan Bioresource Technology
पालमपुर, हिमाचल प्रदेश, भारत
Palampur, Himachal Pradesh, India

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Annual Report 2011-12

With Best Compliments from

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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

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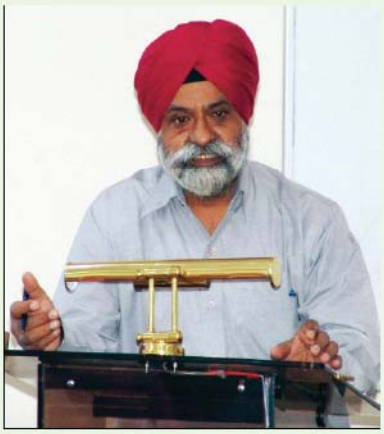
Director's Report.....



In the background of a larger global economic slowdown, development based on bioeconomy triggered by locally generated bioresources and their utilisation gains importance for sustainability. Bioeconomy encompasses the agriculture, food, health and environmental sectors and is a critical facet of inclusive growth touching all sections of society. I feel happy that CSIR-IHBT through its mandate addresses to some important issues and feel privileged to highlight some of the findings and happenings during the preceding year i.e. 2011-12.

Energy through hydropower generation is significant for growth in the Himalayan region, however, the environmental hazard through dumping sites is disastrous. Scientists of CSIR-IHBT successfully demonstrated the greening of 10 sites of NHPC in the Kullu district of Himachal Pradesh and this novel approach can serve as a model for similar reclamation elsewhere.

Bamboos are a vital bioresource and for creating awareness, the Institute has created a Museum in the 'Bamboo Home'. This practically displays the multifaceted utility of bamboos. Our activity on distribution of quality planting material and providing training on diversified food products and charcoal from bamboos gained momentum. Efforts of our tea research team are bearing fruit as after two decades of impasse they have identified a consistently high performing tea clone yielding 25% higher productivity over the existing best. Importantly, this is a Kangra type clone that does not affect the quality and geographic indication. Planting material is being multiplied for extending to planters and new plantations. In apple we now have an established technology to extract dietary fibers as a nutraceutical and some snacks from apple pomace which is otherwise a biowaste.

In our ongoing efforts on thermostable superoxide dismutase (SOD) from high altitude a recombinant SOD with better stability and consistent action was developed. This is now being used in trials to extend the shelf life of important fruits and vegetables. Trancriptome analyses of leaf and rhizome tissues of *Picrorhiza kurrooa* depicting genome wide changes in gene expression in context with change in temperature have led us to better understand Picrosides synthesis under change of environmental response. Similar work is also being carried out on tea and podophyllum. Our scientists exploring the *in silco* horizons have developed one of the most accurate miRNA target identification software, "p-taref" for plant systems.

Our Chemical Science group contributed significantly in the area of nanocatalysis and synthetic methodologies targeting antimalarial and antidiabetic molecules. Solid-supported nano particles and metal phthalocyanine based catalysts were developed and applied for the synthesis of bioactive molecules. Work on dehydrative-Heck olefination of secondary aryl alcohols in ionic liquid for stilbenoide synthesis has been well received in the best journal of organic chemistry.

On the extension front, the HP/ J&K/ Uttarakhand state governments departments impose trust and our trainings now are a regular routine putting a positive pressure on our scientists to take our know-how to the grass roots. This is also evident from the demand and off take of quality planting material of floriculture crops, bamboos, and medicinal and aromatic plants. On a turnkey basis, CSIR-IHBT set up two plant tissue culture units and handed over one to the Forest Department of Haryana at Seonthi in Kurukshetra district and one to DRDA Mandi HP at Chauntra. CSIR-IHBT also catalysed the production of disease free root stocks of apple by providing stock cultures of meristem raised material of MM111, MM106 and M793. In addition, stock cultures of Liliums and Gerberas were also extended to commercial tissue culture units empowering the Small Scale Sector. Our program on providing TCPs of potato to M/s Mahindra Shubh Labh Pvt. Ltd. Mohali continued successfully. Importantly, our technology for the production of disease free Saffron corms is now taken up in Kashmir for the benefit of the farmers of that region.

For HRD the year was historic as at the initiative of DG CSIR, Academy of Scientific and Innovative Research (AcSIR), with its headquarters at CSIR was established by an Act of Parliament (No. 6/1/ CSIR-AcSIR/2010-PPD). This gives opportunity to our young post graduation students to be a part of a quality S&T network of CSIR laboratories for higher studies in interdisciplinary areas.

CSIR-IHBT acknowledges the CSIR Headquarters for its generous support. The faith reposed by our funding agencies namely, DBT, DST, DAE, ICAR, Ministry of Food, Ministry of Environment and Forests is greatly appreciated.

The guiding and motivating role of our Research Council (RC) and the positive outlook of our Management Council (MC) motivated team CSIR-IHBT to put its best effort forward in achieving its mandate of environmental, societal and scientific goals for the economic benefit of our people.

Paramvir Singh Ahuja

निदेशक की कलम से.....

व्यापक स्तर पर वैश्विक आर्थिक मंदी की पृष्ठभूमि में स्थानीय जैवसंपदा और उसके प्रयोग द्वारा उत्प्रेरित जैवआर्थिकी आधारित विकास को स्थायीत्व की दृष्टि से गति मिली है। जैवआर्थिकी में कृषि, खाद्य, स्वास्थ्य और पर्यावरण क्षेत्र समाविष्ट हैं और यह समाज के सभी वर्गों के समग्र विकास के लिए निर्णायक पहलू है। मुझे यह बताते हुए हर्ष हो रहा है कि सीएसआईआर–आई.एच.बी.टी. ने अपने उद्देश्यों के द्वारा कुछ महत्वपूर्ण मुद्दों को हल किया है, और मुझे विगत वर्ष 2011–12 की कुछ उपलब्धियों एवं कार्यकलापों को आपके समक्ष प्रस्तुत करने में गर्व हो रहा है।

हिमालय क्षेत्र के विकास के लिए जलविद्युत से ऊर्जा उत्पादन बहुत ही महत्वपूर्ण है, फलस्वरूप इन परियोजनाओं स्थलों में से निकले मलवे को इधर–उधर फेंक देने से होने वाले पर्यावरणीय संकट गम्भीर हैं। संस्थान के वैज्ञानिकों ने हिमाचल प्रदेश के कुल्लू जिले के एनएचपीसी परियोजना के 10 स्थलों में सफलतापूर्व हरियाली ला दी है और इस विशिष्ट पहल से इस प्रकार के अन्य स्थलों के उद्धार के लिए एक मिसाल कायम हो गई है।

बाँस बहुत ही महत्वपूर्ण जैवसंपदा है और इसकी जागरुकता के लिए संस्थान ने बाँस से एक संग्रहालय तैयार किया है। इसमें बाँस के बहुआयामी उपयोग के बारे में व्यावहारिक तौर पर दर्शाया गया है। अच्छी गुणवत्तायुक्त रोपण सामग्री उपलब्ध कराने और बाँस से विविध खाद्य उत्पादों और चारकोल बनाने के लिए प्रशिक्षण देने संबंधी संस्थान के प्रयास ने गति पकड़ी है। चाय पर अनुसंधान कर रही हमारी एक टीम के प्रयास अब सफल हो रहे है, जिन्होंने दो दशकों के बाद एक उत्तम क्लोन को पहचाना है, जिससे इस समय इस क्षेत्र में उपब्लब्ध सबसे अच्छी कृषोपजाति के मुकाबले में 25% अधिक उत्पादन प्राप्त हुआ है। यहां यह महत्वपूर्ण है कि यह कांगड़ा जाति का क्लोन है जिससे कांगड़ा चाय की ख्याति प्राप्त गुणवत्ता तथा कांगड़ा की भौगोलिक सूचक की पहचान हमेशा अक्षुण्ण रहेगी। उत्पादकों को पौध उपलब्ध कराने के लिए रोपण सामग्री को बहुगुणित किया जा रहा है। हमने अब सेब में आहारीय रेसों को पृथक करने तथा उससे न्यूट्रास्यूटिकल बनाने की तकनीक विकसित कर ली है और सेब के भुक्तशेष से कुछ स्नैक्स भी तैयार कर लिए हैं, जो पहले जैवव्यर्थ होता था।

उच्च तुंगता क्षेत्रों वाले क्षेत्रों से थर्मोस्टेबल सुपर ऑक्साइड डिस्म्यूटेज (SOD) पर चल रहे हमारे कार्यक्रम में बेहतर स्थायीत्व और सुसंगत क्रिया वाले एक रिकम्बीनेंट सुपर ऑक्साइड डिस्म्यूटेज को विकसित किया गया है। इसे अब महत्वपूर्ण फलों और सब्जियों को अधिक समय तक तरोताजा रखने के लिए परीक्षणों में प्रयुक्त किया जा रहा है। तापक्रम में परिवर्तन के परिणामस्वरूप *पिक्रोराइजा कुरुआ* जिनोम में व्यापक बदलाव को देखते हुए इसकी पत्तियों एवं कंदो के ऊतकों का ट्रांसक्रिप्टोम विश्लेषण किया गया। सिलको होरीजोन पर कार्य कर रहे हमारे वैज्ञानिकों ने पादप पद्धति के लिए एक बहुत ही सही miRNA लक्ष्य को पहचानने के लिए `p-taref' नामक सॉफ्टवेयर को विकसित किया है।

हमारे रसायन वैज्ञानिकों के समूह ने मलेरिया और मधुमेह रोधी अणुओं को लक्षित सूक्ष्म उत्प्रेरक और संश्लेषित पद्धति के क्षेत्र में बहुत ही महत्वपूर्ण योगदान दिया है। ठोस आधारित सूक्ष्म कणों और धातु थैलोसायानाइन आधारित उत्प्रेरकों को विकसित किया और जैवसक्रिय अणुओं के संश्लेषण के लिए प्रयुक्त किया गया। स्टिलबेन्वाइड के संश्लेषण हेतु आयन द्रव्य में सेकेण्डरी एराइल अल्कोहल के डिहाइड्रेटिव–हेक डिफाइनेशन के लिए हमारे प्रयास को सराहा गया है, तथा कार्बनिक रसायन शास्त्र के सर्वोत्तम जर्नल में इसे स्थान मिला है।

विस्तार सेवाओं के क्षेत्र में हिमाचल प्रदेश, जम्मू–कश्मीर, उत्तराखंड राज्यों की सरकारों के विभिन्न विभागों ने हमारे संस्थान में विश्वास व्यक्त किया है, और अब संस्थान द्वारा नियमित रूप से प्रशिक्षण कार्यक्रमों के आयोजन से हमारे संस्थान के वैज्ञानिकों पर अपने ज्ञान को ग्रामीण क्षेत्रों तक पहुंचाने का महत्वपूर्ण दायित्व है। पुष्प फसलों, बाँसों तथा औषधीय एवं सगंध पौधों की गुणवत्तायुक्त रोपण सामग्री की लगातार आपूर्ति एवं मांग से इस बात की पुष्टि होती है। संस्थान ने दो ऊतक संवर्धन इकाइयों को तैयार करके सौंप दिया है, जिनमें एक हरियाणा में वन विभाग के लिए कुरुक्षेत्र के सिंयोंथी तथा दूसरा हिमाचल प्रदेश में जिला ग्रामीण विकास अभिकरण मण्डी के चौंतड़ा नामक स्थान में है। संस्थान ने विभज्योतक द्वारा तैयार सामग्री MM111, MM106 तथा MM793 के संवर्धों को उपलब्ध करवाकर सेब के रोगरहित मूल स्कंधों के उत्पादन को उत्प्रेरित किया है। इसके अतिरिक्त, लघु क्षेत्र को समर्थ बनाने के लिए व्यावसायिक उत्तक संवर्धन इकाइयों को लिलियम और जरबेरा के संवर्ध भी उपलब्ध कराए जा रहे हैं। मैं. महेन्द्रा एण्ड महेन्द्रा को उत्तक संवर्धन तकनीक से तैयार आलू के पौधों को उपलब्ध कराने का कार्य भी लगातार सफलतापूर्वक चल रहा है। केसर के रोगरहित कॉर्म के उत्पादन की हमारी तकनीक को अब कश्मीर में उपयोग में लाया जा रहा है ताकि उस क्षेत्र के किसानों को लाभ मिल सके।

मानव संसाधन विकास के क्षेत्र में यह वर्ष ऐतिहासिक रहा क्योंकि सी.एस.आई.आर. के महानिदेशक के प्रयासों पर संसद के अधिनियम (सं.6/1/सीएसआईआर–एसीएसआईआर/2010–पीपीडी) द्वारा वैज्ञानिक और नवीकृत अनुसंधान अकादमी का गठन किया गया है, जिसका मुख्यालय सीएसआईआर में होगा। इससे हमारे युवा स्नातकोत्तर छात्रों को गुणवत्तायुक्त विज्ञान और प्रौद्योगिकी के सीएसआईआर प्रयोगशालाओं के नेटवर्क में अन्तर्विषयी क्षेत्रों में उच्च शिक्षा प्राप्त करने का अवसर प्राप्त होगा।

उदारतापूर्वक सहयोग के लिए सीएसआईआर–आईएचबीटी परिषद् मुख्यालय के प्रति आभारी है। जैवप्रौद्योगिकी विभाग, विज्ञान और प्रौद्योगिकी विभाग, आणविक ऊर्जा विभाग, भारतीय कृषि अनुसंधान परिषद्, खाद्य मंत्रालय, पर्यावरण और वन मंत्रालय जैसी वित्तीय सहायता प्रदान करने वाली एजेन्सी द्वारा हममें विश्वास रखने के लिए हम आभार प्रकट करते हैं।

अनुसंधान परिषद् की मार्गदर्शी एवं प्रेरणादायक भूमिका तथा प्रबन्ध परिषद् के सकारात्मक दृष्टिकोण से सीएसआईआर–आईएचबीटी की टीम को जन–कल्याण के लिए पर्यावरणीय, सामाजिक और वैज्ञानिक लक्ष्यों की प्राप्ति के लिए सर्वश्रेष्ठ प्रयास करने की प्रेरणा प्राप्त हुई है।

परमवीर सिंह अहलावत

(ijeohj flag vgyrk)

CHARACTERIZATION AND MANAGEMENT OF HIMALAYAN BIORESOURCES

FIELD SURVEY

Surveys were conducted to inventorize plant resources of western Himalaya and to understand the habitats of vascular plants (flowering plants and pteridophytes). Botanical surveys were also carried out in different seasons to the forest areas of Chamba, Kangra, Kullu, Mandi and Una districts of HP during the year (**Table 1**).

Table 1 Details of the field surveys conducted during 2011-2012

Months	Areas surveyed	Objectives
June 2011	Ashapuri & Tinbud (Kangra district)	Floristic survey
July 2011	Bankhandi, Dehra & Uttarala (Kangra district)	
August 2011	Jogindernagar, Machhial and Bir forest (Mandi district); Bharmour (Chamba district) and Kullu (Kullu district)	
October 2011	Dharamshala (Kangra district); Sandhol (Mandi district); Renuka, Nahan & Haripur Dhar (Sirmaur district)	Ecological studies
November 2011	Dehra, Fatehpur & Indora (Kangra district); Nehrian, Bhattera and Amb (Una district)	
January 2012	Nehrian & Gujrada forest areas (Una district)	

In addition, various short field visits were conducted to the adjacent areas of Palampur, HP to collect plant samples. Besides recording the ecological attributes during field studies, plant samples (both live as well voucher specimens) were collected for introduction and conservation in the fernery and botanical garden, and also for preservation as reference material in the herbarium (PLP) of the institute.

Sapium (*Sapium sebiferum*)

Surveys revealed successful naturalization of *S. sebiferum* in the western Himalayan region, occupying 8.28% geographical area of HP. The plants were distributed between 569 to 1632m amsl forming close canopy woodlands in mesic areas (**Fig.1**). Its maximum representation was on south-west facing slopes (**Fig. 2**). A total of 246 flowering plant species were found growing in the stands having sapium. These plants belonged to 197 genera placed in 72 families. Of these, 78 were exotics with maximum representation from America (33%).

Fig. 1 Dense woodland of sapium in mesic areas

Attributes such as fast growing potential, multiple modes of reproduction and high fecundity were found to render the species highly invasive.

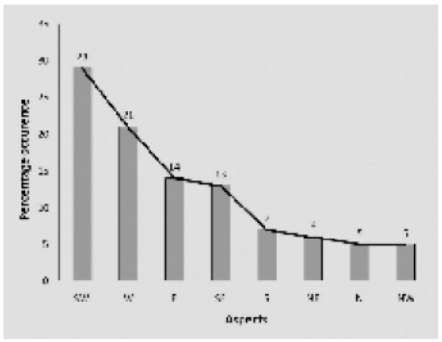


Fig. 2 Distribution of Sapium in different aspects

Trade in medicinal plants

Surveys in the interior areas of Dhauladhar mountain range showed heavy pressure of trade on high value medicinal plants. During the growing season (May/June to September/October), on an average, 5.2 kg (fresh weight) of *Picrorhiza kurrooa* per day was usually collected by an individual. As many as 300-400 plants were uprooted and processed in the field (**Fig. 3**) to get one kg dry plant material, before being transported to the road heads or local markets.

Fig. 3 On field processing of *P. kurrooa*

Ethnobotany

Interaction with the traditional healers of Kangra district (HP) revealed the use of 66 plant species comprising of 25 herbs, 23 trees, 10 climbers and 8 shrubs for treating 33 diseases related to weight management, health foods and hair care. Eight plant species viz., *Achyranthes aspera*, *Aegle marmelos*, *Boerhavia diffusa*, *Carum copticum*, *Cassia fistula*, *Curcuma longa*, *Eupatorium adenophorum* and *Piper nigrum* are used in both, single and multiple plant based remedies. Amongst plant parts, use of leaf (25%) is most common, followed by fruits (21%) and seeds (14%). Bulb, inflorescence and wood resin are rarely used (1% each). The powder (28%), paste (21%) and decoction (12%) are the prominent means of remedies.

Vascular flora of Kinnaur district

A checklist was compiled for the vascular flora of Kinnaur district (HP). This checklist included 893 taxa (viz., species, subspecies and varieties) belonging to 881 species of angiosperms and gymnosperms distributed among 102 families and 433 genera, and 30 species of pteridophytes. The latest delineation of families by 'Angiosperm Phylogeny Group (APG) III system, 2009' was employed for classification. The Asteraceae had maximum number of 123 species, followed by Poaceae (68), Rosaceae (58), Leguminosae (49) and Lamiaceae (38). Among the genera, *Artemisia* was the most diverse genus with 19 species, followed by *Potentilla* (14), *Saussurea* (13), *Polygonum* (11), *Astragalus* (10), *Lonicera* (10) and *Nepeta* (10). The family-to-genera ratio was 1:4.25 and the genera-to-species ratio was 1:2.04, as in other regions of western Himalaya. Out of 893 taxa, the flora of Kinnaur included 606 herb species, 63 trees, 108 shrubs, 28 climbers, 67 graminoids and 21 sedges and rushes. A total of 108 (12.2%) were endemic to western Himalaya and 27 (3%) were threatened under IUCN categories.

Landuse/Landcover mapping of Lahaul-Spiti

A landuse/landcover classification of Lahaul-Spiti district of HP was carried out using IRS 1D LISS III satellite data of October, 2002 (**Fig. 4a**). The classified map categorized the whole region into 9 broad classes viz., habitations, agriculture/plantations, stony/barren, scree/moraines, alpine

scrubs and grasslands, snow/ glaciers, forests and rivers/ lakes (**Fig. 4b**). The result showed that the 61.8% of Lahaul-Spiti is occupied by stony/ barren and scree/ moraine landcover classes. Its 17.9% region is covered by alpine scrubs/ grassland and 1.5% is covered by forest. The 1.9, 0.2 and 0.9% of the area is occupied by habitations, agriculture/ plantations and river/ lakes, respectively. Its 15.2% area is under permanent snow/ glaciers.

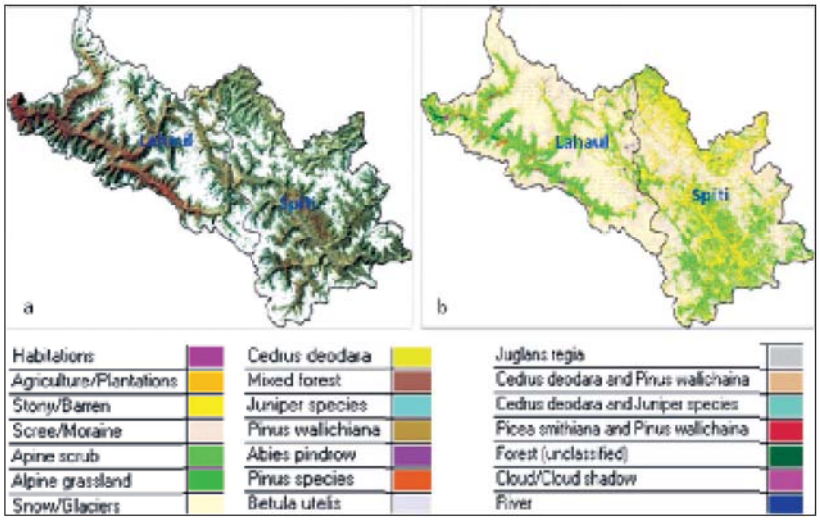


Fig. 4 a) IRS LISS III satellite image and b) Landuse/ landcover map of Lahaul-Spiti (HP)

Exploratory studies on climate change and adaptation of species complexes (NWP-0020)

Preparation of baseline information on selected protected areas

The physical, soil and geological maps of the Dhauladhar Wildlife Sanctuary (DWLS), Great Himalayan National Park (GHNP), Rupi-Bhabha Wildlife Sanctuary (RWS) and Pin Valley National Park (PNP) were prepared in GIS environment (**Fig. 5**). These were prepared by scanning, geo-referencing and digitization of the hard copy maps published by Survey of India (SOI), Dehradun; National Bureau of Soil Survey & Landuse Planning (NBSS & LUP), Nagpur and Wadia Institute of Himalayan Geology, Dehradun. The physical maps depict information on major locations, transport network, contours, glaciers and rivers in the area of study. The soil and geological maps provide information on soil taxonomy and lithological units of the region.

Fig. 5 a) Geological maps of DWLS

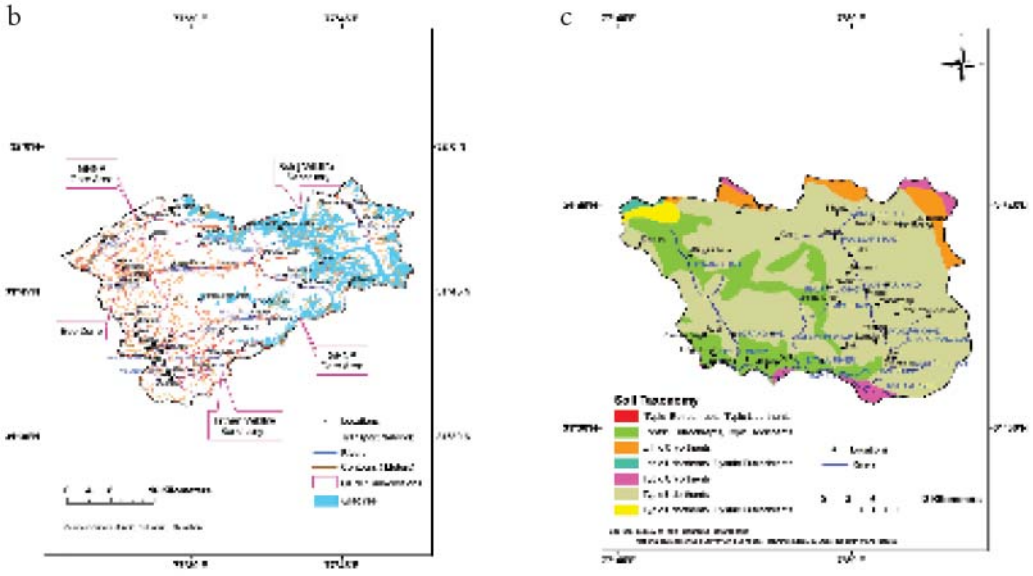


Fig. 5 b) Physical map of GHNP and c) Soil map of RWS

Landuse/ Landcover mapping of GHNP

The landuse/ landcover classification of GHNP using ETM satellite images of November, 2000 revealed that 44.37% of its area is occupied by scree/ stony and snow classes (**Fig. 6**). The

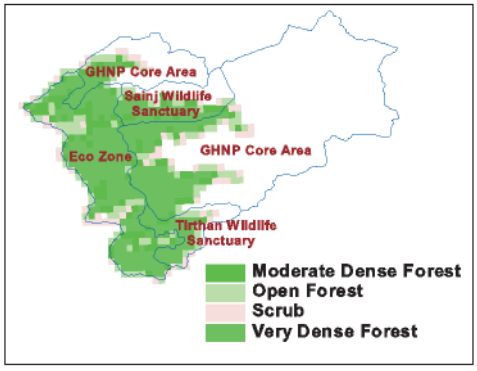


Fig. 6 Forest cover density of GHNP

31.94 and 20.54% area are under forest cover and pastures, respectively. The water bodies and habitations collectively constitute 1.92% area of GHNP. The forest cover densities of these protected areas were derived from forest cover map generated using Landsat TM satellite data (**Fig. 7**). The maximum density was observed in its Eco Zone (72.18%) followed by Tirthan wildlife sanctuary (56.13%) and Sainj wildlife sanctuary (40.5%). The core area had lowest forest cover density (15.73%).

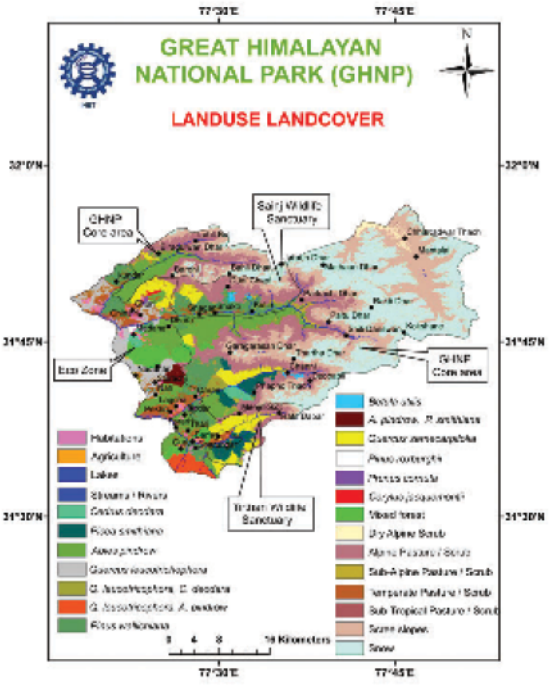


Fig. 7 Landuse/ landcover map of GHNP

Estimation of net primary productivity of GHNP

The Net Primary Productivity (NPP) of GHNP was estimated using MODIS satellite data of 2011. The average annual NPP was 1.024 g C/m²/day and ranged between 0.024 to 2.514 g C/m²/day (**Fig. 8**).

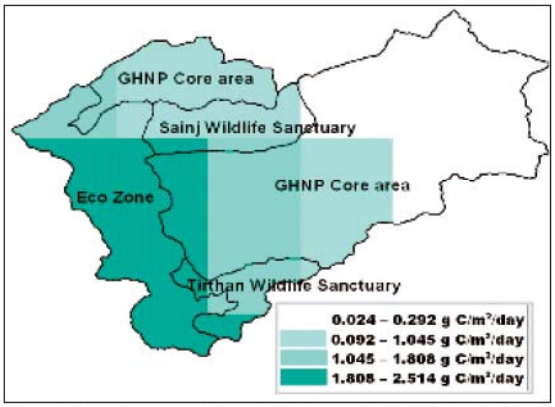


Fig. 8 Net Primary Productivity of GHNP in 2011

Ten long term ecological research plots were established in western Himalayan region. Baseline and environmental data on biodiversity assessment and community analysis for various ecosystems were collected as these are critical for assessing species recruitment and migration. Higher plant species (313) belonging to 204 genera and 68 families from Rupi Bhabha valley were recorded. Additionally, 237 species were encountered and recorded from the forests of Bilaspur Division. Degradation of spruce forest due to temperatures was recorded in Himalaya. In Rupi Bhabha valley, the altitudinal distribution of plants followed a hump shaped curve with maximum diversity in the middle elevations. The species with narrow altitudinal distribution limits were higher in the higher elevations. This is a significant observation in the light of upward migration of species (**Fig. 9**).

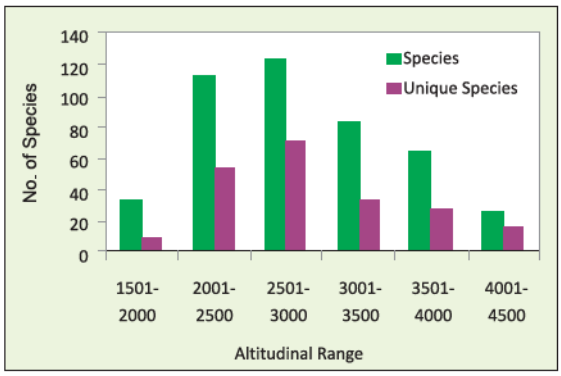


Fig. 9 Altitudinal distribution of plants species in Rupi Bhabha Valley

The distribution of *Rumex nepalensis* (L.) Spreng in Himalaya was studied for possible differences in its high altitude (HA) and low altitude (LA) populations. Seeds collected from these areas showed a distinct variation in colour. Mean seed weight of the HA population was about 80% higher than that of LA type. The HA seed population raised at CSIR-IHBT showed two-fold increase in the ratio of palisade to spongy parenchyma thickness as compared to LA (**Fig. 10**). Compared to LA type, leaf stomatal density declined by 62%, but pore length increased by 30% in HA plants. The ratio of chlorophyll a to chlorophyll 'b' was 20% higher and net photosynthetic rates increased by 25% in HA plants.

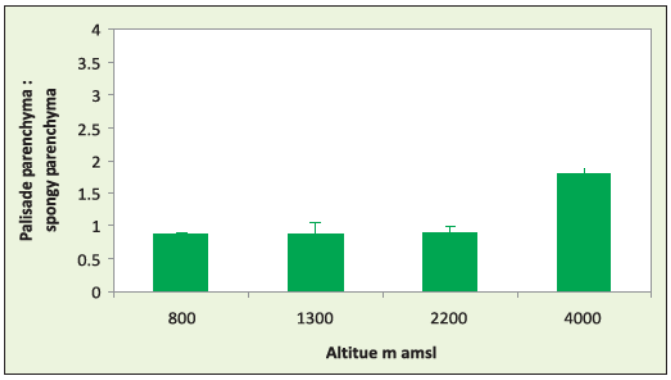


Fig. 10 Ratio of palisade to spongy parenchyma in seed raised population of *R. nepalensis* from different altitudes

In western Himalaya, highest growth at breast height was recorded in *Cedrus deodara* dominated forests (647.14±191.7cu m) followed by

bamboo dominated forests (215.47±205.8 cu m). The khair sissoo and the euphorbia scrub forests recorded low values for the total volume (7.09±6.35 cu m and 10.05±5.19 cu m, respectively).

Agro-meteorological indices viz., growing degree days (GDD), heliothermal unit (HTU) and photothermal unit (PTU) for *Trifolium repens* was developed for mathematical models for predicting climate change. Phenological studies under Free Air CO_2 Enrichment (FACE) and Free Air Temperature Increase (FATI) under FACE exhibited dry matter accumulation advantage towards root as compared to shoot. However, *R. nepalnesis* FATI favored growth.

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

The project was initiated in June 2010 to execute the plantation of trees/shrubs at the 10 closed dumping sites (DS) of NHPC Parbati Hydroelectric Project Phase-II in Kullu district as per the MoU signed between CSIR-IHBT and NHPC.

Three dumping sites, DS-2 and DS-3 in Manikaran valley (Barshaini), and DS-6 in Garsa valley were undertaken for planting in April, July and August, respectively. As a result of the sowing of pelleted seeds of shrub and herb species viz., *Rumex hastatus*, *Tagetes minuta*, and *Erigeron* sp., under canopy growth of these species along with local grasses were also observed in these dumping sites. In November 2011, the rate of survival of trees transplanted earlier at the 8 dumping sites was recorded. The trees growing in these sites include *Alnus, Aesculus, Ailanthus, Pinus*, *Cedrus*, *Populus*, *Robinia* (**Fig. 11**), *Salix*, *Punica*, *Quercus* and bamboo. Average height of each tree (n=20) species was also recorded. The rate of establishment (survival per cent) of the trees transplanted at the 8 sites is given in **Table 2**.

Fig. 11 *Robinia* trees at DS-14, Sund, Sainj valley, Kullu after one year of plantation

Table 2 Establishment rate of trees transplanted at the sites during 2010-11

Dumping site	Location in district Kullu, HP	Rate of establishment (%)
DS-01	Barshaini, Manikaran valley	60.0
DS-02	Barshaini, Manikaran valley	87.7
DS-03	Barshaini, Manikaran valley	81.9
DS-06	Shilagarh, Garsa valley	84.3
DS-12	Sund, Sainj valley	85.4
DS-13	Sund, Sainj valley	93.5
DS-14	Sund, Sainj valley	86.6
DS-16	Rahla, Sainj valley	84.5

During February- March 2012, saplings of *Aesculus, Ailanthus*, *Pinus wallichiana*, *Cedrus*, *Robinia* and *Quercus semicarpifolia* were planted in the remaining 2 dumping sites DS-8 and DS-9 in Raila, Sainj valley.

CONSERVATION AND SUSTAINABLE UTILIZATION OF BIORESOURCES

Strengthening of herbarium

Herbarium is a constant source of valuable information on plants in terms of habitat and species diversity, distribution, abundance/ rarity, phenology and traditional uses of plant resources of any particular region. To-date, over 100 uses of the herbaria are known across the world. To enrich the existing repository of CSIR-IHBT, around 300 voucher specimens (75 pteridophytes and 225 angiosperms) collected from different localities during the year, were added in the herbarium (PLP) of the institute. Amongst the new additions to the herbarium are *Broussonetia papyrifera, Cornus macrophylla, Corylus colurna, Engelhardtia spicata, Eremostachys superba, Jasminum grandiflorum, Olea cuspidate, Pavetta indica, Parrotiopsis jacquemontiana, Sapium insigne, Sauraria japonica, Spondias pinnata, Xylosma longifolium* (angiosperms) and *Pteridium aquilinum*, *Asplenium pseudofontanum, Phymatopteris oxyloba*, *Adiantum incisum* subsp. *indicum, Dennstaedtia appendiculata, Coniogramme affinis*, *Marsilea minuta* and *Selaginella* spp. (pteridophytes). To-date, the herbarium has around 15,000 specimens belonging to 1430 species, 632 genera and 156 families.

Comprehensive Traditional Knowledge Digital Library (NWP-0040)

Information on 6000 records on folk traditional knowledge from the published sources was entered in the electronic database. Morphological descriptors including vernacular names of 100 medicinal plants used in Ayurveda were prepared, and the information generated was entered in the database. To-date, information on 24,000 records on folk traditional knowledge associated with plant resources, mostly from western Himalaya, and morphological descriptors of 1450 target plants were entered in the database designed by the nodal CSIR-TKDL unit.

Introduction to botanical garden

To enrich the existing botanical garden of the institute with new additions, plants were procured from different sources like forest areas of Chamba, Kangra, Kullu and Mandi districts of HP; National Botanical Research Institute (CSIR-NBRI), Lucknow and locally from forests and

private nurseries. A total of 125 plant species comprising of 79 trees, 20 shrubs, 14 climbers and 12 pot plants were introduced. Some of interesting the species collected are *Buxus wallichaiana, Ceiba pentendra, Corylus colurna, Clerodendrum thomsoniae, Cryptolepis buchananii, Engelhardtia spicata, Erythrina blackei, Jasminum grandiflorum, Myrica esculenta, Plumaria rubra, Rhododendron arboretum, Sapium insigne, Sophora japonica, Thunbergia grandiflora, Tibouchina urvilleana* and *Wisteria sinensis.*

Introduction of some unique ferns to the fernery

The fernery of CSIR-IHBT contains a collection of 100 species of pteridophytes (**Fig. 12**). Besides these, 23 new species of ferns collected from different parts of HP were introduced in the current year. These include *Pteridium aquilinum*, *Asplenium pseudofontanum, Phymatopteris oxyloba*, *Ophioglossum reticulatum*, *Adiantum incisum* subsp. *indicum, Dennstaedtia appendiculata, Coniogramme affinis*, *Marsilea,* 3 species of *Selaginella* and 2 spp. of *Nephrolepis.* The remaining 10 species collected from other states are as follows (**Table 3**).

Fig. 12 CSIR-IHBT fernery

Table 3 Ferns collected from different locations outside HP

Name of species	Collection site	Native place
Microsorum punctatum (L.) Copel.	New Delhi	South India, Western Ghats
Microsorum scolopendria (Burm. f.) Copel.	Hyderabad	South India, Western Ghats
Nephrolepis spp. (variegated)	New Delhi	North-East Himalaya
Pteris cretica var. alboleanata	New Delhi	North-East Himalaya
Pteris vittata L. subsps. *vittata*	Lucknow	Common in low altitude areas
Psilotum nudum L.	CSIR-NBRI Lucknow	Amarkantak hills, MP
Blechnum orientale L.	CSIR-NBRI Lucknow	South India, Western Ghats
Pronephrium species	CSIR-NBRI Lucknow	Darjeeling, North-east Himalaya

In the entire collection of 123 species maintained in the fern house, 2 species *Cyathea spinulosa* and *Psilotum nudum* are listed under the critically endangered category by IUCN (**Fig. 13**).

Fig. 13 a) ***Cyathea spinulosa*****, b)** ***Psilotum nudum*** **and c)** ***Ophioglossum reticulatum***

Bioresource inventorization with a focus on bioprospecting of pteridophytes of western Himalaya (Funded by National Bioresource Development Board, Govt. of India)

Studies on Pteridophytes

In order to understand the habitat and distribution range of target pteridophytes in western Himalaya, preliminary field surveys were conducted in 6 forest localities in Chamba, Kangra, Mandi and Una districts of HP (**Table 4**). In addition, several short visits around Palampur were carried out. Efforts were made to identify locations specific for the target plants. During field explorations, live plant samples were collected for introduction in the fernery, and voucher specimens for identification and preservation of material as reference in the herbarium (PLP) of the Institute.

Table 4 Details of the field surveys conducted

Date	Areas surveyed
29.06.2011	Ashapuri /Tinbud areas of Kangra district
27.07.2011	Bankhandi and Dehra areas of Kangra district
29.07.2011	Uttarala area of Kangra district
03.08.2011	Jogindernagar, Machhial and Bir forest areas of Mandi district
07-12.08.2011	Bharmour area of Chamba district
29.11.2011	Nehrian, Bhattera and Amb areas of Una district

Distribution maps of pteridophytes

In order to prepare distribution maps of the pteridophytes of HP, the information on locations of *Adiantum* and *Cheilanthes* species were recorded from published sources. The geographical coordinates of these locations in terms of latitude and longitude were plotted on the administrative map of HP in Geographic Information System (GIS) environment. The maps depicting distribution of species of *Adiantum* (6) and *Cheilanthes* (12) were prepared (**Fig. 14**).

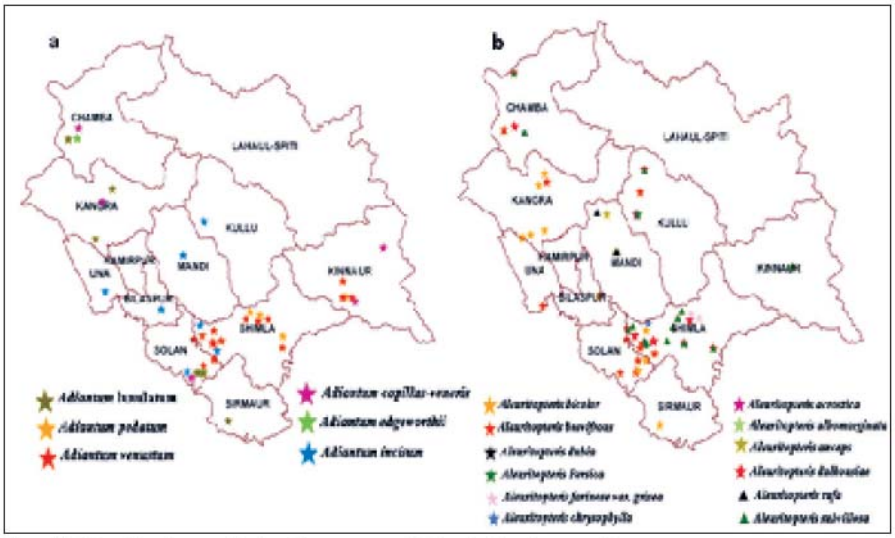


Fig. 14 Distribution of a) *Adiantum*, and b) *Cheilanthes* species

Characterization of fern spores by SEM

A repository of viable spores of 25 ferns species and 2 fern-allies maintained in the CSIR-IHBT Fernery were preserved in spore packets made of brown paper sheets for studies on viability and regeneration.

Work on the characterization of spores by scanning electron microscopy was initiated because characterization of spore morphology, surface ornamentation and spore type play key role in fern taxonomy (**Fig. 15**).

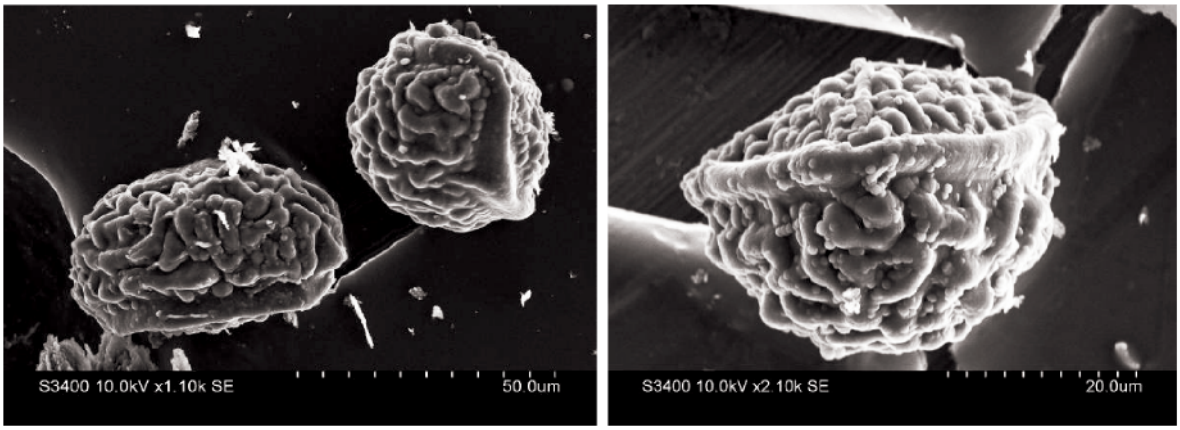


Fig. 15 Ornamentation of fern spores and magnified view of a single monolete type spore

Prospecting of bioactive molecules from pteridophytes for metal loaded industrial wastes and their metabolic adaptations (Funded by Department of Science and Technology, Govt. of India, Women Scientist Scheme)

Survey and collection of ferns and fly ash

Surveys were conducted in fly ash (FA) contaminated areas of NTPC at Kanti, Muzaffarpur, Kahalgaon and Bhagalpur (Bihar). *Pteris vittata* L., *Thelypteris dentata* (Forssk.) E.P. St. John,

Diplazium esculentum (Retz.) Sw. and *Ampelopteris prolifera* (Retz.) Copel. were found growing luxuriantly in the vicinity of fly ash without any visual phytotoxic symptom. The collected specimens were processed for herbarium and the sporophylls of the ferns growing in polluted sites were stored in desiccators for studies under lab conditions. Fly ash samples from different polluted sites were also collected for analysis of physico-chemical properties.

Physico-chemical properties of fly ash and garden soil

The physico-chemical properties like pH, electrical conductivity, bulk density, porosity and water holding capacity with different metal contents of fly ash were analysed. Garden soil was used as control (**Table 5**).

Table 5 Physico-chemical properties of fly ash and soil samples collected during different seasons

Parameter	Kahalgaon FA			Kanti FA			Garden Soil		
	Sep	May	Dec	Sep	May	Dec	Sep	May	Dec
pH	8.9±0.21	8.1±0.35	8.3±0.31	9.8±0.23	9.3±0.21	9.5±0.13	7.6±0.11	6.9±0.13	7.1±0.21
E C (inmhos cm^{-1})	9.7±0.51	6.2±0.03	8.17±0.4	8.3±0.3	7.9±0.51	8.11±0.5	3.5±0.06	2.8±0.05	3.1±0.05
CEC	1.69±0.05	1.53±0.06	1.43±0.05	1.63±0.6	1.41±0.05	1.39±0.4	1.9±0.05	1.7±0.02	1.8±0.03
Total N (%)	0.023±0.2	0.011±0.1	0.017±0.3	0.19±0.1	0.013±0.2	0.023±0.2	0.51±0.3	0.31±0.1	0.29±0.3
Avl. P (%)	0.016±0.1	0.012±0.2	0.021±0.1	0.031±0.2	0.025±0.2	0.018±0.1	0.27±0.3	0.21±0.1	0.23±0.2
Organic C (%)	1.13±0.03	1.19±0.01	1.25±0.02	1.41±0.02	1.23±0.03	1.29±0.01	1.48±0.2	1.35±0.3	1.41±0.2
Bulk density	1.39±0.3	1.21±0.1	1.29±0.2	1.25±0.02	1.15±0.01	1.21±0.02	0.96±0.2	0.81±0.1	0.94±0.5
WHC	28.5±0.5	39.5±0.4	31.8±0.3	35.8±1.1	41.5±1.4	37.5±1.2	48.7±2.2	38.8±2.7	41.3±3.2
Metals (μg^{-1}dw)									
Zn	78.2±3.6	63.5±5.1	55.3±4.5	58±4.5	48.2±3.6	38±2.5	32.7±0.2	41±2.1	37±1.2
Fe	919±39.3	749±15.1	841±19.2	839±9.1	739±8.3	789±8.5	318±9.3	284±7.1	295±7.5
Ni	208±13.5	188.5±9.5	168.1±8.5	313±19.5	288.5±11	189±9.5	97±0.5	88±0.2	91±0.3
Cu	46.5±5.5	26.3±2.1	31.5±3.5	38.5±2.5	29±1.7	36.5±1.5	24±0.3	18±0.3	21±0.3
Mn	74±5.2	59.5±3.1	44.4±3.3	67±5.2	54.5±3.1	42.5±3.2	49±2.1	38±1.1	42±2.2
Cr	97±7.5	76±5.5	83±7.3	87±7.3	81±5.3	78±5.7	9±1.3	7±0.5	5.5±0.3
Cd	7.8±1.5	5.8±1.2	6.02±0.2	6.8±1.5	6..1±1.3	5.9±0.5	BDL	BDL	BDL
Pb	41±3.6	29±1.3	38±2.6	28±1.6	23±1.3	18.5±1.2	BDL	BDL	BDL
Al	317±11.5	213±7.5	285±9.7	515±15.1	487±13.7	437±11.5	18±1.1	15.8±.05	12±1.2
As	25±2.6	19±1.3	21±1.6	27±1.2	23±1.1	25±1.4	BDL	BDL	BDL
Si	156±7.5	127±3.8	139±5.5	127±17.8	127±17.8	127±17.8	11±1.5	9.8±0.5	8±0.3

Mean of triplicate±SD, BDL= Beyond detection limit.

Fern culture and heavy metal accumulation

Different protocols for mass propagation of ferns were adopted for selection of healthy and equal aged gametophytes and sporophytes for further biochemical analysis. Pot experiments for environmental studies of different fern species were also designed deploying different combinations of fly ash (25 to 100%) and garden soil. The harvested fern samples were analyzed for heavy metal accumulation (**Fig. 16**). The effect of metal stress on fresh biomass, Chl a, Chl b, total Chl and carotenoids were recorded (**Fig. 17**).

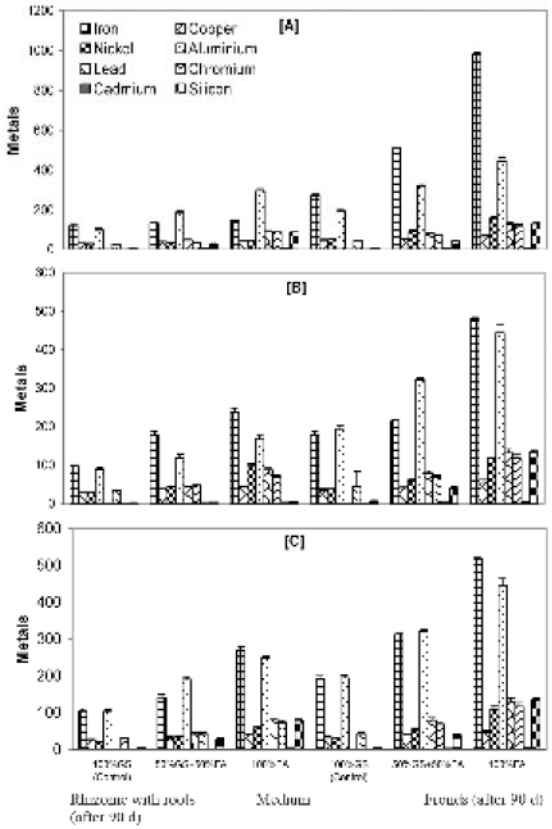


Fig. 16 Effect of different combinations of fly-ash on metal accumulation of three fern species (A) *P. vittata*, (B) *A. prolifera* and (C) *D. esculentum* on rhizoms with roots and fronds after 90 d

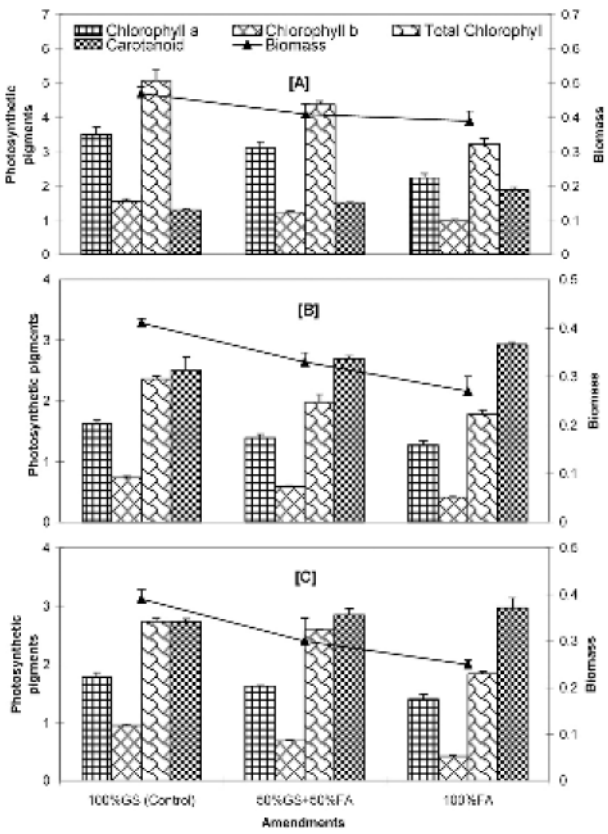


Fig. 17 Effect of different combinations of fly-ash on total biomass and photosynthetic pigments of three fern species (A) *P. vittata*, (B) *A. prolifera* and (C) *D. esculentum* on fronds after 90 d

Anti-oxidative enzymes

Ferns growing on different media having varying combinations of fly ash and garden soil exhibited various degree of oxidative stress and generated antioxidants like MDA (malonaldehyde), SOD (superoxide dismutase), APX (ascorbate peroxidase) and GPX (glutathione peroxidase) (**Table 6**).

Table 6 Effect of different concentration of fly ash (FA) on antioxidants, cystein content and non-protein thiols

Fern species	Treatment	Parameters					
		MDA	SOD	APX	GPX	Cystein	NPSH
Pteris vittata	Control	67±3.4	75±3.4	79±3.5	33±2.1	267±13.7	261.5±13
	25% FA	87±5.1	97±5.3	103±5.4	55±3.4	309.7±31	379.2±33
	50% FA	112±7.3	125±8.2	135±7.3	79±6.7	398.8±27	423.5±15
	100% FA	139±6.5	148±7.8	161±9.4	94±7.4	621.4±33	555.5±43
Ampelopteris prolifera	Control	49±2.2	64±4.1	63±2.7	41±2.1	167±5.4	87.7±4.3
	25% FA	66±4.2	85±3.3	85±4.7	63±2.4	241±7.9	191.5±5.4
	50% FA	82±6.3	99±5.2	97±6.1	89±6.3	345±9.3	231.2±11
	100 %FA	109±7.4	128±6.9	111±9.2	104±8.2	487±14.5	473.7±29
Diplazium esculentum	Control	58±3.2	44±2.3	77±4.5	21±1.5	135±5.7	121.1±9
	25% FA	89±6.1	65±4.3	88±5.4	38±2.1	176±9.4	161.5±9.3
	50% FA	97±5.3	77±3.2	99±7.3	67±3.4	265±8.7	219.3±13
	100 %FA	129±7.7	92±5.4	124±9.1	89±4.7	339±15	401.7±31

Mean of three samples±SD

Centre for High Altitude Biology (CeHAB)

The site of the CeHAB (32°34'16.5" N and 76°58'31" E) at Ribling (Tandi, Lahaul & Spiti, HP) was assessed for species diversity. The vegetation type was found to be alpine meadows (3433m amsl) with the south-west facing mild slopes dominated by grasses. The species diversity estimates as quantified through random sampling are given in **Table 7**.

Table 7 Diversity index of CeHAB

Diversity Index	Value
Number of Taxa	27
Simpson_D	0.355
Shannon_H	1.531
Evenness_e^H/S	0.165

GENOMICS AND PROTEOMICS

Engineering SOD for enhanced thermo-stability

Superoxide dismutase (SOD) catalyzes a two-step dismutation of the toxic superoxide radical ($O_2^{-\cdot}$) to molecular oxygen and hydrogen peroxide through alternate reduction and oxidation of copper ion at diffusion-limited catalytic rate. A unique Cu-Zn SOD from *P. atrosanguinea* Lodd. var. Argyrophylla (Wall. ex. Lehm.) was identified earlier at CSIR-IHBT. It was functional at temperatures ranging from sub-zero to >50 °C. The protein retained its activity even after autoclaving at 121 °C and 1.1 kg cm^2 for 20 min. The thermostability of the Cu-Zn SOD was further improved by developing 7 mutants where amino acids at targeted positions were replaced by site-directed mutagenesis. Amino acids in the electrostatic loop determine the shape and strength of the electrostatic field around the active site. Thus, two important charged residues in the electrostatic loop, Leu-132 and Ser-135 were replaced by Glu and Lys in two separate mutations. Mutation of alanine at position 4 cause amyotrophic lateral sclerosis in human. When Ala and Ile were mutated in two separate mutations, the tolerance of the enzyme to autoclavability was reduced.

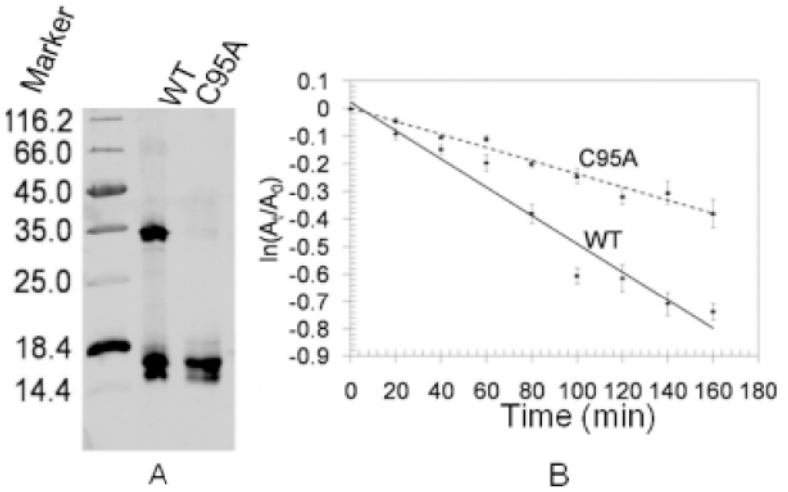


Fig. 18 Effect of mutation on alteration of monomer to dimer ratio (A) and thermal inactivation Kinetics (B) in wild type (WT) and mutated (C95A) super oxide dismutase. (Source: Scientific Reports (Nature Publishing Group) 2: 387, 2012)

Further analysis of the Cu-Zn SOD on relative difference in solvent accessibility criterion suggested the presence of free Cys-95 on the dimer interface played an important role in subunit association. Observations on structurally critical long-range contacts suggested a possible role of Cys-95 in oligomerization. This role of Cys-95 was evaluated *in silico* by replacing free Cys-95 with Ala. Ala was chosen because it eliminates side chain beyond the β- carbon, does not impose extreme electrostatic/ steric effects, nor alters the main-chain conformation. This increased the monomer to dimer ratio by 33 folds in C95A (**Fig. 18A**). The specific activity of C95A was also higher. The importance of higher monomer to dimer ratio for enhanced thermal tolerance was evident from the study on thermal inactivation kinetics (**Fig. 18B**). Computational data revealed that a lower thermal inactivation of C95A after autoclaving was due to reduced irreversible denaturation. The lower values of PDF physical energy and the DOPE score further indicated C95A structure

to be least restrained. Mutation of free Cys-95 to Ala rendered the protein more stable. C95A was also least susceptible to cleavage by the proteolytic enzymes, trypsin and chymotrypsin (**Fig. 19**) at normal temperature. Although papain digested the enzymes partially, yet 85 to 90% activity was still retained. The protein has limited access to partially and globally unfolded conformations under native conditions with minimized accessible conformations to proteolytic attack.

The engineered SOD can be used for developing transgenic plants tolerant to abiotic stresses, particularly where the temperature rise is as high as 50-60 °C.

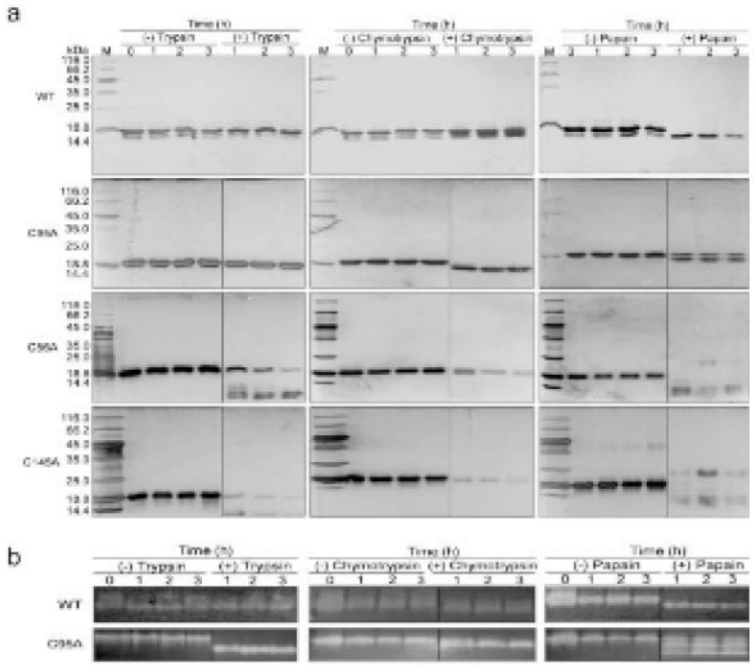


Fig. 19 Effect of incubation of SOD with proteolytic enzymes as seen on a SDS-PAGE (a) and the activity staining gel (b) *(Source: Scientific Reports (Nature Publishing Group) 2: 387 (2012)*

Developing formulation for improvement of food quality by lowering the level of reactive oxygen species (Funded by Department of Biotechnology, Govt. of India)

Free radical scavenging enzymes, superoxide dismutase (SOD), catalase and ascorbate peroxidase enzymes were used to prevent/ delay the spoilage and to increase the shelf life of food items. Three formulations were developed using SOD enzyme as one of the components and applied on tomato variety "Palam Pink' and spinach variety "Palak F1 Softy". Application of the formulation reduced the spoilage/ scald development in ripe tomato fruits which had better contents of lycopene, ascorbic acid, reducing sugar, total antioxidant activity and reducing power. In case of spinach, SOD application was found effective in maintaining higher chlorophyll content and higher beta-carotene content was recorded in leaves. Three more formulations containing catalase in addition to SOD were developed. Tomatoes treated with these formulations showed higher ascorbic acid content and total antioxidant activity. The developed formulation also reduced scald development/ spoilage in apple during post-harvest storage.

Biochemical and proteomic evaluation of horse gram (*Macrotyloma uniflorum* (Lam.) Verdc.) (Funded by the Department of Science and Technology, Govt. of India)

Drought is one of the major abiotic stresses affecting the agricultural production worldwide. A generally drought tolerant legume, horsegram was chosen to compare and decipher the biochemical mechanisms of drought stress tolerance. For this, a drought tolerant (HPK4) and a sensitive variety

(HPKC2) of horsegram were subjected to drought stress. Leaf and root tissues of these plants were harvested for biochemical and antioxidant enzymatic assays. The Relative Water Content (RWC), proline and phenol content were found to be significantly higher in the tolerant variety under drought stress. However, the protein and malondialdehyde (MDA) content was significantly higher in the sensitive variety under drought stress (**Fig. 20**). Among the antioxidant enzymes, peroxidase (POD), superoxide dismutase (SOD), catalase (CAT) and glutathione-s-transferase (GST) showed significant increase in the tolerant variety under drought stress. The results suggested that higher levels of RWC, phenols and proline accumulation in tolerant variety of horsegram could play an important role in drought stress tolerance.

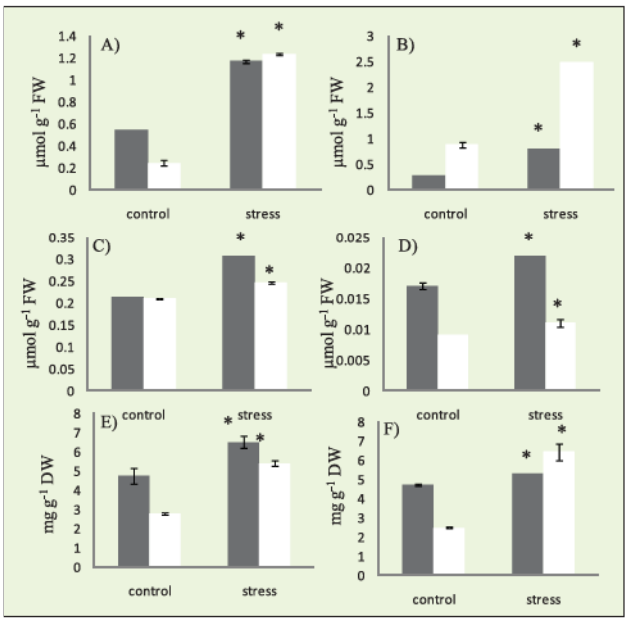


Fig. 20 Proline content in leaves (A) and roots (B) of horsegram. The malondialdehyde content in the leaves (C) and roots (D) of horsegram. Phenol content in the leaves (E) and roots (F) of horsegram, The black bars represent HPKC 2 variety and the white bars represent HPK 4 variety. The values are mean of triplicates with SD. The values marked with the symbol '*' are significant at 5% level

For proteomic analysis, three protocols viz. trichloroacetic acid (TCA)-acetone, phenol and multi-detergent were compared for protein extraction from horsegram. Quality of protein from phenol method was found superior than other protocols. Difference in the quality of proteins extracted through these three methods can be visualized through one-dimensional gel electrophoresis (**Fig. 21A**). The chosen protocol was applied for depletion of abundant proteins and appearance of low-/ non-abundant proteins from horsegram analyzed through 2-DE (**Fig. 21B**). This study will help in identification and characterization of low-/ non-abundant proteins.

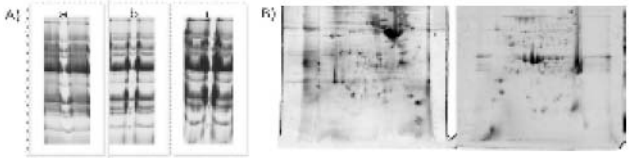


Fig. 21 A) Three different protocols; a) TCA-acetone b) phenol-acetone and c) multi-detergent were compared for the extraction of protein from horsegram by 1-DE analysis. Phenol-acetone method was better than other two methods. B) Application of the chosen protocol for 2-DE analysis of horsegram protein

Exploration for making plants survive, develop and multiply under dark condition (CSIR funded under EMPOWER scheme)

The possibility of making plants grow and multiply under dark conditions was explored. Seeds of the model plant, Arabidopsis ecotype Col-0 were sown and kept under light/ dark conditions and subjected to various environmental and chemical treatments. Few treatments that affected plant biomass and chlorophyll content were identified (**Fig. 22**). In two-dimensional gel electrophoresis of proteins extracted from plants grown under specified conditions, differential expression was recorded (**Fig. 23**).

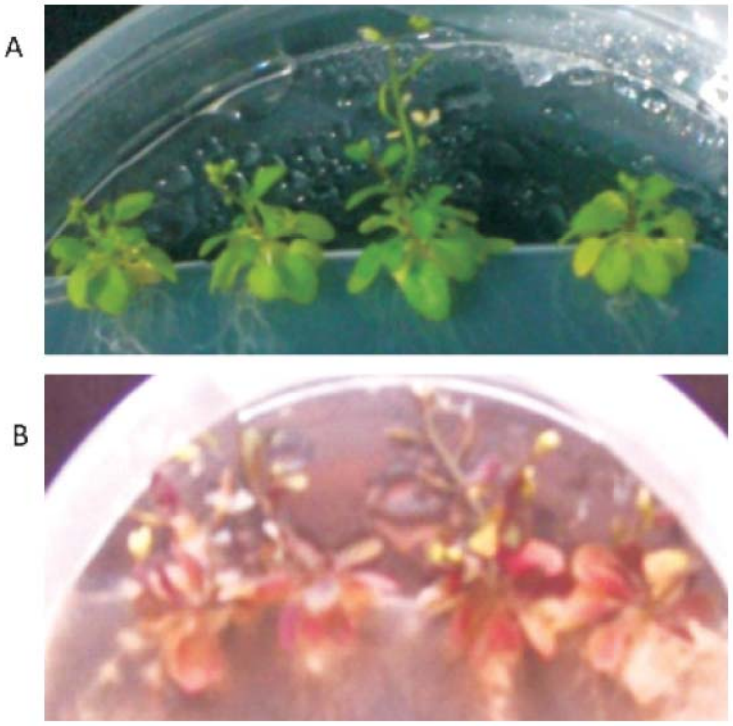


Fig. 22 Effect of treatment on chlorophyll pigments in Arabidopsis. (A) Control plants under light condition; (B) Treated plants under light condition

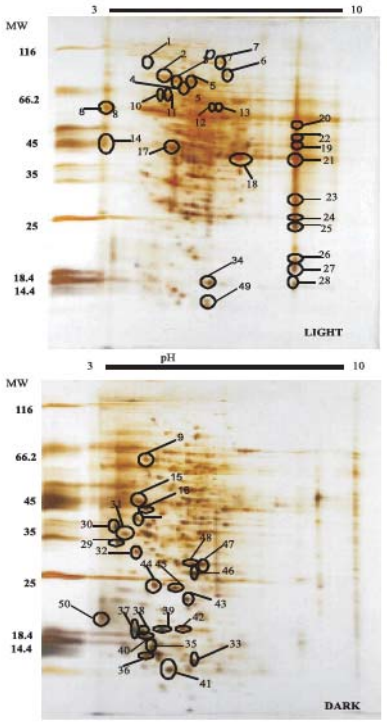


Fig. 23 Two-Dimensional gel electrophoretic analysis of proteins from Arabidopsis plant grown under light or dark conditions

Improving carbon and nitrogen sequestration through transgenic approach: a strategy to lower greenhouse gases (Funded by Department of Science and Technology, Govt. of India)

Photorespiration is known to lower the efficiency of photosynthesis. Reducing photorespiratory loss of CO_2, or recapturing the same, can enhance CO_2 assimilation capacity of plant. There is evidence now to suggest that some plants at higher altitudes can fix CO_2 directly from the atmosphere and from their own respiration, an ability not known for plants at low altitude. The work on high altitude biology has suggested a novel mechanism of CO_2 sequestration. Accordingly, phosphoenol pyruvate carboxylase (PEPCase), aspartate amino transferase (AAT) and glutamine synthetase (GS) enzymes were over-expressed in *Arabidopsis*. The transgenic plants exhibited improved carbon fixation efficiency at different irradiance and CO_2 levels (**Fig. 24**).

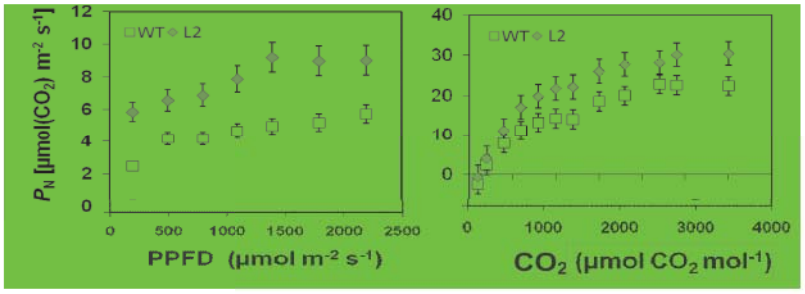


Fig. 24 CO_2 fixation rate of control (WT) and transgenic plants (L2) at different light (PPFD, photosynthetic photon flux density) and CO_2 levels

Nitrogen use efficiency in *Brassica juncea*

There is an urgent need to develop *Brassica juncea* with improved nitrogen use efficiency (NUE). Therefore, genes involved in uptake, transport and assimilation of nitrogen (TAIR 10; http://www.arabidopsis.org/) were identified in the model plant, Arabidopsis which belongs to the same family as *B. juncea*. It also shares high degree of sequence homology. Analysis of microarray data revealed differential regulation of various nitrogen metabolism genes in response to various abiotic stresses at different time points.

The nitrate transporter (BjNRT1) gene was amplified through PCR and the sequence was confirmed. Considering the importance of Dof1 (DNA binding with one finger) transcription factor in the carbon and nitrogen metabolism in plants, two genes encoding the TFs from *B. juncea* were also cloned.

Pathway engineering and system biology approach towards homologous and heterologous expression of high-value phytoceuticals (artemisinin, picrosides, morphine, withanolides, podophyllotoxin) (NWP-008)

The project focussed on understanding the molecular basis of metabolite production in *Podophyllum hexandrum* and *Picrorrhiza kurrooa*. Improved protocol for the isolation of RNA from rhizome tissue of *P. hexandrum* was developed and transcriptome data were generated. *De novo* assembling was performed over the filtered reads, followed by in-house developed computational pipeline to obtain a total of 60,089 assembled transcript sequences, with an average coverage of 88.34 and average length of 543.11 bp. A total of 11 full-length genes associated with podophyllotoxin biosynthesis were cloned and analyzed. These were *Phenylalanine ammonialyase* (*PAL*), *p-CoumaroylCoA ligase* (*4CL*), *Cinnamic acid 4-hydroxylase* (*C4H*), *Hydroxycinnamoyl transferase* (*HCT*), *Caffeic acid 3-O-methyltransferases* (*COMT*), *Cinnamoyl CoA NADPH oxidoreductase* (*CCR*), *Pinoresinol lariciresinol reductase* (*PLR*) *and Secoisolariciresinol dehydrogenase* (*SLD*), *P450s* (of 3 different types). Detailed expression analysis identified the possible regulatory genes of the pathway. *SLD* was functionally validated. Transcriptome data were generated for leaf tissue of *P. kurrooa*. A total of 74,336 assembled transcript sequences were obtained, with an average coverage of 76.6 and average length of 439.5. A regeneration protocol was also standardized using leaf segments and aseptic shoot cultures were raised.

Fig. 25 Putative transformants

Work on genetic transformation was continued using the transcription factor *WRKY* from *P. kurrooa* in pCAMBIA1302 vector and *GUS* gene in *Agrobacterium* strain GV3101. Parameters were optimised for developing transgenic plants using *GUS* reporter gene (**Fig. 25**). The genomic DNA of putative transformants tested positive in PCR with *gus* gene-specific primers (**Fig. 26**).

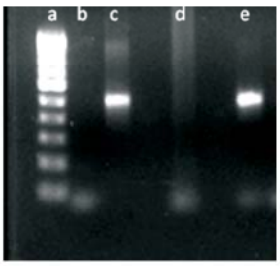


Fig. 26 PCR analysis of gus transformant, a: 100 bp ladder, b: -ve control (Blank), c: +ve control d: untransformed, e: transformed

Metabolic Engineering of Vinca Alkaloid Pathway

Transcriptome of young leaves of *Catharanthus roseus* was sequenced and analysed with a target to clone various hydratases for the possibility of conversion from 16–methoxytabersonine into 16-methoxy-2, 3-dihydro-3-hydroxytabersonine.

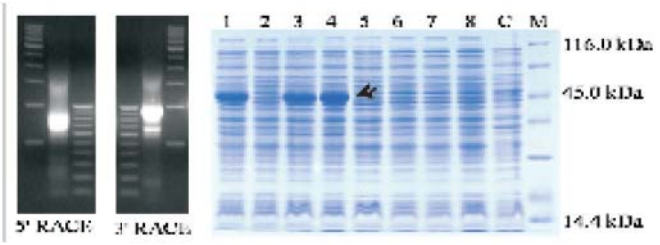


Fig. 27 Expression of Scaffold 12057 in *E. coli*; M: protein marker; C: control (-IPTG); 1-8: induced (+IPTG); Theoretical Mol. Wt (43.08) + His-tag Mol. Wt (2) = 45.08 kDa. The location of induced protein is marked by an arrow

Scaffold 12057 was cloned to a size of 1.158 Kb (encoding 386 aa) using 5' and 3' RACE. The protein (45.08 kDa) was expressed on SDS-PAGE (**Fig. 27**).

Putative hydratase (C220804), Scaffold 14527, and C218090 were cloned and expressed in *E. coli*. However, some of them that could not be expressed in *E.coli* included S7018, C158946, C197736, C186618, and S2928.

Post-transcriptional silencing of flavonol synthase mRNA in tobacco fruits with arrested seed set

A strategy was proposed for the generation of seedless or low-seeded fruits through post-transcriptional gene silencing (PTGS) of flavonol synthase gene. The FLS silenced lines had reduced mRNA (20-80%), quercetin (25–93%) and anthocyanidins but increased levels of catechin, epi-catechin and epigallocatechin. The delayed flowering in these lines was attributed to decrease in level of indole acetic acid (IAA) in shoot apices. Pollen germination was hampered in these lines due to their inability to produce functional pollen tube. Their pods contained significantly less number of seeds.

Normal pollen germination and pollen tube growth was restored when the germination media contained 1mM quercetin. The role of quercetin in pollen germination and plant fertility was established (**Fig. 28**).

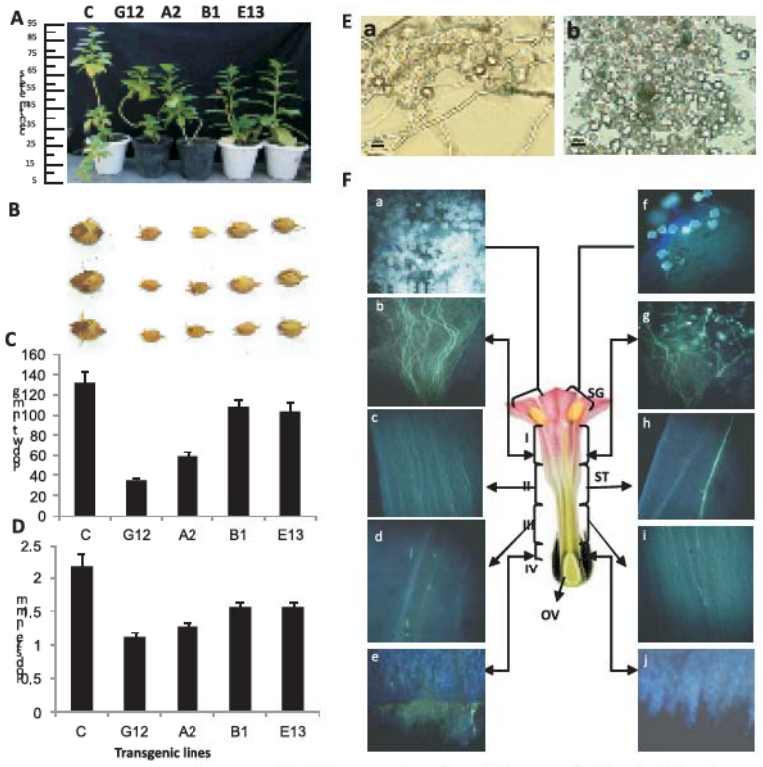


Fig. 28 FLS silenced transgenic tobacco showing (A) morphological features, (B-D) yield (E) *in vitro* and (F) *in vivo* pollen germination

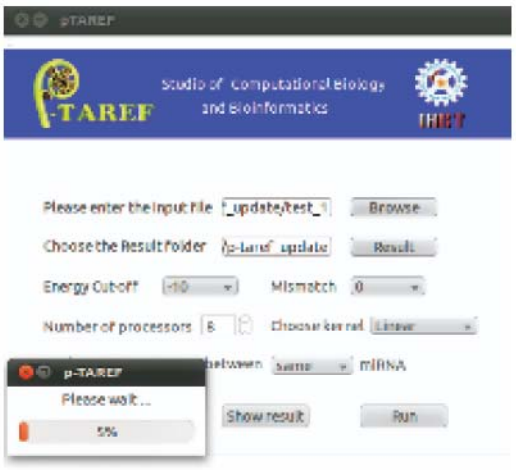
Exploration for doubling the number of proteins synthesized by a plant species: Why only ATG is translation start codon? Can we make other existing codon(s) to act as translation start codon(s)? (CSIR funded under EMPOWER scheme)

The project aimed at exploring the possibilities of initiating the synthesis of proteins from codons other than ATG. A target gene encoding green fluorescent protein (gfp) was selected with the aim to mutate its translation start codon (ATG) and developing a vector system for its expression analysis. *E. coli* M15 cells transformed with *pQE 60* containing GFP. SDS-PAGE analysis showed the induction of gfp expression. ATG was mutated using site directed mutagenesis for analysis of its effect on translation initiation.

COMPUTATIONAL BIOLOGY AND BIOINFORMATICS

Accurate identification of microRNA targets in plant system (Funded by Department of Biotechnology, Govt. of India)

A SupportVector Regression (SVR) approach was used for plant miRNA target identification and utilizing the position specific dinucleotide density variation information around the target sites. It was named as p-TAREF (plant-Target Refiner). The performance of p-TAREF was compared with other prediction tools for plants with utmost rigor. Accurate detection of miRNA targets from species like *Arabidopsis,* alfalfa, rice and tomato suggested gross usability of p-TAREF for plant species. It was used to identify targets for complete rice transcriptome supported by expression and degradome based data. miR156 was found to be an important component of the rice regulatory system, where control of genes associated with growth and transcription was predominant. The entire methodology was implemented in a multi-threaded parallel architecture in Java to enable fast processing for web-server as well as standalone versions. It can be used on a simple desktop computer in concurrent mode and it can help in gathering experimental support for predictions made through on-the-spot expression data analysis in its web-server version and performance detail shown in **Table 8**.



p-TAREF standalone version

Table 8 Performance comparison between psRNA-target, Target-align and p-TAREF

	psRNA target		Target-align		P-TAREF (polynomial kernel)	
	Beauclair *et al.*	ASRP	Beauclair *et al.*	ASRP	Beauclair *et al.*	ASRP
TP	81	119	64	103	104	262
FN	23	168	40	184	0	25
TN	119	119	119	119	119	119
FP	0	0	0	0	0	0
Sn	77.88	41.16	61.53	35.888	100	91.29
Sp	100	100	100	100	100	100
MCC	0.81	0.4146	0.678	0.4586	1	0.86
ACU%	89.68	58.620	82.06	50.800	100	93.84

*TP=True Positive,FP=False positive, TN=True Negative, FN= False negative, Sn=sensitivity, Sp=Specificity, MCC= Mathew Correlation Coefficient; Ac=Accuracy

(Source: Employing Machine Learning for reliable miRNA target identificaiton in plants. Jha A and Shankar R, BMC Genomics, 2011, 12:636)

De novo transcriptome assembly, annotation and expression for *P. kurrooa*

Read data were generated and assembled for transcriptome sequencing. The impact of temperature over the transcriptome profile was studied digitally using short reads. The entire transcriptome annotation and computational study was carried out digitally (database at http://scbb.ihbt.res.in/Picro_information/index.php). For the first time, the concept of dissimilar sequence clustering was applied to minimize the inflated number of transcripts. *De novo* transcriptome assembly, annotation and expression study pipeline as well as parallely coded software Filter were developed to clean and opt for suitable Illumina reads. Several critical pathways genes were differentially expressed at two different temperatures. The developed NGS pipeline and protocol is shown in **Fig. 29**. (Source: De novo sequencing and characterization of *Picrorhiza kurrooa* transcriptome at two temperatures showed major transcriptome adjustments. Gahlan P, Singh HR, Shankar R, Sharma N, Kumari A, Chawla V, Ahuja PS and Kumar S, BMC Genomics, 2012, 13:26).

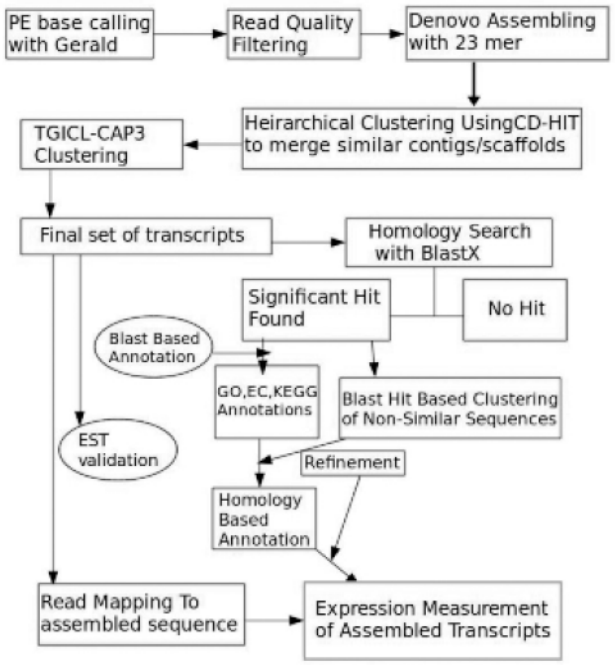


Fig. 29 Pipeline developed for de novo next generations sequencing and data analysis

Regulatory epicenter discovery in microRNA precursors (Funded by DBT and EMPOWER scheme)

miRNAs are small non-coding RNAs with average length of ~21 bp. Their formation seems to be dependent upon multiple factors besides Drosha and Dicer in a tissue/stage-specific manner and involves the interplay of several specific binding factors. The transcription factor binding sites in and around the genomic sequences of precursor miRNAs and RNA-binding protein (RBP) sites in miRNA precursor sequences were analysed and tested. The miRNA precursor regions were found to be positionally enriched for binding of transcription factors as well as RBPs around the 3' end of mature miRNA region in arm 5. The pattern and distribution of such regulatory sites were characteristic of precursor miRNA sequences when compared with non-miRNA sequences as negative dataset and tested statistically. A sudden sharp peak for binding sites was observed in the enriched zone near the mature miRNA region compared with 1 kb upstream regions. Expression-data-based correlation analysis between such miRNAs and their corresponding transcription factors and RBPs for this region showed some specific groups of binding factors and associated miRNAs. Some of the over-represented transcription factors and associated miRNAs with high expression correlation values, useful in cancer-related studies were identified. The highly correlated groups hosted experimentally validated composite regulatory

modules, in which Lmo2-GATA1 was predominant. For co-expression similarity evident among the many RBP–miRNAs associations supporting the Regulon model suggested a common control of these miRNAs by the associated RBPs (**Fig. 30**). The characteristic distribution of regulatory sites in precursor miRNA sequence regions was proposed to be critical in miRNA transcription, processing, stability and formation.

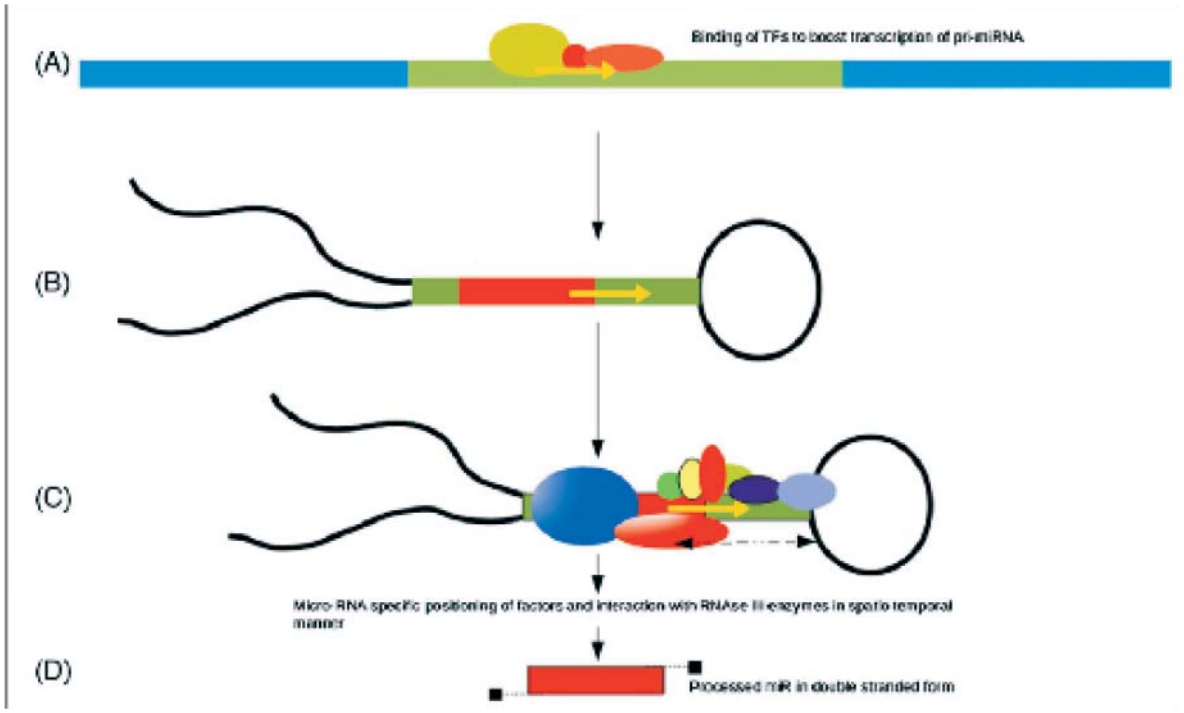


Fig. 30 The proposed regulatory epicenter model for transcriptional as well as post transcriptional regulation of microRNAs (Source: The regulatory epicenter of miRNAs, Jha A, Mehra M, Shankar R, Journal of Biosciences, 36(4):621-38).

Integrative network biology approach for therapeutic studies

Complex systems analysis and graph theory were used to study protein interactomes and identify potent targets of asthma and secondary bone cancer disease conditions.

Tracing the evolutionary origin of disease-resistance genes in plants

The genome wide survey of plants revealed large number of nucleotide binding site-leucine rich repeat (NBS-LRR) genes known to have important role in defense. To identify the NBS-LRR genes in all the available plant genomes, the HMM profile of NB-ARC domain (Pfam: PF00931) was adopted as a query in HMM searches encoded in different plant genomes with E-value < $1e^{-05}$. In domain annotation of NBS-LRR genes, the above mentioned genes collected in respective plant genomes were screened for domains annotation by using Pfam_Scan search. The NBS-LRR genes were also screened by SMART and other domains (ProDom) for domain boundaries. The domains were selected only if the criteria were met with E-value < $1e^{-05}$ (**Table 9**).

Table 9 Genome-wide survey of NB-ARC domain in plants

Group/Divisons	Species	NB-ARC domain
	Arabidopsis lyrata	179
	Arabidopsis thaliana	203
	Citrus clementia	579
	Carica papaya	35
	Cucumis sativus	64
	Citrus sinensis	483
	Eucalyptus grandis	695
	Glycine max	353
Eudicots	*Malus domestica*	921
	Manihot esculenta	217
	Mimulus guttatus	312
	Medicago truncatula	491
	Prunus persica	332
	Populus trichocarpa	485
	Ricinus communis	150
	Vitis vinifera	295
Monocots	*Sorghum bicolor*	251
	Setaria italica	429
Lycopodiophyta	*Selaginella moellendorffii*	16

NANOBIOLOGY

Synthesis of nanoparticles

In continuation to previous work on nanobiology, *Lonicera japonica* and *Bauhinia variegata* were explored for synthesis of Ag and Au nanoparticles (**Fig. 31**). A correlation between the size and shape of synthesized metallic nanoparticles and the concentration of plant extract, molarities of parent metallic compound, time of incubation and temperature was established.

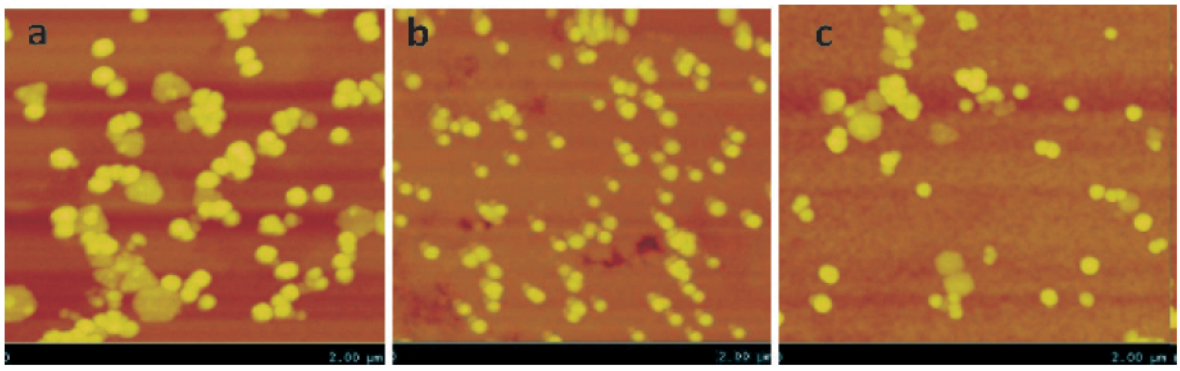


Fig. 31 NPs synthesized from leaf extracts: a & b) *Lonicera japonica* and c) *B. variegata*

Cellular oxido-reductive proteins control the *Chlamydomonas reinhardtii* mediated biosynthesis of silver nanoparticles

The role of diverse cellular proteins in the synthesis and capping of silver nanoparticles using *C. reinhardtii* as a model system was demonstrated (**Fig. 32**). The *C. reinhardtii* cell free extract and *in vivo* cells were used to synthesize silver nanoparticles (SNPs) ranging from 5±1 to 15±2 nm and 5±1 to 35±5 nm in size, respectively. SNPs biosynthesized *in vivo* were localized in the peripheral cytoplasm and at one side of flagella root i.e. the site of ATP transport and synthesis related enzymes. This indicated the involvement of oxidoreductive proteins in the biosynthesis and stabilization of SNPs. This was confirmed by alterations in size distribution and decreased rate of SNPs synthesis in protein-depleted fractions.

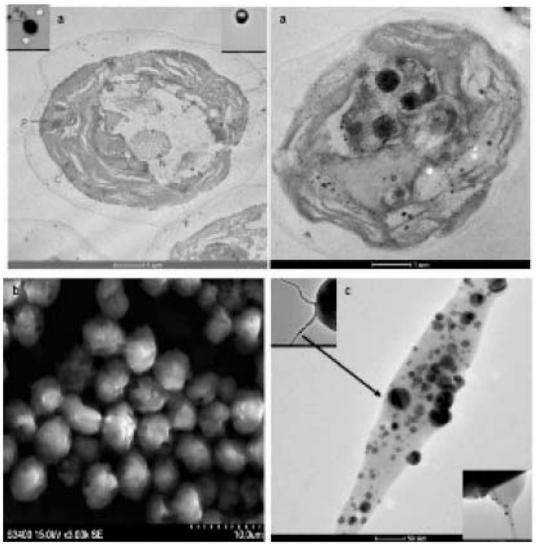


Fig. 32 Cellular localization of *in vivo* synthesized silver nanoparticles (a) TEM micrograph of thin section (~60 nm) and (b) SEM image of 1 mM $AgNO_3$ incubated *C. reinhardtii* cell. (c) Silver nanoparticles localized on the flagellum

NATURAL PRODUCTS CHEMISTRY

SHATAVARI (*Asparagus racemosus*)

The plant is recommended in ayurveda for galactagogue, anti-inflammatory and immunomodulatory activities. Two steroidal saponins, shatavaroside A and B (**Fig. 33**), were evaluated for immunomodulatory activity using polymorphonuclear leucocyte function test. The activity was further confirmed by nitroblue tetrazolium, nitrous oxide and chemiluminescence assays. Both steroidal saponins were found active at 5 ng/ml and can act as potent immunostimulants.

Asparagus racemosus

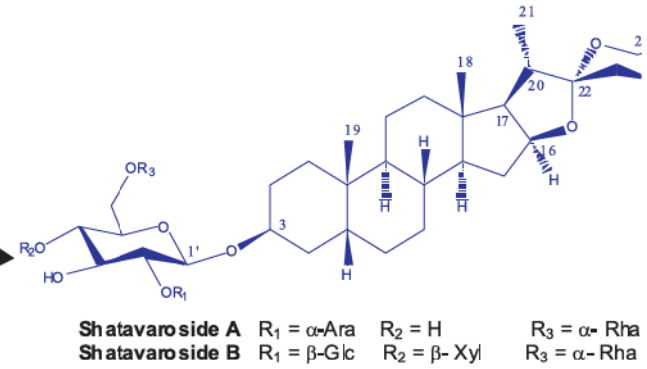
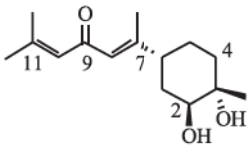


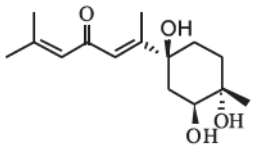
Fig. 33 Chemical structures of immunomodulatory steroidal saponins

DEODAR (*Cedrus deodara*)

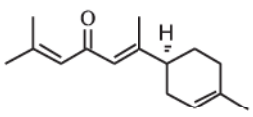
It is the main source of cedar wood oil. Two novel sesquiterpenes, (*E*)-(2*S*, 3*S*, 6*R*)-atlantone-2,3-diol, (2*S*, 3*S*, 6*S*)-atlantone-2,3,6-triol and two known sesquiterpenes, (*E*)-α-atlantone, atlantolone were isolated and characterized from *n*-hexane extracts (**Fig. 34**). The *n*-hexane and chloroform extracts of sawdust, (*E*)-α-atlantone and atlantolone exhibited antifungal activity against *Aspergillus flavus, A. niger, A. ochracoeus, A. parasiticus* and *A. sydowii*.



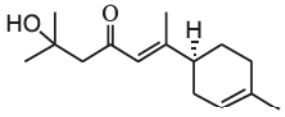
(*E*)-(2*S*, 3*S*, 6*R*)-Atlantone-2,3-diol



(2*S*, 3*S*, 6*S*)-Atlantone-2,3,6-triol



(*E*)-aAtlantone



Atlantolone

Fig. 34 Chemical structures of sesquiterpenes isolated from *C. deodara*

GUDUCHI (*Tinospora cordifolia*)

Tinospora cordifolia

The immunomodulatory activity of different extracts, fractions and isolated compounds in relation to phagocytosis and reactive oxygen species production in human neutrophil cells were investigated using the PMN phagocytic function studies, NBT, NO and chemiluminescence assay. Hot water extract, ethyl acetate and water fractions exhibited significant immunomodulatory activity. Chromatographic purification of these fractions led to the isolation of 11-hydroxymustakone, *N*-methyl-2-pyrrolidone, *N*-formylannonain, cordifolioside A, magnoflorine, tinocordiside and syringin. Cordifolioside A and syringin were reported to possess immunomodulatory activity (**Fig. 35**). Other five compounds showed significant enhancement in phagocytic activity and increase in nitric oxide and reactive oxygen species generation at concentration 0.1-2.5 µg/ml.

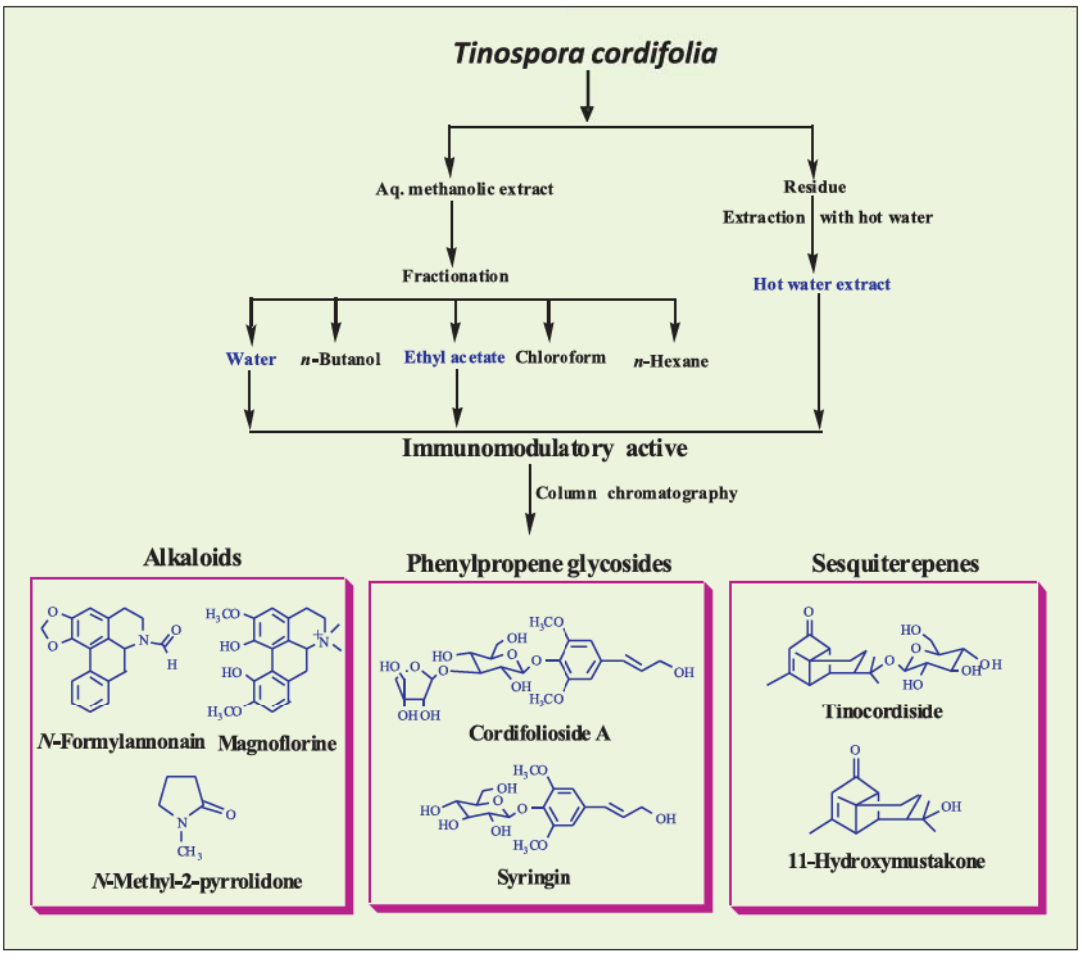


Fig. 35 Evaluation of immunomodulatory activity of *T. cordifolia*

CHINESE ALBIZIA (*Albizia chinensis*)

It is a native of mixed deciduous forests of humid tropical and sub-tropical monsoon climates and has antioxidant, antiseptic, antidysenteric, antitubercular, antitumor, spermicidal, molluscicidal and insecticidal properties. Ultra-performance liquid chromatography coupled with electrospray ionization quadrupole time-of-flight mass spectrometry (UPLC-ESI-QTOF-MS) was used to study the phenolic composition of the ethanolic extracts of various parts (flowers, leaves, pods and bark) using water (0.05% formic acid)–methanol as the mobile phase. Overall, fifteen known and unknown compounds constituting flavonols, their glycosides, procyanidins and galloyl tannins (**Fig. 36** and **37**) were characterized (**Table 10**).

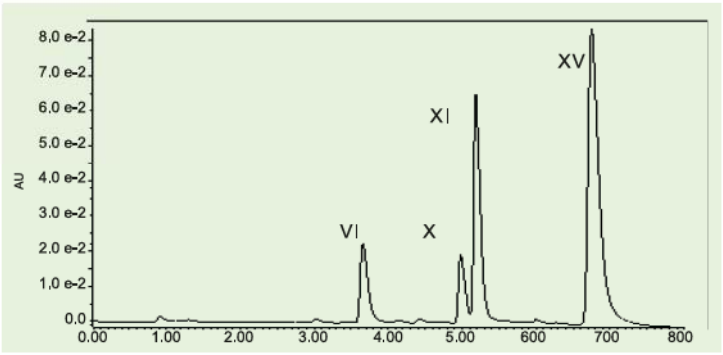


Fig. 36 UPLC-DAD chromatograms of standard mixture

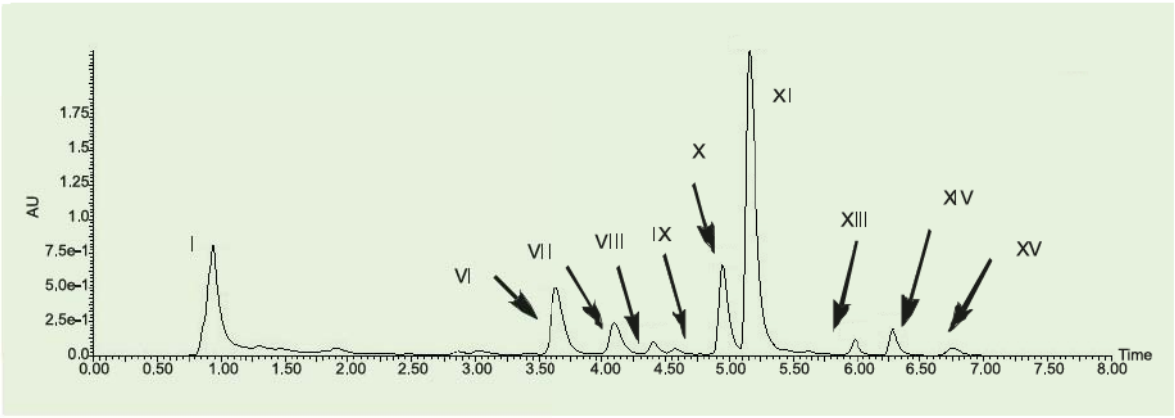


Fig. 37 UPLC-DAD chromatograms of methanolic extracts of *A. chinensis* flowers

Table 10 Identification of phenolic compounds in methanolic extracts of different parts of *A. chinensis*

Peak No.	t_R (min)	UV Spectra	Calculated MW	Positive ion mode		Phenolic compounds
				MS	MS-MS	
I	0.92	210, 272	380	381	219, 201	Procyanidin[c]
II	1.30	210, 262	382	383	367, 247, 217, 166	Procyanidin[c]
III	1.50	210, 283	-	-	-	Procyanidin[c]

Peak No.	t_R (min)	UV Spectra	Calculated MW	Positive ion mode		Phenolic compounds
				MS	MS-MS	
IV	1.90	210, 262	408	409	300, 247, 185	Procyanidin[c]
V	3.31	258, 352	486	487	365, 267, 215, 319, 267, 205, 175	Myricetin-3-*O*-glycoside
VI	3.64	259, 352	464	465	361, 341, 319, 205, 175	Myricetin-3-*O*-rhamnoside[a]
VII	4.08	256, 354	464	465	383, 367, 303, 229, 205, 175, 121, 109	Quercetin-3-*O*-galactose
VIII	4.40	256, 355	434	435	303, 233, 205, 175	Quercetin-3-*O*-pentoside[b]
IX	4.51	255, 356	434	435	349, 303, 213, 139	Quercetin-3-*O*-pentoside[b]
X	4.94	256, 353	434	435	303, 245, 209, 102	Quercetin-3-*O*-arabinofuranoside[a]
XI	5.16	256, 350	448	449	303, 147, 129	Quercetin-3-*O*-rhamnoside[a]
XII	5.70	266, 356	498	499	287, 175	Kaempferol-3-*O*-glycoside[c]
XIII	5.99	266, 356	418	419	404, 349, 326, 287	Kaempferol-3-*O*-arabinofuranoside[b]
XIV	6.27	264, 356	432	433	407, 389, 350, 287, 148, 103, 85, 71	Kaempferol-3-*O*-rhamnoside[b]
XV	6.73	256, 367	302	303	257, 229, 201, 183, 153, 137, 111, 95, 69	Quercetin[a]

[a]Compounds conclusively identified by comparison with authentic standard. [b]Compounds tentatively identified by UV and mass spectral data. [c]Samples tentatively identified by UV spectral data

TIRMIRA (*Zanthoxylum armatum*)

It is extensively used in the Indian System of Medicines for preventing toothache and as a carminative, stomachic and anthelmintic. Its chemical investigation led to the isolation of three cinnamoyl amides, one lignan and one cinnamoyl ester from bark, five flavonoids from leaves and two isobutyl amides from seed extracts. The structures of these compounds have been elucidated as *N*-(4-methoxyphenylethyl)-3',4'-methylenedioxycinnamamide, *N*-(3,4-dimethoxy-phenylethyl)3',4'-methylenedioxycinnamamide, *N*-(3,4-dimethoxyphenylethyl)-3', 4'-dimethoxycinnamamide, methyl-4-isoprenyloxycinnamate, epicatechin **5**, vitexin, isovitexin, rutin, *N*-isobutyl-*2E,4E,8Z,10E*-dodecatetraenamide and *N*-(2'-hydroxyisobutyl)-*2E,4E,8Z,10E*-dodecatetraenamide with the help of 1D and 2D NMR experiments including COSY, DEPT, HMQC and HMBC spectroscopy as well as ESI-QTOF-MS/MS analysis (**Fig. 38**).

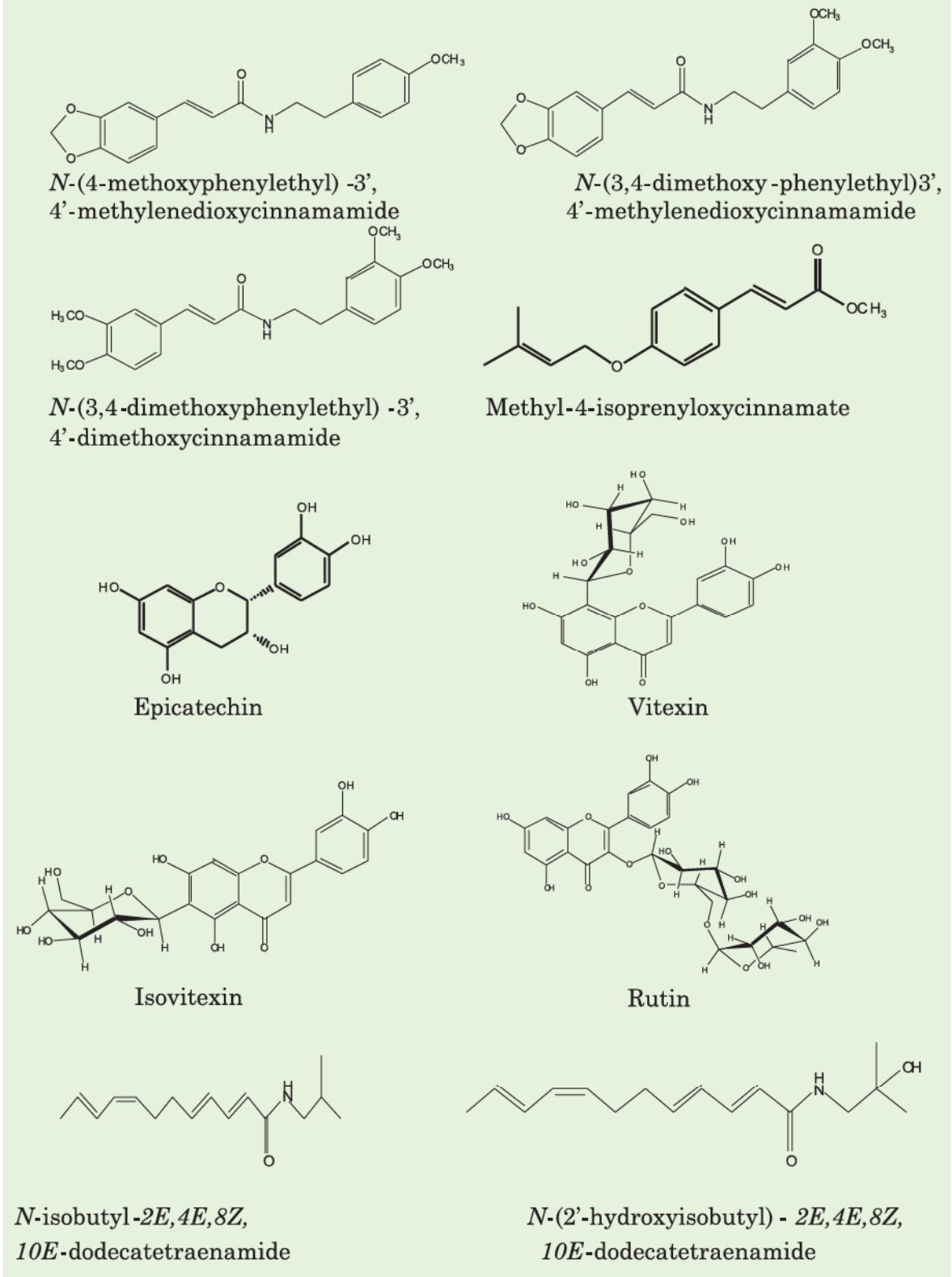


Fig. 38 Chemical structures of compounds isolated from *Z. armatum*

HAWTHORN (*Crataegus oxyacantha*)

It is considered to be one of the best cardiac tonic found in plant kingdom. A reverse phase high performance thin layer chromatography (RP-HPTLC) method was developed for determination of vitexin, hyperoside, vitexin-2''-*O*-rhamnoside, quercetin and apigenin in leaf extract. The method employed precoated plate of RP-18 silica gel $60F_{254}$ as the stationary phase with acetonitrile-methanol-water-formic acid (10:10:20:0.05, v/v/v/v) as mobile phase and densitometric determination was carried out at 254nm in reflection/absorption mode. The method was validated for accuracy, precision and robustness.

Crataegus oxyacantha

PICRORHIZA (*Picrorhiza kurrooa*)

A non-destructive leaf area estimation model was developed using linear measurements of leaf length (L) and maximum width (W). A linear model having LW as the independent variables (y=0.333 + 0.603LW) provided the most accurate estimate (R^2=0.955, RMSE= 0.573, CV=7.46%) of leaf area. Validation of the model (**Fig. 39**) showed that the correlation between actual and simulated values was very high (R^2=0.9053) with low RMSE (0.39) and CV (5.44%).

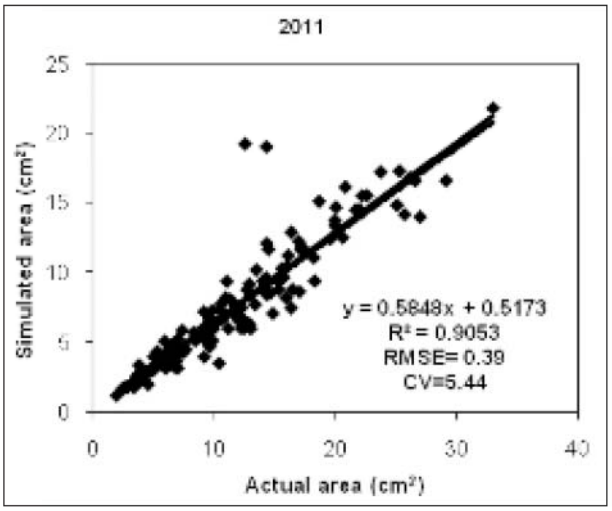


Fig. 39 Validation of the actual vs simulated leaf area

The medicinal property of the plant is attributed to picroside I and II, which are modulated by temperature. Accumulation of the picrosides was higher in plant growing at 15°C as compared to 25°C. Transcriptomes at these two temperatures were established and analysed to understand molecular basis of picrosides accumulation.

Evaluation of *P. kurrooa* acessions

During 2006 to 2010, different accessions were evaluated for growth and marker compound accumulation pattern under field conditions at village Chuner, Distt. Chamba (HP) located at an elevation of 2538m amsl. Six accessions with higher picroside content and vegetative growth were identified for further multiplication. Accession CSIR-IHBT-PK-8 recorded higher leaf numbers/ plant (250), length of 6th leaf (5.4cm), stolon girth (7.5mm) and plant spread in N-S direction (50.0cm). Picroside-I (P-I) content in leaf was higher in CSIR-IHBT-PK-2 (3.89%) followed by CSIR-IHBT-PK-11 (3.72%) and CSIR-IHBT-PK-21 (3.70%). Picroside-II (P-II) content in leaf

was higher in CSIR-IHBT-PK-5 (4.82%). P-I content in rhizomes varied from 0.20 to 4.14% and P-II varied from 0.83 to 7.29% in different accessions. Higher P-I in rhizome was found in CSIR-IHBT-PK-16 (4.14%). Rhizomes showed higher amount of P-II as compared to P-I.

During May 2010 some high yielding accessions of *P. kurrooa* were planted under farmer's field at Sansha village, Distt. Lahaul & Spiti (**Fig. 40**).

Fig. 40 Evaluation of *P. kurrooa* acessions at farmers field in Sansha village, Lahaul & Spiti

DAMASK ROSE (*Rosa damascena*)

Effect of diurnal variability and storage conditions

Field experiments were conducted to study the effect of diurnal variability and storage conditions of flower petals on oil content and composition of damask rose during 2011. The highest essential oil content (0.043% v/w) was obtained from the petals which were harvested at 4.00 am and the lowest (0.017% v/w) from the petals harvested at 2.00 pm. The percentage of citronellol and nerol, the main components of rose oil, increased with delay in harvesting. Geraniol content (33.02%) was maximum, when the petals were harvested at 10.00 am but significant reduction was observed thereafter up to 6.00 pm. Temperature during storage also affected the oil content and composition. There was 8.5 and 27.6% reduction in oil content when the petals were stored for 24h at 4°C and 18±1 °C or 25±1 °C, respectively. The fresh distilled petals showed 27.4% of geraniol yield, which declined to 4.4, 6.9 and 18.1% after 24h of storage at 25±1 °C, 18±1 °C and at 4 °C temperature, respectively.

Processing

About 7355kg fresh rose flowers were distilled at pilot scale to produce 2.576l rose oil (0.035% (v/w) and water (2000l).

A comparative study of the chemical composition of rose oil and water produced on pilot plant is given in **Table 11**. No change in phenyl-ethyl-alcohol (PEA) content was observed during the last three years in the rose oil. The ratio of citronellol to geraniol was 1.24 and 1.35 during 2010 and 2011, whereas the ratio was very low (0.56) during 2009 because of high geraniol content.

The oil content in the rose water, produced during 2011, was estimated by redistilling the rose water as well as liquid-liquid partition with dichloromethane (DCM). The DCM extracted oil possessed higher content of PEA (77%) than the redistilled oil (2%). However, higher content of linalool (16.7%), citronellol (42.7%) and geraniol (24%) was recorded in redistilled oil.

Table 11 Chemical composition (%) of rose oil and water

Compound Name	Rose oil			Rose water - 2011	
	2009	2010	2011	HD	DCM
Linalool	1.64	8.39	5.88	16.72	2.01
cis-Rose oxide	0.08	0.16	0.17	---	---
Phenyl ethyl alcohol	1.97	1.87	1.58	2.02	77.16
trans-Rose oxide	0.08	---	0.06	---	---
Terpinen-4-ol	0.29	0.66	0.43	0.38	0.10
α-Terpineol	0.47	2.78	1.67	6.68	1.40
Nerol	14.57	15.08	8.12	---	---
Citronellol	11.79	16.34	19.21	42.71	8.63
Geraniol	21.00	13.16	14.19	24.10	4.02
Eugenol	1.31	1.95	1.01	3.50	2.15
Methyleugenol	0.81	1.12	0.77	---	---
(*E,E*)-Farnesol	1.70	---	1.20	---	---
Stearoptene content	31.53	19.04	33.98	---	---
Oil yields (%)	0.033	0.038	0.035	0.025	0.05

Establishment of Germplasm Resource Centre and Chemical Characterization of *Hippophae* (Funded by DBT, Govt. of India, New Delhi)

A national level germplasm repository of *Hippophae* was established at "Churbhut Phat" (32°33'58" N latitude 76°58'21"E longitude and 3263m amsl) Keylong, Lahaul & Spiti district (HP) (**Fig. 41**). Plantation of *Hippophae* accessions (from Uttrakhand, Sikkim, Arunachal Pradesh, J&K, HP and abroad) was started in the month of May 2011 in an area of two hectares (**Fig. 42** and **43**).

Fig. 41 *Hippophae* Resource Centre at Keylong

Reversed Phase-HPLC method was developed to determine the variation of six phenolics i.e. rutin, quercetin-3-*D*-*O*-galactoside, quercetin, myricetin,

Fig. 42 Hippophae acessions maintained in polysleeves ready for transplantation to germplasm resource centre

Fig. 43 Plantation of Hippophae at germplasm resource centre

kaempferol and isorhamnetin in *Hippophae* leaves and fruits collected from different locations of HP, Uttarakhand and Assam. Considerable variation was recorded in the content and type of quantified flavonoids. Higher percentage of rutin followed by quercetin-3-*D*-*O*-galactoside was observed in leaves in comparison to fruits.

WALNUT (*Juglans regia*)

It is a deciduous tree and native to the mountain ranges of Central Asia. It is a rich source of phenolic compounds which are responsible for its antioxidant and antiproliferative activity. Seven phenolic compounds, namely quercitrin, gallic acid, myricetin, rutin, quercetin, caffeic acid and juglone were quantified by RP-HPLC in methanol extract (MOH), hexane (HEX), chloroform (CHL), ethyl acetate (EA) and butanol (BU) fractions as well as water insoluble part (INS) (**Table 12**). The amount of each phenolic compound was more in EA. The marker compound juglone was detected only in methanol extract and water insoluble part.

Table 12 Contents (mg/g) of phenolic compounds determined by HPLC

Compound	MOH	HEX	CHL	EA	BU	INS
Gallic acid	32.2 ±0.13	3.4 ± 0.30	2.8 ± 0.35	37.5 ± 0.55	26.3 ± 1.32	10.1 ± 0.05
Caffeic acid	1.9 ± 0.12	nd	nd	2.0 ± 0.14	0.8 ± 0.05	0.9 ± 0.25
Quercitrin	124.6 ± 2.2	5.5 ± 0.5	9.5 ± 0.5	191.2 ± 1.85	92.1 ± 0.82	70.2 ± 0.4
Rutin	7.6 ± 0.4	traces	0.8 ± 0.25	11.9 ± 0.14	9.5 ± 0.26	6.2 ± 0.6
Myricetin	8.9 ± 0.8	1.5 ± 0.22	2.1 ± 0.01	14.4 ± 0.7	7.9 ± 0.32	5.2 ± 0.2
Quercetin	3.1 ± 0.04	nd	traces	5.7 ± 0.61	2.9 ± 0.23	traces
Juglone	1.7 ± 0.01	nd	nd	nd	nd	2.8 ± 0.46

Values are mean±standard deviation (n=3); nd - not detected

TROPICAL ALMOND (*Terminalia catappa*)

It is distributed throughout the tropics in coastal environment. The chemical investigation of the plant collected from South Africa led to the isolation of six molecules, of which two were characterized as β-sitosterol and ellagic acid (**Fig. 44**).

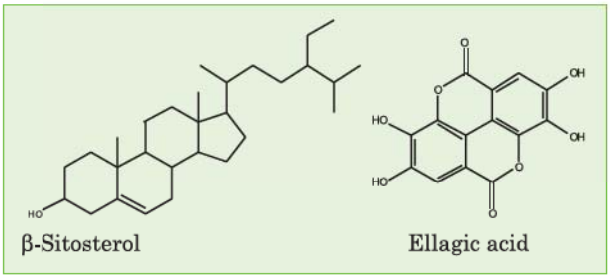


Fig. 44 Chemical structures of compounds isolated from *T. Catappa*

INDIAN HORSE CHESTNUT (*Aesculus indica*)

The plant commonly occurs in the temperate Himalaya and its anti-inflammatory, vasoconstrictor and vasoprotective properties are attributed to aescin, a mixture of saponins. A pilot scale (130 kg) process was developed for extraction of aescin from seeds.

EUCALYPTUS (*Eucalyptus citriodora*)

Eucalyptus oil is widely used in the fragrance industry. The volatile fractions were extracted from leaves by supercritical carbon dioxide extraction (SCE) and different hydrodistillation (HD) techniques *viz*., water distillation (WD) and water-steam distillation (WSD). HD techniques produced higher product yields (1.5%) as compared to SCE (0.7%). Citronellal, the major component, was found maximum in SCE (79%) followed by WSD (72.6%) and WD (62.4%). Although SCE produced lower yields than the HD techniques, its extract was found superior in terms of higher concentration of citronellal.

ARNEBIA (*Arnebia euchroma*)

Arnebia euchroma, commonly known as 'Ratanjot' of Boraginaceae family grows in wild at an altitude of 4000 to 4200 m amsl in the Himalayan region. Its roots are a good source of red naphthoquinone pigments having pharmaceutical properties.

Arnebia euchroma

In continuation to previous work, different strategies such as different inoculum types, inorganic phosphate sources, and *in situ* extraction methods were employed to enhance the yield of naphthoquinone pigments using cell suspension cultures. The callus was induced and multiplied on MS medium supplemented with 10μM 6-benzylaminopurine (BAP), 5μM indole-3-butyric acid (IBA), 0.8% (w/v) agar and 3% (w/v) sucrose, whereas pigment was produced in modified whites' medium.

Direct inoculum (DI) build-up (solid to liquid culture) process enhanced the yield of naphthoquinone pigments (**Fig. 45**). Potassium containing phosphate sources registered higher

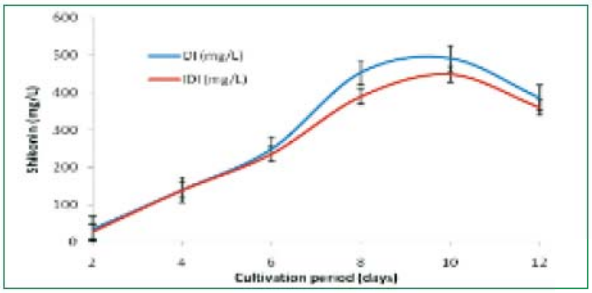


Fig. 45 Effect of inoculum build-up process on naphthoquinone

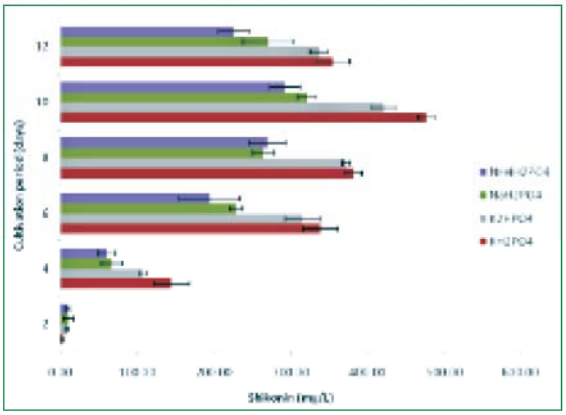


Fig. 46 Effect of phosphate source on naphthoquinone pigment yield

yield of pigments as compared to ammonium and sodium (**Fig. 46**).

High-density liquid paraffin (PHW) as *in situ* extraction solvent along with other optimized growth factors significantly increased the yield of naphthoquinone pigments up to 72% (**Table 13**). A decrease in cell biomass was evident from average growth rate (AGR) in two-phase culture as compared to control.

Table 13 Effect of *in situ* extraction on average growth rate (AGR) and shikonin yield (±SD)

Treatment(s)	AGR (D^{-1})	Shikonin yield (mg l^{-1})
Control	0.068 ± 0.018	369.38± 31.89
Paraffin Light Weight (PLW)	0.061 ± 0.015	552.50± 74.40
Paraffin Heavy Weight (PHW)	0.056 ± 0.013	637.15± 58.10

RHODODENDRON (*Rhododendron anthopogon*)

Volatile oil composition of the leaves was studied using different extraction techniques. Results from different extraction methodologies were compared with headspace analysis (HS). A total of 27, 31 and 17 constituents were identified in SCE, HD and HS, respectively. SCE (40°C/140 bar) showed β-caryophyllene (5.96%), α-humulene (4.06%) and *p*-menthadiene-2,9-diol (7.28%) as major constituents, whereas, HD oil dominated with limonene (11.26%), β-caryophyllene (11.62%), α-humulene (7.22%) and E-nerolidol (5.83%). In HS analysis, limonene (24.14%), γ-*terpinene (40.73%),* α-terpinene (4.92%), β-phellandrene (3.44%) and β-ocimene (7.15%) were present as major constituents.

Population assessment and identification of superior genetic stock of *Picrorhiza kurrooa* Royle ex Benth and *Valerian jatamansi* Jones by screening different populations from north-western Himalayas (Himachal Pradesh and Uttarakhand)

(Funded by National Medicinal Plant Board, New Delhi)

Fifty five samples of *V. jatamansi* were analyzed for valepoteriate and velerenic acid contents by HPLC. Nine samples were found to have more than 3.5% of valepoteriates. The sample HFRI\ VJ\ CH\ 08\ 202 was observed to have the highest content of valepoteriates (4.6%). Velerenic

acid was detected in traces in all the samples. Sixty two samples of *P. kurrooa* were analyzed for picrosides (Picroside-I and Picroside-II). Thirty two samples were found to have more than 5.0% of total picroside (P-I and P-II). The sample HFRI/ PK/ 04/ NDT/ 203 was observed to have highest picroside (9.3%, P-I=6.4 and P-II=2.9).

Investigations of secondary metabolites from plants as possible extractants for actinides and longlived radionuclides (Funded by BARC, Govt. of India)

Fifty crude extracts were prepared from *Funaria hygrometrica, Halianthus annuus, Brassica juncea* and *Musa acuminata* and evaluated for radionuclides uptake, in which four extracts showed appreciable activity. Out of 20 fractions prepared from these four active extracts, only four fractions showed high efficiency for the uptake. One of the active fractions showed high content of carbohydrates (49%) and protein (20%).

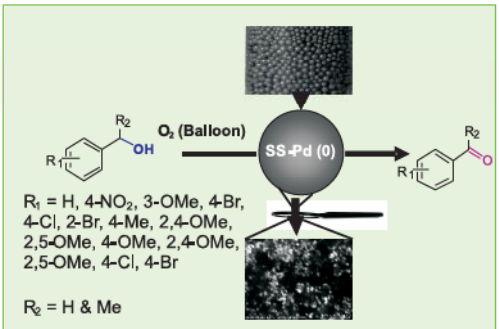
Discovery and preclinical studies of new bioactive molecules (natural and some synthetic) and traditional preparations (NWP-0037)

During the period, 33 extracts from four plants and 9 parts were prepared and sent to different laboratories for bioactivity. Four extracts were prepared after isolation of pure active molecules for reconfirmation of activity. Four pure molecules from two lead fractions were found to have good antimalarial and antifilarial activities.

SYNTHETIC CHEMISTRY

Aerobic oxidation of benzyl alcohols

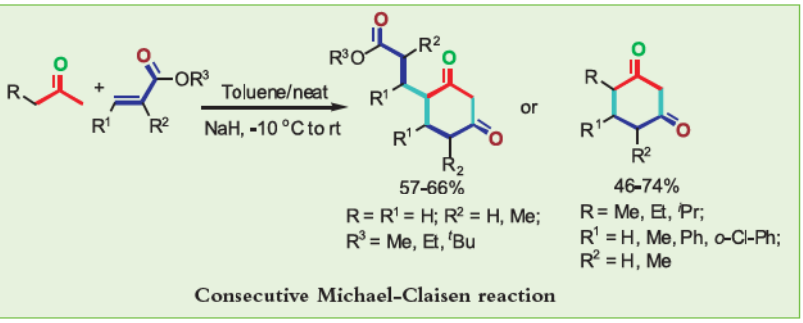
Solid-supported nano and microparticles of Pd(0) (SS-Pd) was used as a heterogeneous catalyst for aerobic oxidation of benzyl alcohols. Primary and secondary benzyl alcohols gave corresponding carbonyls in good yields. In addition, the catalyst could be reused up to five runs without significant loss of activities.



Oxidation of benzyl alcohols to carbonyles

Synthesis of substituted cyclohexane-1,3-diones

A long existing problem of synthesizing cyclohexane-1,3-dione derivatives (CDD) from unreactive acetone through consecutive Michael-Claisen process was solved under this study. The practical applicability of this process was tested for a novel compound ethyl 3-(2,4-dioxocyclohexyl) propanoate up to 20 gm scale. When the scope of different acetone derivatives were investigated, it resulted with similar consecutive Michael-Claisen process for CDD synthesis. The reaction

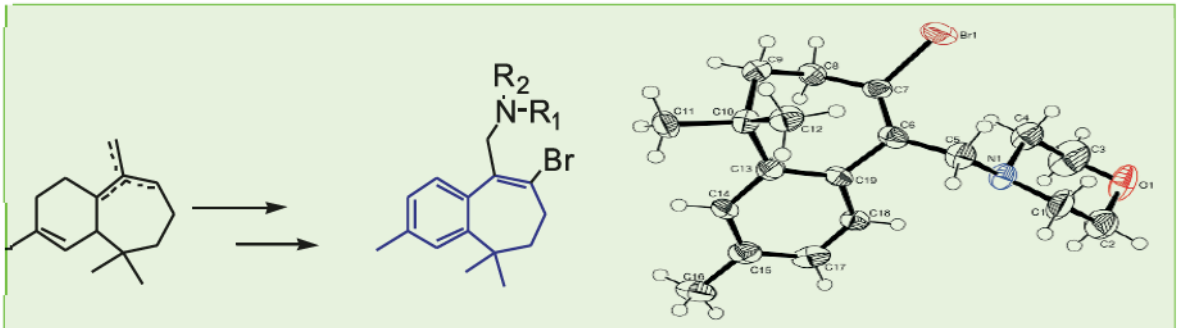


Consecutive Michael-Claisen reaction

exhibited remarkable regioselectivity in Michael addition followed by Claisen cyclization. In this process high substrate selectivity was observed for CDD synthesis following consecutive double-Michael-Claisen and Michael-Claisen processes.

Value addition of Himachalenes

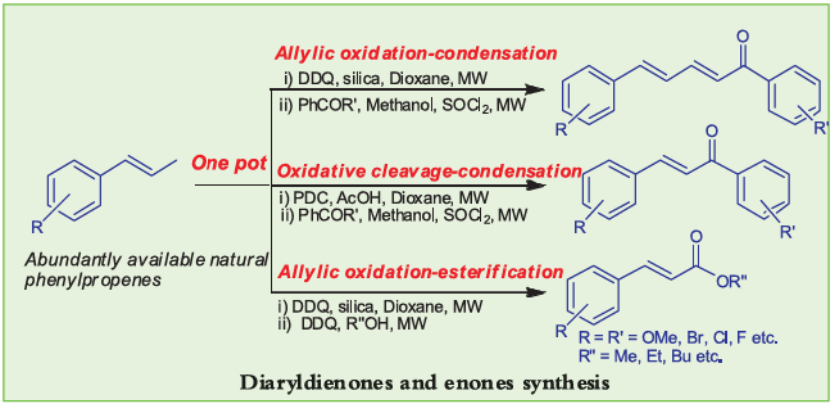
A new series of benzocycloheptene amino vinyl bromide derivatives were synthesized from isomeric mixture of himachalenes through two step consecutive reactions. The unusual structure of benzocycloheptene amino vinyl bromide derivative was confirmed by NMR and X-ray crystallography. The newly synthesized derivatives were further evaluated for their antidepressant activities.



Benzocycloheptene amino vinyl bromide derivatives

Synthesis of antimalarial diaryldienones and enones

A tandem allylic oxidation-condensation/esterification sequence was developed, wherein, abundantly available methoxylated phenylpropenes were directly transformed into corresponding dienones (1,5-diarylpenta-2,4-dien-1-ones) and enones (chalcones and cinnamic esters). Preliminary antimalarial activity studies against *Plasmodium falciparum* (*Pf*3D7) revealed promising lead candidates for developing newer and economical antimalarial agents. In particular, two enones were found to possess comparatively better activity (IC_{50} = 4.0 and 3.4 μM, respectively) than licochalcone (IC_{50} = 4.1 μM), a well known natural antimalarial compound.

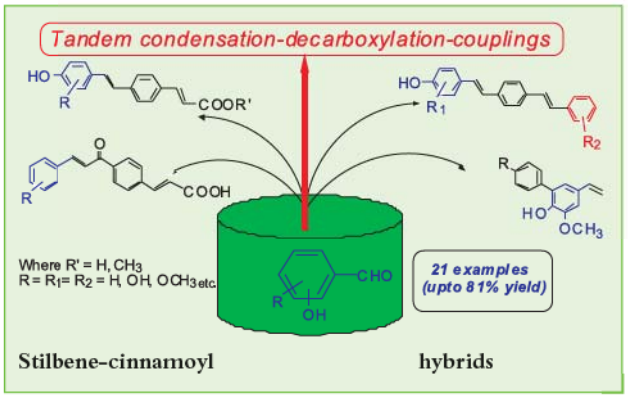


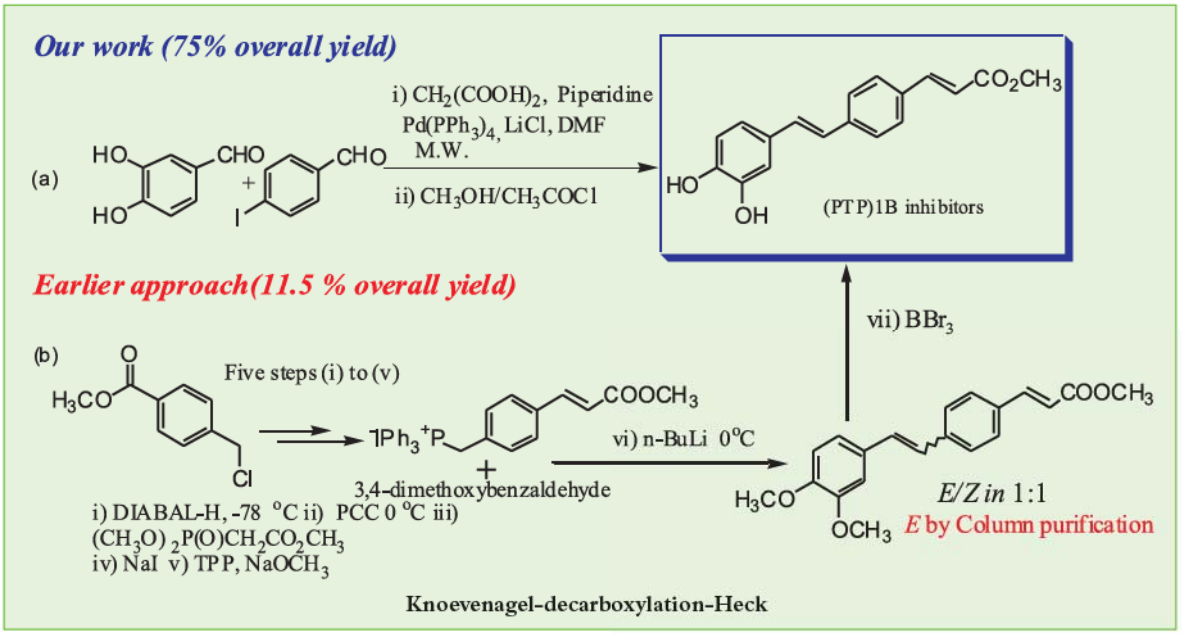
Diaryldienones and enones synthesis

Synthesis of hydroxy functionalized antidiabetic stilbene-cinnamoyl hybrids and unsymmetrical distyrylbenzenes

Some novel tandem reactions involving chemoselective Knoevenagel/Perkin condensation-decarboxylation-Heck/Suzuki or Aldol-Heck sequences were achieved. These enabled the first concise and efficient synthesis of several important hydroxy functionalized compound

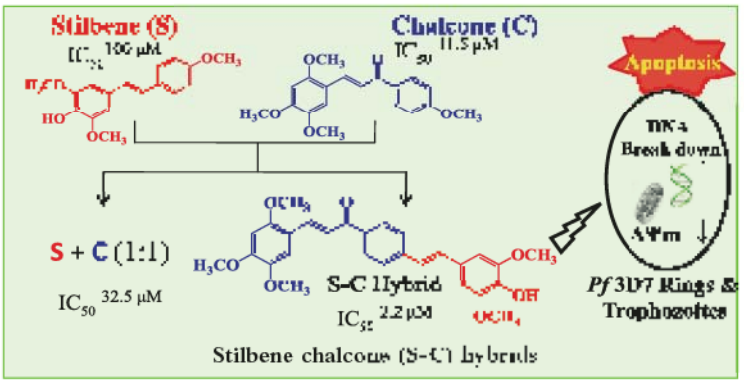
classes such as potent PTP1B inhibitor stilbene-cinnamoyl hybrids, cinnamoyl-cinnamic acid hybrids, unsymmetrical distyrylbenzenes and biarylstyrenes, which otherwise require multiple steps besides protection-deprotection manipulations. For example: a one-pot double Knoevenagel-decarboxylation-Heck transformation was developed towards synthesis of a potent protein tyrosine phosphatase (PTP)1B inhibitors (antidiabetic drug candidate) in 75% yield, whereas, previously reported method required seven steps to provide above stilbene-cinnamoyl hybrid in only 11.5% yield.





Claisen-Schmidt-Knoevenagel-Heck approach for synthesis of stilbene chalcone hybrids

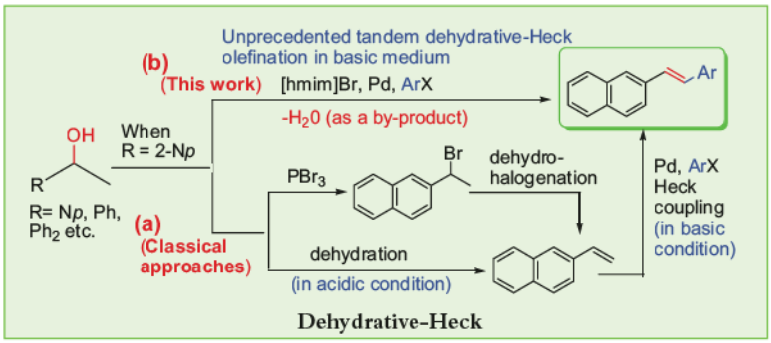
Novel stilbene chalcone (S-C) hybrids were readily accrued *via* sequential Claisen-Schmidt-Knoevenagel-Heck approach and evaluated for antiplasmodial activity in *in vitro* red cell culture using SYBR Green I assay. The most potent hybrid showed IC_{50} (μM) of 2.2, 1.4 and 6.4 against 3D7 (chloroquine sensitive), Indo and Dd2 (chloroquine resistant)



strains of *Plasmodium falciparum,* respectively and have good selectivity indices for HeLa (42.3) and L929 Fibroblast (45.5) cell lines. Interestingly, the respective individual stilbene (IC_{50} >100 µM), chalcone (IC_{50} 11.5 µM) or an equimolar mixture of stilbene and chalcone (IC_{50} 32.5 µM) were less potent than the S-C hybrid. Studies done using specific stage enriched cultures and parasite in continuous culture indicated that the potent S-C hybrid spares the schizont but blocks the progression of the parasite life cycle at the ring or the trophozoite stages. Further, the hybrid caused chromatin condensation, DNA fragmentation and loss of mitochondrial membrane potential in *P. falciparum*, thereby, suggesting their ability to cause apoptosis in malaria parasite.

Dehydrative-Heck olefination of 2° aryl alcohols in ionic liquid for stilbenoide synthesis

Alcohols being readily accessible have received great attention as precursors in various tandem oxidative /dehydrative cross coupling strategies. However, the direct use of 2° aryl alcohols as an *in situ* source of styrene (via dehydration) in Heck coupling has remained unexplored. The cross contamination of reagents/catalysts due to different media requirements in Heck and dehydration steps, limit the scope when these two steps are required to be done in one pot. Moreover, 2° aryl alcohols under Heck like conditions generally get converted into respective carbonyls via isomerization or oxidation processes.



A tandem strategy was developed wherein 2° aryl alcohols were directly coupled with aryl halides to provide stilbenoids through a dehydrative Heck sequence in the ionic liquid [hmim]Br and producing only water as by-product under microwave irradiation. Classical methods do not permit this sequence to proceed in one pot, due to cross contamination of catalysts while other methods require multiple steps.

This is the first report of its kind that utilizes HPTLC for the detection of the products formation which finally allowed to establish the optimum condition for formation of stilbenoids (**Fig. 47, and 48**).

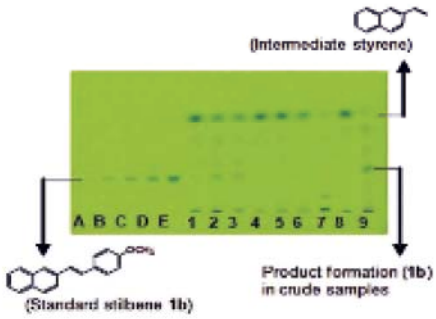


Fig. 47 HPTLC CCD image at 254 nm: standard tracks (A-E) of 1b at different concentrations, samples tracks 1-9 indicating formation of 1b

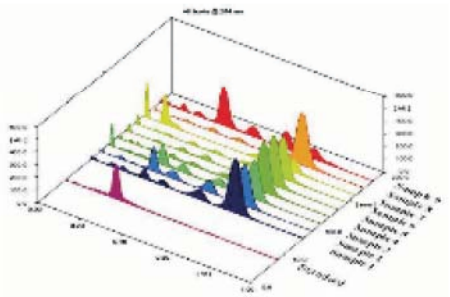
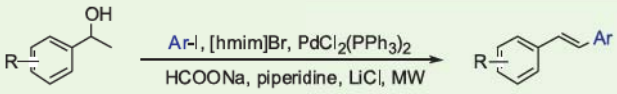
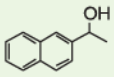
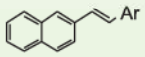
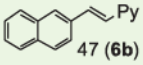
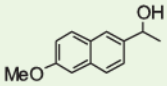
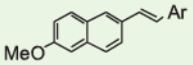
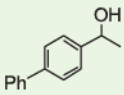
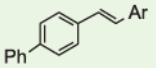
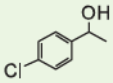
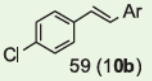
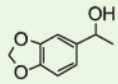
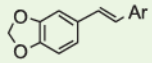
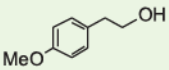
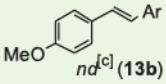


Fig. 48 3D HPTLC densitogram of samples

Substrate scope of tandem dehydrative-Heck coupling[a]



Entry	Aryl alcohol	Aryl halide (Ar-I)	Time (min)	Yield[b]
1		Ar = 4-OMe-C_6H_4	15	 78 (**1b**)
2		Ar = 4-OH-C_6H_4	30	77 (**2b**)
3		Ar = 4-Cl-C_6H_4	15	84 (**3b**)
4		Ar = 4-NO_2-C_6H_4	15	89 (**4b**)
5		Ar = 4-CF_3-C_6H_4	15	83 (**5b**)
6		Ar = 3-C_6H_4N	25	 47 (**6b**)
				
7		Ar = 4-OH-C_6H_4	30	75 (**7b**)
8		Ar = 4-$COCH_3$-C_6H_4	15	76 (**8b**)
9		Ar = 4-OH-C_6H_4	30	 74 (**9b**)
10		Ar = 4-$COCH_3$-C_6H_4	15	 59 (**10b**)
				
11		Ar = 4-$COCH_3$-C_6H_4	15	63 (**11b**)
12		Ar = 4-CN-C_6H_4	15	68 (**12b**)
				
13		Ar = 4-OMe-C_6H_4	30	*nd*[c] (**13b**)

[a] CEM monomode microwave; General conditions: aryl halide (0.85 mmol), aryl alcohol (1.28 mmol), $PdCl_2(PPh_3)_2$ (4 mol%), LiCl (8 mol%), HCOONa (1.28 mmol), piperidine (0.85 mmol), [hmim]Br (1.5 g),120W, 150°C. [b] Isolated yield. [c] Not detected

Cobalt phthalocyanine catalyzed reductive amination of carbonyl compounds in a green solvent

Cobalt phthalocyanine has been employed for highly chemoselective reductive amination of aldehydes and ketones in ethanol. A large range of functional groups such as nitro, acid, amide, ester, nitrile, halogen, lactone, methoxy, hydroxy, alkene, *N*-benzyl, *O*-benzyl and heterocyclic functional groups were well tolerated under present reaction conditions. The method was also applicable to the synthesis of *N*-substituted isoindolinone derivative by the reductive amination-intramolecular amidation of 2-carboxybenzaldehyde with aniline. Use of green solvent with low loading of catalyst under ambient reaction conditions makes the present method superior to earlier reported methods. Other remarkable advantages of this methodology include high isolated yields, clean reactions and easy work-up procedure. In the mechanistic studies, the reaction using Ph_2SiD_2 as reducing agent

resulted in clear insertion of deuterium on the carbon of the double bond (as confirmed by 1H NMR) indicating hydrosilylation of the imine to give an intermediate *N*-silylamine, followed by solvolysis with ethanol or a trace amount of water. The role of CoPc was proposed to be activation of imine intermediate *via* a Lewis acid-base interaction (**Fig. 49a**).

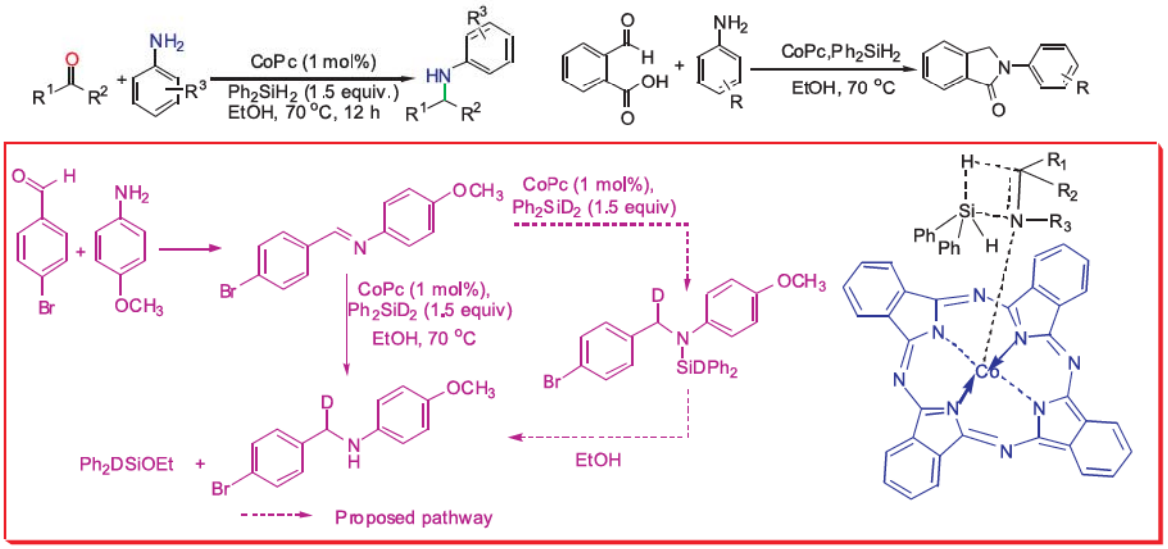


Fig. 49a Reductive amination of carbonyl compounds

Nickel phthalocyanine assisted highly efficient and selective carbonyl reduction

A reusable green catalytic system based on nickel phthalocyanine with polyethylene glycol-400 was developed for highly chemo- and regioselective reduction of carbonyl compounds to corresponding alcohols at room temperature. The catalytic system tolerated various aromatic, hetero aromatic and aliphatic carbonyl compounds with high turnover number and frequency. This was the first report on regioselective reduction of 1,3- and 1,4-benzenedicarbaldehydes to corresponding alcohols. The catalyst was reused up to seven times without any significance loss in activity. PEG-400, by making crown ether-type complex with sodium borohydride, facilitated the attack of hydride on carbonyl group which was activated by NiPc through Lewis acid–base interaction (**Fig. 49b**).

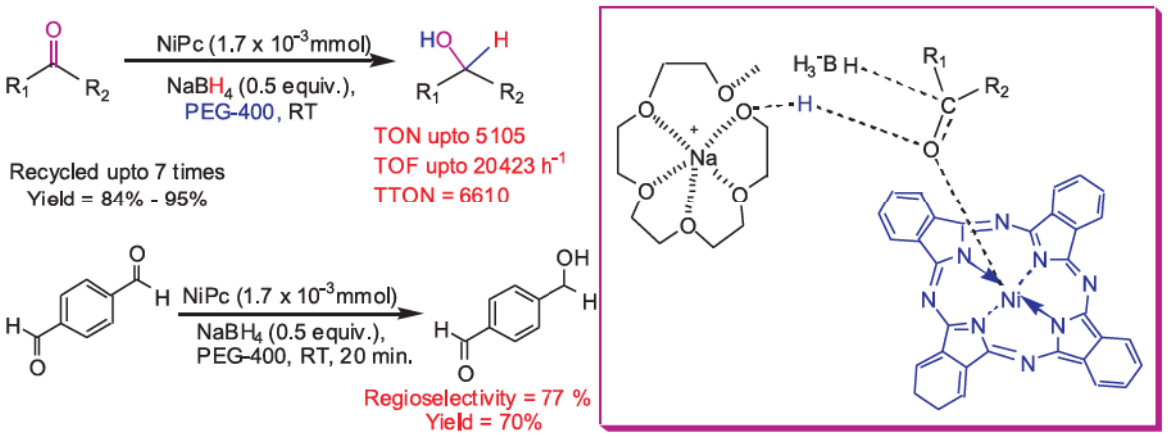


Fig. 49b Carbonyl reduction

EDIBLE AND SPICE CROPS

APPLE (*Malus* sp.)

Improvement of apple through biotechnological interventions (Funded by Depatment of Biotechnology, Govt. of India)

SYBR green real time PCR based detection of *Venturia inaequalis*

The robustness of PCR-RFLP based assay to detect and distinguish *V. inaequalis*, the causal agent of apple scab from other fungal pathogens of apple was reported earlier. DNA isolated from the pure culture of *V. inaequalis*, *A. alternata*, *G. cingulata, C. acutatum, M. laxa* and *B. cinerea* were subjected to SYBR based RT-PCR assay. The melting curve analysis revealed distinct T_m for *V. inaequalis* as compared to other tested fungi (*V. inaequalis*: T_m =89.155; *A. alternata:* T_m=84.42: *G. cingulata:* T_m=86.77; *C. acutatum:* T_m=86.32; *M. laxa:* T_m=84.2 and *B. cinerea:* T_m=83.2; **Fig. 50 & 51**). Interestingly, the assay was able to detect the pathogen in the field infected leaf (**Fig. 52**).

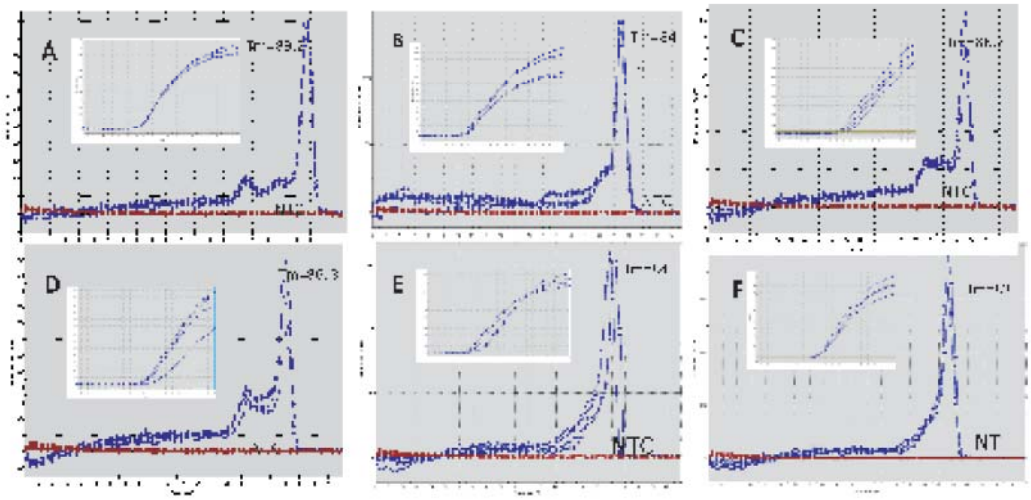


Fig. 50 Melting curve analysis of different fungal pathogens

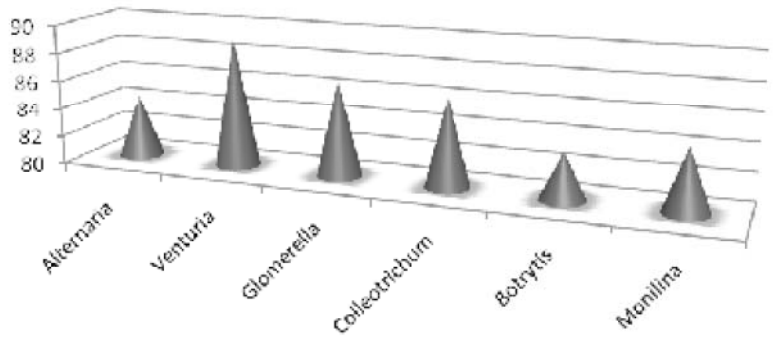


Fig. 51 Melting temperature of pathogens obtained through real–time PCR analysis

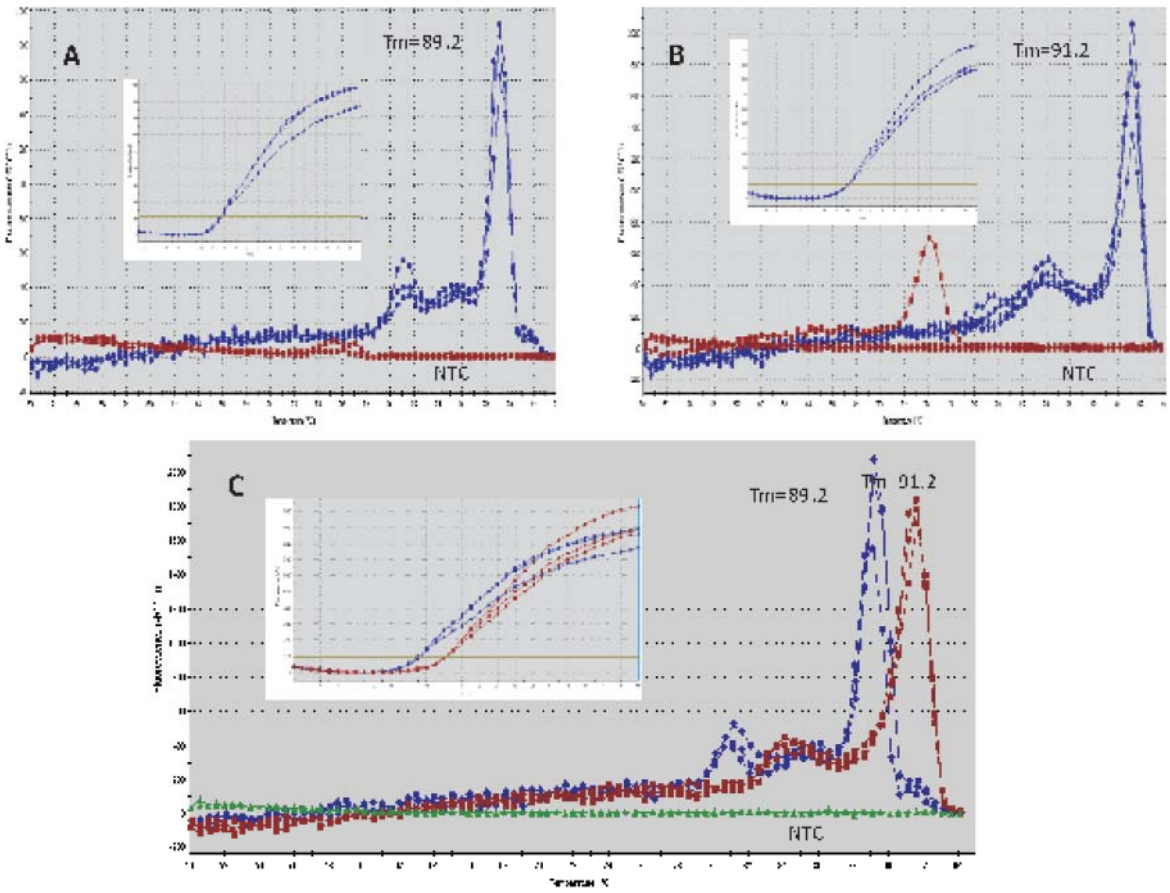


Fig. 52 Melting curve analysis from field infected leaf sample

PCR-RFLP based apple fungal pathogen detection system

To monitor the presence of fungal pathogens in apple samples, various PCR based methodologies were devised. As more than one pathogen can be present in the orchard at a given time point, a single assay is required to detect several pathogens simultaneously. Universal primer pair was designed to PCR amplify fungal rDNA sequences which upon digestion with a particular restriction enzyme yielded polymorphisms in band sizes for several fungal pathogens (**Fig. 53**). Furthermore, a Perl based tool PathDec was developed to assist the user in interpretation of the PCR-RFLP data generated in wet lab experiments. The assay is simple, sensitive and robust in detecting the pathogens, even if, they are present together as mixture. It can also identify and detect apple scab pathogen in less than 6 hours before the visual appearance of the disease symptoms.

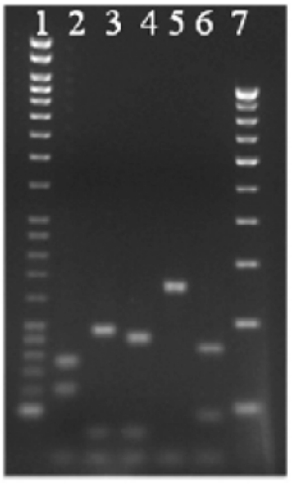


Fig. 53 PCR-RFLP assay (lane 1: 20 bp ladder; 2: *Alternaria alternata*; 3: *Glomerella cingulata*; 4: *Colletotrichum acutatum*, 5: *V. inaequalis*, 6: *Botrytis cinerea*: & 7: 100 bp DNA ladder)

Identification and characterization of virulence factors to understand disease causing mechanism

In order to study the mode of colonization of *V. inaequalis* on apple, GFP (Green Fluorescent Protein) tagged strains and genetic transformation assays for *V. inaequalis* were generated. The genetic transformation protocol for *V. inequalis* was standardized and conidia electroporated with GFP plasmid. The transformants selected on PDA+ hygromycin plates produced typical emerald green fluorescence when observed under the FITC filter (**Fig. 54**).

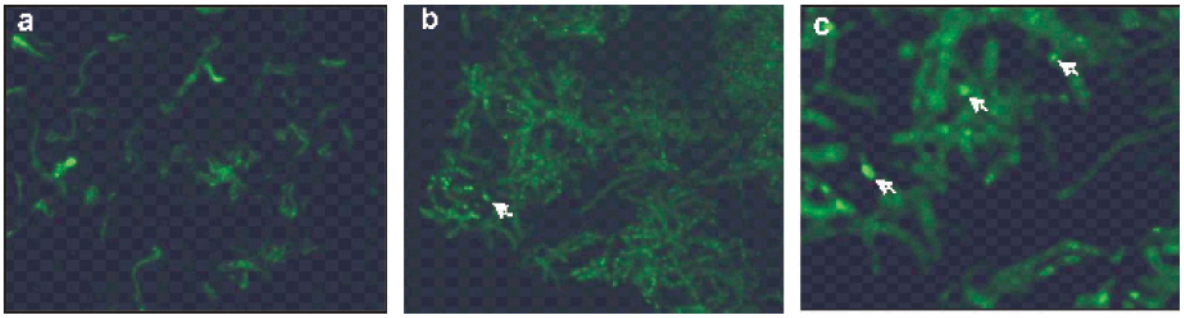


Fig. 54 Fluorescence micrographs of GFP transformants and wild type strain of *V. inaequalis* a): micrographs of mycelium from wild type isolate where the observed green signal is due to cell wall autofluorescence; b) and c): mycelium from GFP tagged *V. inaequalis* isolate, white arrow points to the green signal due to GFP tagging

Screening the efficacy of natural compounds on the growth and virulence ability of *V. inaequalis* on apple

To control *V. inaequalis*, a screen was setup to test the efficacy of several plant derived compounds against the pathogen. Three such compounds demonstrated antifungal property. **Fig. 55A** demonstrates the efficacy of one such compound. Furthermore, the efficacy of plant derived essential oils was tested. Interestingly, three of the tested essential oils demonstrate the fungicidal properties **(Fig. 55B)**.

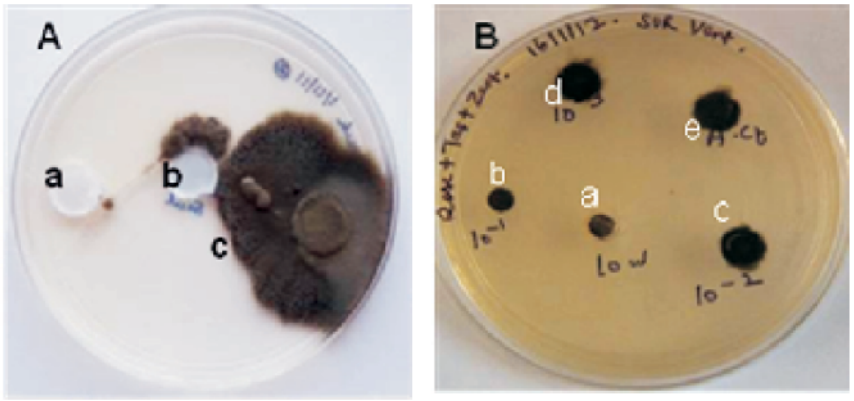


Fig. 55 Efficacy of plant derived natural compounds (A) and essential oils (B) against *V. inaequalis*. Fig. 55A a) the purified natural compound, b) the hygromycin as positive control, and c) the mock treatment (as negative control) and Fig. 55B The mixture of essentials at different dilutions a) Undiluted, b) 10 fold, c) 100 fold, d) 1000 fold and e) acetone treated control

Molecular characterization of important viruses for understanding evolutionary relationship among isolates

Apple chlorotic leaf spot virus (ACLSV)

It is a flexuous virus with a single stranded RNA and a 7.5 kb genome (**Fig. 56**) containing three ORF's encoding the replicase (216 kDa), movement (50 kDa) and coat (22 kDa) proteins, respectively. In characterizing the complete genome (~7.5 kb without polyA tail) of the Indian isolate, the replicase gene (150-5798) was identified to have four domains, viral methyl transferase for mRNA capping, peptidase and viral helicase for viral RNA replication, and RNA dependent RNA polymerase, a non-structural protein. Though the complete genome sequence showed 84 and 81% homologies with that of a Japanese A4 strain (AB326223) and a plum ACLSV strain, respectively, the CP gene showed 97% homology with a Chinese isolate and an Indian ACLSV isolate. In comparison of the amino acid sequences, the replicase showed 89% identity with that of the Japanese A4 strain, whereas ORF2 and ORF3 shared 90 and 97% identities with the Japanese A4 strain and the Chinese isolate (Acc. No. EF079060), respectively. Likewise, the CP showed 97% identity with the Indian apple isolate (Acc. No. AM494510).

Fig. 56 Genome organization of ACLSV

Apple stem grooving virus (ASGV)

It is a type member of genus *Capillovirus* distributed worldwide in *Malus* spp. ASGV has a ssRNA of ~6.5 kb length (**Fig. 57**) excluding 3' polyA tail and contains two overlapping ORFs RdRp (241 kDa), MP (36 kDa) and CP (27 kDa). Complete genome (~6.5 kb) was amplified and cloned in pGEMT easy vector, which was end sequenced. The 5' end of the sequenced genome displayed 90% homology with a *Citrus tatter leaf virus* isolate from Taiwan.

Fig. 57 Genome organization of *Apple stem grooving virus*

Apple stem pitting virus (ASPV)

The genome structure (**Fig. 58**) consists of an ORF1 which codes for a putative RNA replicase, ORF 2, 3, and 4 (triple gene block;TGB) encoding movement proteins and ORF5 encoding coat protein. The complete nucleotide sequence of the Indian isolate consists of 9267 nucleotides (nt), excluding the poly (A) tail at its 3' end. The 5' and 3' UTRs were 29 and 135 nt, respectively. In homology analysis, the CP matched only 73 and 71% at the amino acid and nucleotide levels. As per the demarcation criteria for *Foveaviruses,* which include the ASPV, and non-isotopic detection by both IC-RT-PCR standardized for ASPV and the indigenous anti ASPV serum, the Indian isolate was confirmed to be a new strain.

Fig. 58 Genome organization of ASPV showing ASPV ORF1 (ASPVgp1) for RNA dependent RNA polymerase, ORF2 (ASPVgp2), ORF3 (ASPVgp3) and ORF4 (ASPVgp4) for Triple Gene Block and ORF5 (ASPV gp5) for coat protein gene

Recombination analysis showed that the Indian isolate is a recombinant displaying 6 potential recombination events (**Fig. 59**) inciting 36.7% disease incidence on infected pome fruit tissues. Out of these 6 events, 2 and 4 were significant. Event two showed recombination between the Indian isolate as the major parent and the Polish isolate (AF345895) as the minor parent, which led to a recombinant isolate like the Chinese one (EU708018). In this recombination event, a region (117–356 nt) of the Indian isolate (FN433599) was replaced by the CP gene sequence of the Poland isolate (AF345895). Occurrence of recombination for event 4 was observed between the Chinese isolate as the major parent and the Brazilian isolate (AJ564638) as the minor parent which led to the rise of the Indian recombinant isolate.

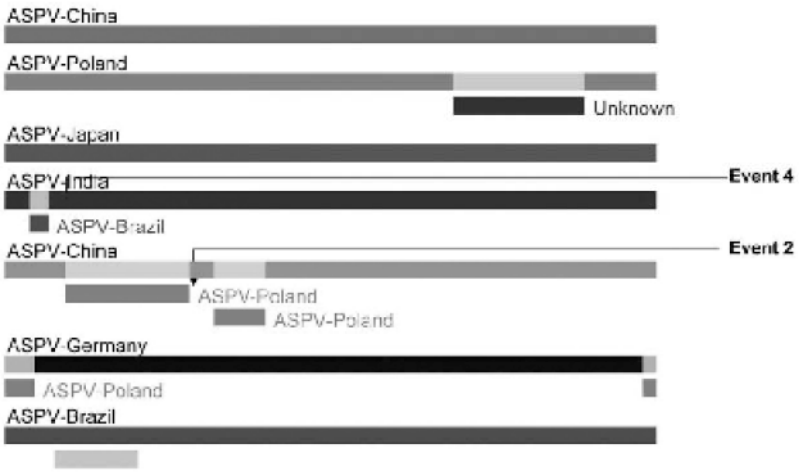


Fig. 59 Recombination detection analysis gave six potential recombination events (PREs)

Apple scar skin viroid (ASSVd) infecting Himalayan wild cherry

In a survey of fruit growing and adjoining forest areas of Kangra region of HP, India, Himalayan wild cherry samples were collected from trees showing mild symptoms, although most of the plants were apparently healthy looking. Two out of 15 samples checked were confirmed positive for ASSVd infection in RT-PCR and sequencing. The sequences showed 99% sequence identity with each other, 91-98% sequence identity with reported sequences from Greece of sweet cherry, *Prunus avium*, cv. Tragana Edissis., Indian isolate of ASSVd (acc. no. FN376408, FN376409, FJ974069, FN547407) and wild cherry, *P. avium*, originated from seedlings (acc. no. FJ974062, FJ974063 and GQ249350).

In the phylogenetic analysis, the ASSVd sequences from Himalayan wild cherry were grouped in a different clade with the ASSVd apple isolate reported from India in comparison to the ASSVd sequences of sweet (originated from seedlings) and wild cherry reported from Greek and ASSVd reference sequences (M36646 and Y00435) reported from Japan.

Since no apple plants are cultivated in the region from which the Himalayan wild cherry was confirmed positive for ASSVd infection, thus origin of the viroid in the Himalayan wild cherry is unclear. The present study reports Himalayan wild cherry (*Prunus cerasoides*) as a new host of ASSVd. Since it is the most commonly used seedling rootstock for cherry in HP further studies are necessary to establish if ASSVd is seed-transmitted in Himalayan wild cherry. Also whether it is natural host of ASSVd with latent symptoms or act as wild reservoir of this viroid needs to be determined.

Determination of viral disease incidence in apple orchards of HP

Areas surveyed were Rohru, Khadapathar, Hatkoti, Jubbal, Kotkhai Kothara of Shimla District. Total of 240 samples were collected from apple orchards randomly and their rootstock, scion wood data was also recorded. All the samples were tested by ELISA, Nucleic acid hybridization and RT-PCR for different pome fruit viruses (**Fig. 60**).

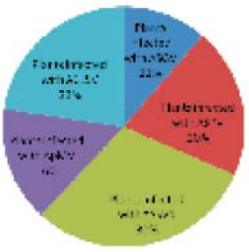


Fig. 60 Pie chart showing the percentage incidence of the viral and sub-viral pathogens in apple orchards in various parts of HP

Cloning the apple and cucumber PP2

Primers were designed for amplifying the phloem protein 2 of apple and cucumber from the already submitted sequences. RNA from the apple bark was extracted and RT-PCR was carried out. The positive amplification obtained was cloned into pGEMT easy vector and sequenced. The sequence matched to the desired phloem protein 2 in BLAST.

PP2 gene was cloned into pET32a expression vector for purification of the expressed protein. The induced protein was purified using an automated Maxwell protein purification system (**Fig. 61**) to yield 1.3 mg/ml.

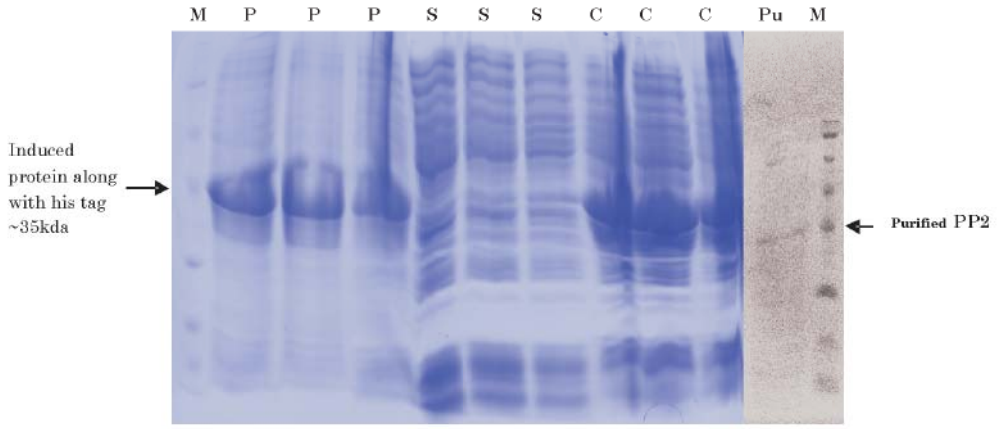


Fig. 61 Induction of cucumber PP2 at~35kDa along with purified cucumber PP2. M-unstained protein ladder, P-pellet, S-supernatant, C-crude protein, Pu-purified protein

Development of diagnostic tools for ACLSV

ACLSV CP gene was cloned in expression vector pET 32a and over expressed in *E. coli* BL21 cells as fusion with His tag. Expressed fusion protein was purified using *Maxwell® 16 Polyhistidine Protein Purification* Kit (Promega) and its identity was confirmed by western blotting (**Fig. 62**).In indirect ELISA, the anti ACLSV CP serum showed specific reaction to known positive plants in the field.

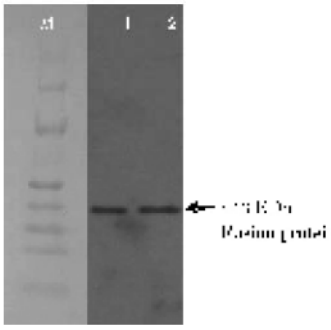


Fig. 62 Western blot confirmation of ACLSV (Protein lane 1&2, M-protein ladder)

Coat protein gene expression of ASPV

ASPV CP gene was cloned into pQE-30 UA expression vector (Qiagen, Germany) as fusion with a 6x His-tagged and transformed into *E. coli* M 15 strain. Expressed protein was purified by Maxwell® Automated His-tagged protein purification system (**Fig. 63**).

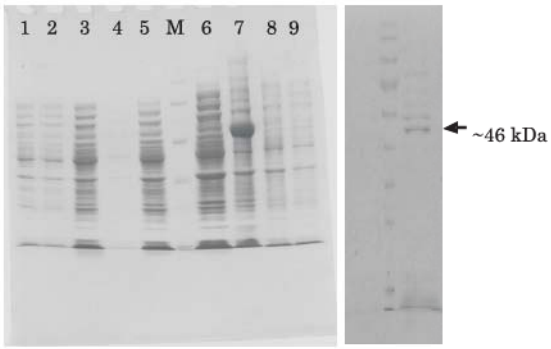


Fig. 63 a) SDS PAGE gel photographs of expression of ASPVCV CP as His-Tag fusion protein. Electrophoretic analysis of extracts of *Escherichia coli* transformed with pQE-UA 30/ ASPVcp before lane 1&2 and after lane 7 IPTG induction. Lane M contains molecular weight marker proteins (Fermentas, USA). The gel was stained with coomassie blue. b) Purified ASPV coat protein

Apple virus diagnostic kits

Tools were developed for antisera based detection of *Apple chlorotic leaf spot* and *Apple stem pitting viruses* (**Fig. 64**). Viral coat protein was over expressed and polyclonal antiserum was developed. Results of ELISA assay was at par with commercially available Bioreba.

Fig. 64 Apple virus diagnostic kits

Genetic transformation of apple rootstock

The apple rootstock MM106 is a semi-dwarf, cold hardy, early fruit bearing rootstock preferred for high density plantations. However, the plant is susceptible to various diseases such as collar-rot caused by *Phytopthora cactorum* and mildew caused by *Podosphaera leucotricha*. Genetically modified plants have the potential to overcome this problem. Therefore, transgenic plants of MM106 were developed from leaves of *in vitro* shoot cultures. Strong GUS expression, PCR and slot blot signals indicated successful transformation (**Fig. 65a, b** and **c**). The gene coding for thaumatin like protein from tea was also introduced into this rootstock in order to confer stress tolerance in these plants.

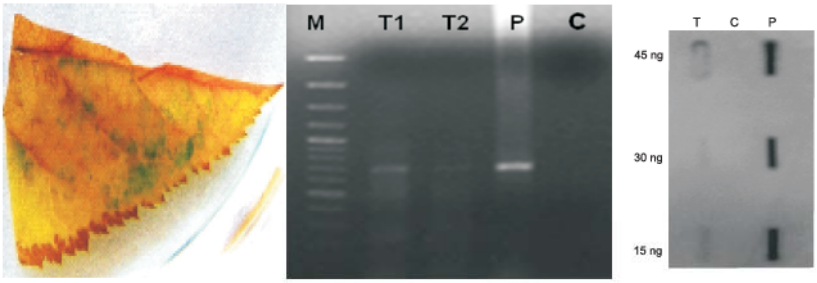


Fig. 65 Genetic transformation of apple rootstock MM106 (a) GUS expression in transformed leaf, (b) PCR of transformants showing the expected amplification product of 690 bp fragment of *gus* gene where Lane M:100 bp marker, lanes T1-T2 transformants, lane P: plasmid serving as positive control, Lane C: untransformed control (c) Slot blot showing positive signals in transformant (T) and plasmid (P) but no signal in untransformed control (C) when 15, 30 and 45 ng DNA were used.

Bioefficacy of acaricides against apple mites

Toxicity of six acaricides was evaluated under laboratory conditions against two-spotted spider mite, *Tetranychus urticae* collected from apple. Abamectin was the most toxic followed by fenpyroximate, spiromecifen, chlorfenpyre, propargite, dicofol and hexythiazox.

Pesticide residue analysis

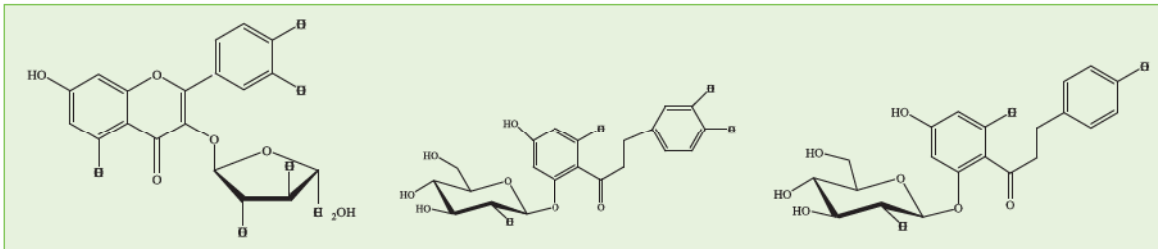
UPLC analytical protocols were standardized (standard curve, limit of detection and quantification, recovery) for pesticide residue analysis of clofentizine, tebufenapyrad and fenpyroximate. A multi-residue method was standardized using GC for simultaneous detection of 10 pesticides (α-HCH, γ-HCH, chlorpyrifos, alchalor, aldrin, heptachlor, α-endosulfan, dieldrin, endrin and bifenthrin) in apple.

Analysis of essential oil

The essential oil extracted by hydrodistillation showed cytotoxic activity against carcinoma cell (C-6, A549 and CHOK1). The GCMS analysis of the oil showed eucalyptol, phytol, α-farnesene, pentacosane, tricosane, podocarpene A and *cis*-3-hexenyl benzoate as major components (**Table 14**). Quercetin-3-O−arabinoside, dihydrochalcone glucoside and phloridzin were isolated and characterized from ethyl acetate fraction of ethanol extract from leaves.

Table 14 Chemical composition of *M. domestica* essential oils

Compounds	%		
	Sample I	Sample II	Sample III
Eucalyptol	43.7	41.0	34.1
α-Farnesene	9.6	9.1	11.1
1,6,10-Dodecatrien-3-ol-3,7,11-trimethyl	2.0	1.9	2.2
cis-3-Hexenyl benzoate	3.1	3.1	4.7
Podocarpene A	3.8	3.4	3.7
Phytol	11.5	10.8	8.3
Tricosane	4.2	3.9	6.1
Pentacosane	7.6	7.2	5.4



Quercetin-3-O-arabinoside **Dihydrochalcone glucoside** **Phloridzin**

Apple pomace (Funded by Ministry of Food Processing and Industries, Govt. of India)

Development of seed separator prototype

Apple pomace is a solid biomass residue generated at fruit juice extraction industries (**Fig. 66**). The major bottlenecks in benefication of apple pomace are its high moisture content,susceptibility to oxidation and presence of seeds, which create hindrance in its application for development of value added food products. Manual separation of seeds is very difficult from huge piles of apple pomace. So efforts were made to develop a process/ prototype for seed separation. A lab scale prototype of seed separation unit of 50l capacity was designed and manufactured (**Fig. 67**), for which a patent has been filed in India.

Fig. 66 Apple pomace generated in fruit juice processing industries

Fig. 67 Prototype for seed separation from apple pomace: Conceived and designed at CSIR-IHBT

The safety evaluation of the developed dietary fibre fractions (**Fig. 68**) was cross validated by an independent agency. A number of value added products were also developed using the extracted dietary fibre.

The adsorption of Nickel (II) metal ion on apple pomace waste was investigated in batch mode. The experiments were carried out for optimization of parameters which affect the bio-adsorption i.e. pH, dose, contact time and metal concentration. The Langmuir isotherm was applied for the determination of maximum adsorption capacity of biosorbents.

Fig. 68 Dietary fibre extracted from apple pomace

STEVIA (*Stevia rebaudiana*)

Crop modeling

An experiment was conducted to evaluate the efficacy of hand-held chlorophyll meter (CCM-200) for non-destructive estimation of total chlorophyll (Chl) in stevia leaf. A regression model was developed using CCM-200 reading as single explanatory variable. The chlorophyll content was predicted by the polynomial model ($Y=\alpha+\beta X+\gamma X^2$). The observed values were recorded (1.136 to 4.710 mg g^{-1}) which was very close to the model predicted values (**Fig. 69**) with a root mean square prediction error (RMSE*p*) less than 0.35 mg g^{-1}. Significant correlation was also observed between observed and model predicted values ($P \leq 0.001$, $R^2=0.876$).

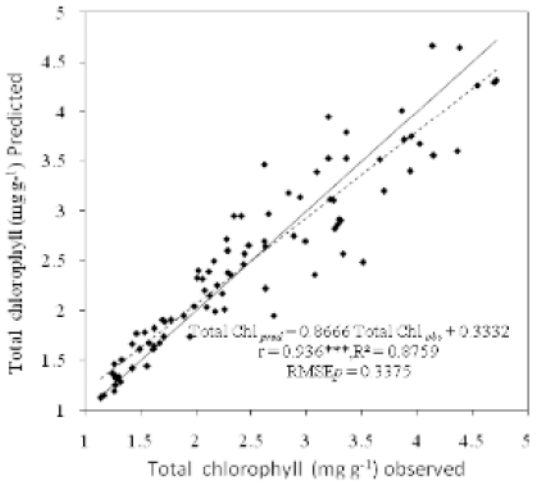


Fig. 69 Validation of the calibrated model for estimating total chlorophyll. Solid line is Chl $_{pred}$ = Chl $_{obj}$; dotted line is best-fit function for Chl $_{pred}$ versus Chl $_{obj}$.

Multi-location trial

The multi-locational field trials at CSIR-IHBT, Regional Horticultural Research Station (RHSS) Jachh and Punjab Agricultural University (PAU), Ludhiana were initiated in 2010 with uniform package and practices to optimize the nitrogen (N), phosphorus (P) and potassium (K) nutrition rate in terms of yield and accumulation of steviol glycosides (SG) in leaves of Stevia plant in different agro-climatic condition. The locations were selected based on the variation of soil types, altitude, temperature and other climatic factors. At CSIR-IHBT and RHSS, the SGs (stevioside + rebaudioside A) content in leaves improved with increasing rate of N and K nutrition (**Fig. 70**). However, negative result was found with higher dose of phosphorus nutrition at RHRS and PAU. The effect of agro-climatic variation on SGs content in leaf was also observed.

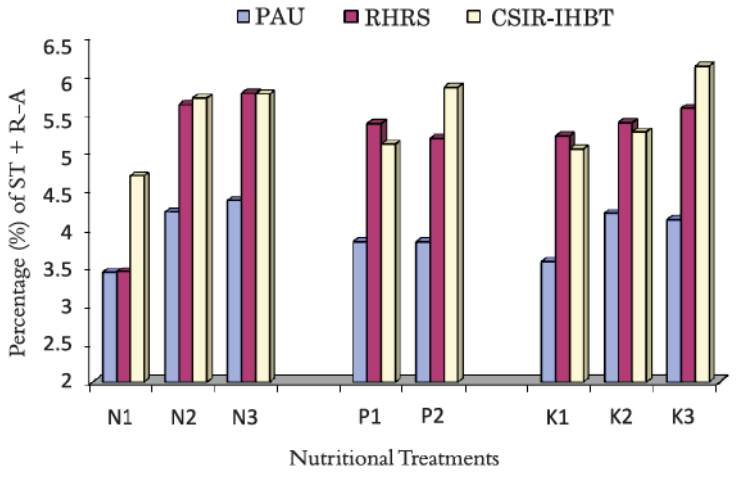


Fig. 70 Effect of NPK on Steviol glycosides (stevioside + rebaudioside A) content in Stevia leaf at different agro-climatic conditions

Steviol glycosides production on pilot plant

The existing process was modified and new purification steps were introduced. In the earlier method, the steviol glycosides (SGs) were extracted from the leaves with water and passed through ion exchange columns, filtered and spray dried. In the improved process, batches of 20 kg stevia leaf were processed on pilot plant and a significant improvement in the SGs content was observed (**Table 15**).

w

SGs	Old process (%)	Improved process (%)
Stevioside	40.55	48.48
Rebaudioside A	15.43	16.7
Rebaudioside C	4.16	5.25
Steviolbioside	5	4.78
Yields	8	8

Effect of spacing and organic mulch on dry leaf biomass

The application of organic mulch as a soil cover is effective in improving the quality of soil and increasing crop yield, especially in organic farming. A field experiment comprising of two spacing (30 x 30 cm and 45 x 30 cm) and four mulch levels (poplar leaf mulch, silver oak leaf mulch, pine needle leaf mulch and no mulch) was conducted during 2010 and 2011 (**Fig. 71**). Higher weed control efficiency (74%) was recorded in poplar mulch followed by silver oak (46%) and pine needle mulch (46%) as compared to control (no mulch). All examined organic mulches significantly decreased with soil temperature. Planting at 30 x 30 cm spacing recorded significantly higher dry leaf biomass as compared to 45 x 30 cm (**Fig.** 72). Mulching with poplar leaf recorded significantly higher dry leaf biomass than the control and pine needle mulch but remained at par with silver oak mulch.

Fig. 71 Poplar leaf mulch

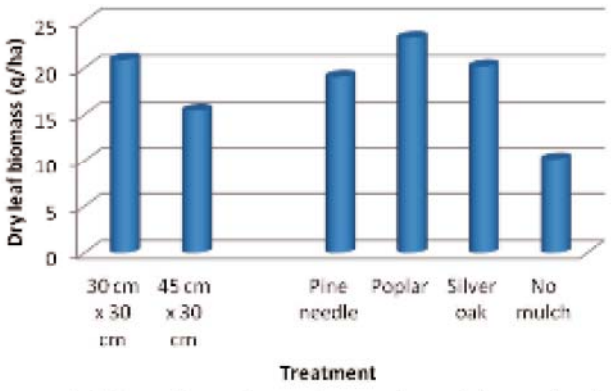


Fig. 72 Effect of spacing and organic mulch on dry leaf biomass of stevia

Hybridization

The work was carried out among selected genotypes for generation of new variability. Parental genotypes were selected on the basis of total glycoside and rebaudioside-A contents, dry leaf weight per plant and resistance to leaf blight. Following crosses

were attempted for hybridization by maintaining the plants in isolation and hand pollinating the individual florets (**Table 16**).

Table 16 The cross attempted for hybridization

Cross Combinations	No. of pollinations	No. of seeds
U 24-4-12 x U 22-5-1	530	111
U 22-5-1 x U 24-4-12	470	28
U 24-4-12 x U 16-5-15	618	238
U 16-5-15 x U 24-4-12	800	415
U 22-5-1 x F 7-2-6	650	15
F 7-2-6 x U 22-5-1	450	6
U 24-4-11 x U 20-4-7	515	94
U 20-4-7 x U 24-4-11	500	54
U 24-4-11 x Canada 1-5-1	580	104
Canada 1-5-1 x U 24-4-11	590	75
C 8-3-4 x U 17-5-7	485	48
C 8-3-4 x U 17-5-7	560	54
E 1-2-1 x U 23-5-12	680	232
E 1-2-1 x U 23-5-12	600	128

Small RNA

Using *in silco* approaches, seven conserved miRNAs namely miR414, miR169, miR319, miR414, miR164, miR167 and miR398 were identified using stem-loop RT-PCR analysis. The detected miRNAs were found to target genes involved in plant growth, development, metabolism and signal transduction (**Fig. 73**).

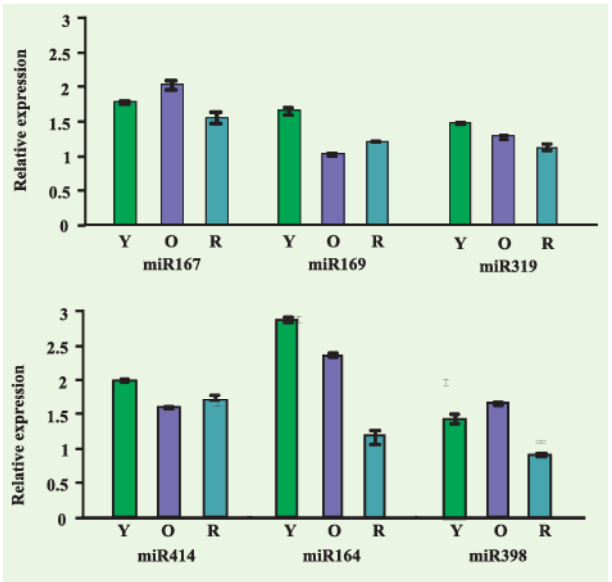


Fig. 73 Expression profile of miRs in young leaf (Y), old leaf (O) and root (R) samples. 18sRNA was used as internal control to equalize cDNA quantity

SAFFRON (*Crocus sativus*)

Saffron is the costliest spice of the world. It's dried orange red trifid stigma is used for flavouring and colouring foods and for medicinal purposes. Only 4-5 corms per mother corm are produced in one growing season through conventional method. The fungal infestation of corms further reduces

the availability of planting material. Therefore, a protocol for *in vitro* cormlet production was developed (**Fig. 74**).

Maximum bud (90%) sprouting was observed on Murashige and Skoog (1962) medium (MS) supplemented with 2,4-D (9.05 µM) and BAP (26.64 µM) during November and December. Direct multiple shoot primordia were initiated from the base of these sprouted buds (**Fig. 75A** and **B**) in presence of BAP (26.64 µM). Shoot multiplication (**Fig. 75C**) was achieved in BAP (26.64 µM) and NAA (1.0 and 5.0 µM). Maximum cormlets (86.07%) were produced from multiple shoots in presence of paclobutrazol (1.7 µM). The *in vitro* produced cormlets showed 91.66 percent sprouting under greenhouse conditions. Increase in cormlet weight (66.88%) was also observed under *in vivo* conditions. These were transferred to their natural habitat at Pampore, Srinagar (J&K), where three fold increase in corm weight was observed after two years.

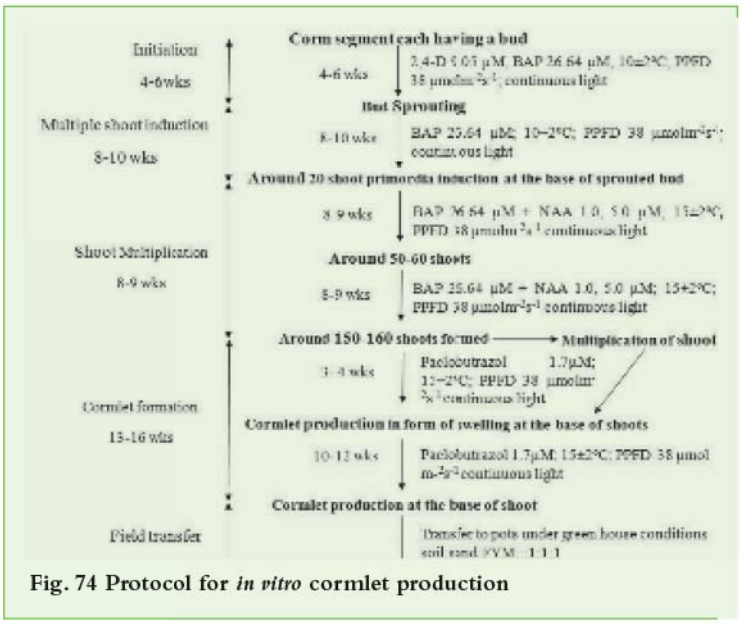


Fig. 74 Protocol for *in vitro* cormlet production

Fig. 75 Multiple shoot and cormlet formation in C. sativus. (A) Sprouted bud (B) Emergence of multiple shoot primordia from the base of bud on 26.64 µM BAP (C) Multiple shoots (D) Cormlets with well developed tunic (E) Harvested *in vitro* cormlets; bar line=1 cm

Demonstration plots were also established at Saffron Research Centre, Sher-e-Kashmir University of Agriculture Science and Technology, Kashmir (SKAUST-K), Srinagar (J&K) in September, 2009. Maximum number of corms (4) and cormlets (5) with 5-7 g weight of mother corm were produced (**Fig. 76**).

Fig. 76 Corms and cormlets of saffron

LARGE CARDAMOM

Eight cultivars of large cardamom from Sikkim viz., Varlangey, Sawney, Seremana, Dzongu Golsey, ICRI-Sikkim-1, ICRI-Sikkim-2, SBLC-05 and SBLC-47 and 40 accessions of local germplam from all over the state were introduced and maintained at the Banuri Farm of CSIR-IHBT (**Fig. 77**). Varlangey was the most promising cultivar for the region with a yield of 200 g/plant capsule. Comparable results were also obtained in the grower's field at Chontra (Distt. Mandi, **Fig. 78**) and Gopalpur (Distt. Kangra, **Fig. 79**). It was observed that for successful cultivation, the plants should be grown under natural or artificial shade to protect it from frost, hail and drought.

Fig. 77 Large cardamom at CSIR-IHBT

Fig. 78 Large cardamom in grower's field at Chontra (Mandi)

During the current year, 1,247 vegetatively propagated plants were distributed to growers of Dharmshala, Gopalpur, Chontra, Sungal and Paprola. Nearly 250 tissue culture raised plants of the cultivar Varlangey are also ready for planting.

Fig. 79 Large cardamom in grower's field at Gopalpur

Analysis of its essential oil showed the presence of 51 compounds including 1, 8-cineole, linalyl propionate, *dl*-limonene, nerolidol, 4-terpineol, terpineol, β-myrcene, *trans*-sabinene hydrate and δ-3-careen. The cardamom oil from HP also recorded some new compounds viz. linalyl propionate 4-terpineol, δ-3-careen, *trans*-sabinene hydrate, 1-phellandrene, α-terpinene, 1-terpineol, bicyclogermacrene, tertracosane, isopinocarvel, ethyl oleate, r-cembrenediol and longifolenaldehyde. The highest content of 1, 8-cineole was recorded in Varlangey and the least in Seremna.

Crystalline and non-hygroscopic colours from spices

The demand for use of natural products in food and pharmaceutical industries besides spice and edible preparation is increasing day by day. In this scenario, a green and cost effective process has been developed to obtain crystalline and non-hygroscopic colored fractions from various plants including commonly used spice and edibles such as methi, coriander, haldi, black carrot, tea and amla (**Fig. 80**).

Fig. 80 Color rich fractions from various spices and edibles

PLANTATION CROPS

TEA (*Camellia sinensis*)

Molecular basis of drought response

Abiotic stresses such as temperature and drought affect the performance and production of tea significantly. Therefore, molecular response of tea to drought, heat and salt stress was studied and a total of 1892 clones were sequenced and analysed. Temporal and spatial gene expression suggested the involvement of chaperones as one of the major mechanisms to protect the plant from drought. Thaumatin like protein, chitinase and late embryogenesis abundant were found to be useful targets for generating "drought stress proof" tea (**Fig. 81**).

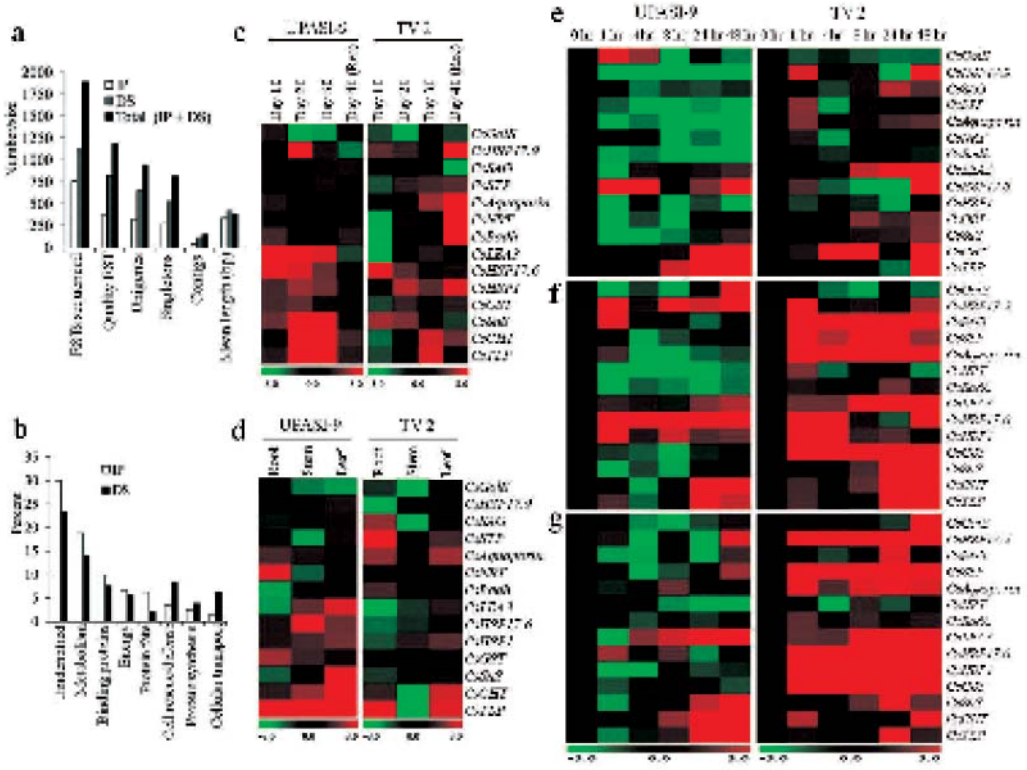


Fig. 81 Molecular analysis of tea to various abiotic stresses. Panel 'a' shows expressed sequence tag (EST) in control (irrigated plants, IP) and drought stressed (DS) subtracted libraries. Major abundant transcripts in IP and DS subtracted libraries are shown in panel 'b'. Heat map diagrams of 14 genes in response to various abiotic stresses are represented in panels 'c' to 'g'

Small RNAs from tea

To understand the regulatory mechanisms in tea metabolism, small RNA (sRNA) library was constructed from tissue used in processed tea i.e. two leaves and a bud. Six novel sRNA candidates were isolated and predicted to target 67 genes responsible for various important plant functions. These were validated through expression analysis in young and old leaf during non-dormant (ND)

and dormant (D) growth phases of tea. Results suggest the probable role of isolated RNAs in development and seasonal variations of tea (**Fig. 82**).

Catechins and prephenate dehydratase

Seasonal variations in catechins, 2-phenyl ethanol and prephenate dehydratase (PDT) enzyme were studied in Assamica and Chinary varieties growing at CSIR-IHBT Experimental Farm. The Assamica variety showed higher catechins and PDT activity in all the three growth flushes with maximum during main growth flush followed by early and backend flush. 2-Phenyl ethanol was higher in Chinary variety in the early flush but decreased with progress in season. *Exobasidium vexans* infection reduced the catechins, 2-phenyl ethanol and PDT activity. Drought stress induced by withholding water for a period of 8 days caused an initial increase which decreased after third day with increasing water stress.

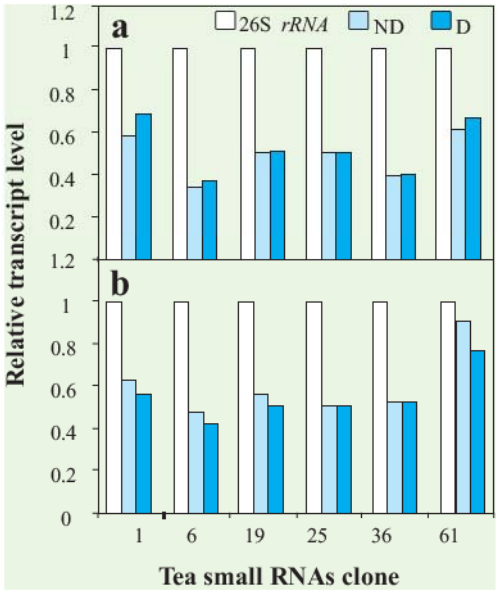


Fig. 82 Expression analysis and functional validation of six sRNAs

Biochemical changes during flower development

Studies conducted in five developmental stages from unopened bud stage (1) to full bloom stage (5) of tea flowers showed higher levels of proteins in stages 1 and 2 which decreased thereafter. In all stages of flower development, the EGCG and EC were the highest and lowest respectively. The EGC and EGCG were highest in stage 3 whereas, proanthocyanidins were highest in stage 2 but decreased to a minimum at full bloom stage. Glycosidic bound volatile compounds viz. linalool oxide cis (3.11%), linalool (22.73%), geraniol (2.69%), 2,4-di-tert-butylphenol (9.71%), methyl palmitate (2.78%), methyl linoleate (2.74%), methyl salicylate (2.62%), α-terpineol (0.33%), β-ionone (1.24%) and nerolidol (0.8%) were higher at stage 3 of flower development.

Volatile flavour components of flowers extracted by simultaneous distillation extraction (SDE) and supercritical fluid extraction (SFE) revealed phenylethanol (14.7%), linalool (7.9%), (*E*)-linalool oxide furanoid (3.5%), epoxy linalool (1.6%), geraniol (2.3%) and hotrienol (1.5%) as major components. The volatile from SDE was dominated with *m*-Xylene (2.6%), (*E*)-linalool oxide pyranoid (5.4%), *p*-myrcene (5.2%), α-cadinol (4.3%) and methyl palmitate (2.9%). HS showed 3-hexenol (2.1%) (*E*)-4,8-dimethyl-1,3,7-nonatriene (20.9%) and linalool (35.1%) as major components. All the methods showed the presence of acetophenone and germacrene D. Floral, fresh and fruity odour of tea flowers was retained by SFE as there was very little loss of heat sensitive volatiles in SFE. The flavour isolated from SFE was superior to SDE.

Selection of elite planting material

Evaluation of clonal plants selected from mother bushes of Kangra Jat and biclonal seed stocks were continued and the performance of the clonal selections over the four years is summarized

in **Table 17**. Average of the 4 years' data showed higher yield of the accession CSIR-Kangra Selection CEF-02 followed by that of CSIR-Seed-stock Selection-3 (**Table 17**).

Table 17 Performance evaluation of elite planting material

Clone/Selection	2008	2009	2010	2011	Mean
CSIR-Kangra Selection BS-070	504	686	672	1094	739
CSIR- Kangra Selection BS-081	589	691	681	1680	910
CSIR- Kangra Selection BS-102	317	437	885	1457	774
CSIR- Kangra Selection CEF-02	1384	1544	1420	2396	1686
CSIR- Seed-stock Selection-1	444	411	895	2076	957
CSIR- Seed-stock Selection-2	130	316	909	1814	792
CSIR- Seed-stock Selection-3	918	765	1245	2722	1412
CSIR- Seed-stock Selection-4	35	35	50	1760	470
CSIR- Seed-stock Selection-5	615	537	350	2252	939
CSIR- Seed-stock Selection-6	482	432	529	1136	644
CSIR- Seed-stock Selection-8	790	634	1120	1819	1091
SA-6	726	648	891	2473	1185
Asha	491	351	544	2319	926
UPASI-9 (Control)	1091	1233	1377	1860	1390
SEM±	61	65	55	72	45
LSD	184	197	166	217	136

*** KMTH – Kilogram of made tea/hectare**

Farm mechanization

Mechanized farm operations were continued and skiffing was done by a skiffing machine STIHL HS 81. It has a double cutting action blade, adjustable for horizontal and vertical cutting of tea bushes for desired shapes and sizes. The performance of the machine was evaluated for the third year. The benefit- cost ratio for machine harvesting was 1.70 to 2.3 and 1.16, 1.33 and 1.42 for level-off skiff, light skiff and medium skiff, respectively.

Hyperspectral data analysis

In this study, the spectral reflectance from the bushes planted in Banuri Tea Experimental Farm, CSIR-IHBT were recorded using handheld Spectroradiometer of 325 to 1075 nm wavelength range (**Fig. 83**). The results revealed that the spectral behaviour of the plantations is influenced by the cultural practices of tea garden management.

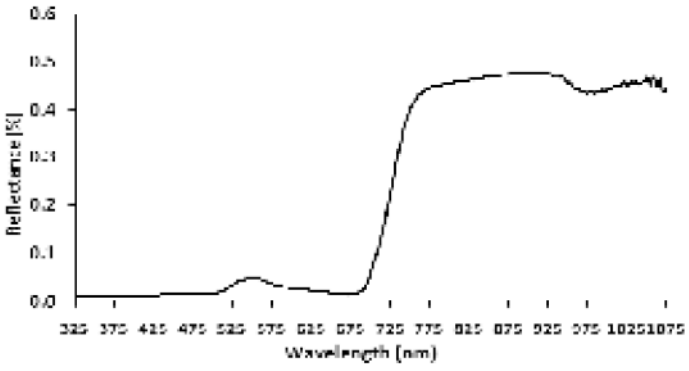


Fig. 83 Spectral reflectance of *Camellia sinensis*

BAMBOO

Promotion and utilization

New stocks of *Dendrocalamus asper* were raised from fresh seeds and a total of over 5.0 lakh plants of 12 different edible varieties were supplied to 15 states of the country including J&K.

In order to enhance the shelf life of bamboo culms before their use for various structural purposes, 10, 6 and 3 m long green round bamboos of *D. hamiltonii* were subjected to a pressure of 1.0 and 1.5 kg/cm² for sap displacement using CCA as a chemical preservative. The rate of sap flow was found to increase with increase in the applied pressure and was dependent on the length of the culms. The diameter of the culms and the amount of preservative used had little bearing on the rate of sap flow **Table 18**.

Table 18 Biometrics of sap flow

Pressure Kg/cm²	Outer diameter	Inner diameter	Outer diameter	Inner diameter	Length m	Amount of chemical used	Rate of flow (1/h)
	94.75	51.37	60.50	33.65	10.00	7.50	2.00
1.5	91.55	47.75	72.45	39.65	6.00	5.50	2.40
	88.40	48.64	80.50	39.65	3.00	3.25	2.60
	85.33	41.70	58.04	29.29	10.00	7.20	2.00
1.5	83.50	40.50	66.85	34.20	6.00	5.75	2.40
	84.50	40.85	75.80	37.65	3.00	3.30	2.75
	92.40	50.40	60.20	33.45	10.00	9.25	1.40
1	90.20	47.50	72.20	36.20	6.00	6.75	1.60
	88.40	48.64	80.50	39.65	3.00	3.80	1.80

Somatic embryogenesis in *Bambusa nutans*

A protocol was standardized for indirect somatic embryogenesis from nodal segments. The clonal fidelity of the plantlets was ascertained using Six EcoRI and MseI primer combinations (E-AGG/ M-CAA, E-AGG/M-CTA, E-AGG/ M-CTG, E-AGC/M-CAA, E-AGC/M-CAC, E-AGC/ M-CTG). A total of 407 clear reproducible fragments were amplified, of which 402 (98.8%) remained monomorphic. The number of fragments detected by each primer combination with an average of 67.8 ranged from 59 (E-AGG/M-CTA) to 78 (E-AGC/M-CAA). The average polymorphism frequency recorded between different morphogenetic events was 1.2%. Results revealed no major genetic variations.

Dendrocalamus hamiltonii

A liquid paraffin overlay (LPO) method was used for medium term storage of rapidly multiplying somatic embryos under slow-growth conditions (**Fig. 84**). The growth of somatic embryos under LPO was suppressed and sub-culturing was not required. Slow growth was associated with changes in sugar metabolism. A sharp decline in starch and non-reducing sugars in rapidly growing embryogenic tissues indicated rapid utilization of starch. A gradual decline in starch stored in somatic embryos indicated slower utilization. Following retrieval from LPO the somatic

embryos showed high recovery and germination (79.78%, 77.49%, 71.22%, 67.13%, and 59.99% after 30, 90, 180, 270, and 365 d of storage, respectively). These proliferated on transfer to MS medium containing 1 mgl^{-1} BAP and 2% sucrose (**Table 19**).

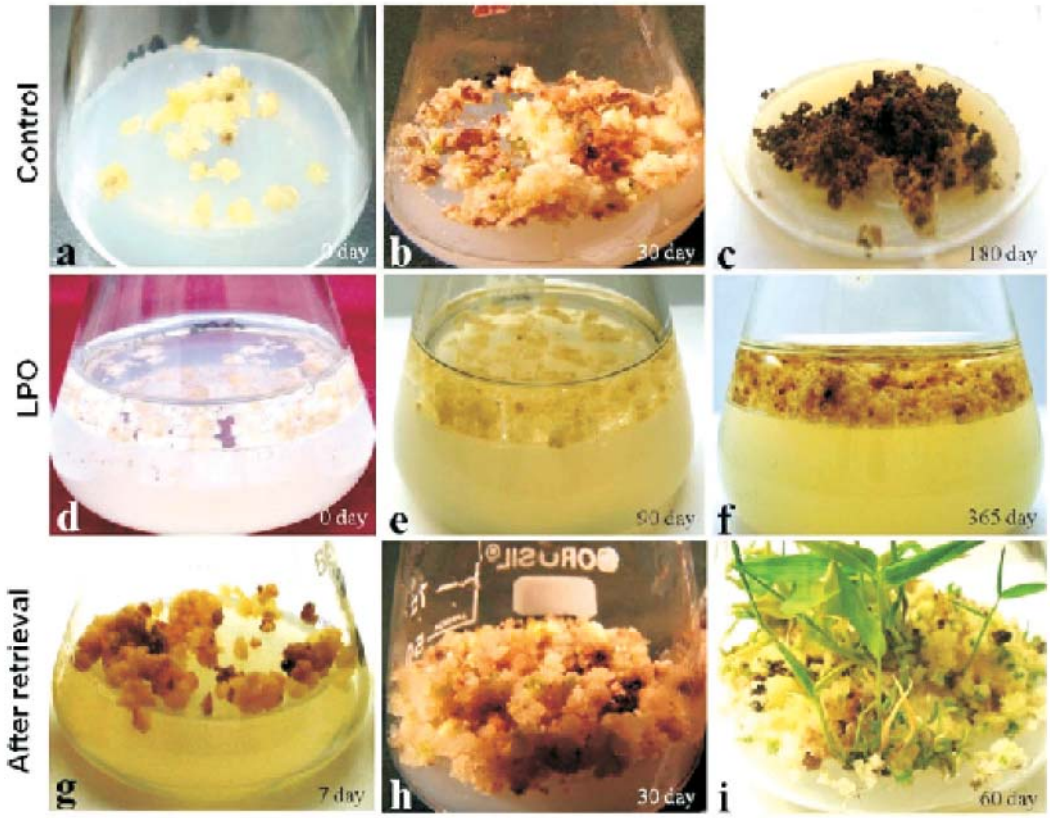


Fig. 84 Storage of *D. hamiltonii* somatic embryos under slow growth conditions: *a – c* not subcultured control subset I at *a* 0d, *b* 30d and *c* 180d: *d – f* somatic embryos stored under liquid paraffin overlay at *d* 0d, e 90d, *f* 365d; and *g – i* response of retrieved somatic embryos after 365d of storage where *g* 7d and *h* 30d after retrieval, *i* germinating embryos after 60d

Table 19 Post-retrieval response of *D. hamiltonii* somatic embryos stored under liquid paraffin overlay (standard error of the mean (SEM))

		Response after retrieval	
Period of storage under LPO (d)	No. of somatic embryos at the time of retrieval (SEM, 0.49)	No. of somatic embryos after 30 d of retrieval (SEM, 0.79)	% Germination after 60 d of retrieval (SEM, 0.68)
30	09.67 a	26.33 a	79.78 a
90	10.33 a	26.67 a	77.49 b
180	11.00 a	24.33 a, b	71.22 c
270	13.00 b	23.33 b	67.13 d
365	17.00 c	21.67 b	59.99 e

Mean values of three replicates. Different lowercase letters within columns indicate significant differences

GINKGO (*Ginkgo biloba*)

The effect of spacing and organic manure on plant growth was studied under agro-climatic conditions of Palampur. The plant height and branch-number were not affected by these factors. The stem diameter at collar level was significantly higher at 2.0 x 2.0m spacing and leaf yield at 1.0 x 1.0m (**Table 20**). In case of organic manure, leaf yield was significantly higher when FYM at 30 t/ha (131 kg/ha) was used as compared to 15 t/ha (118 kg/ha).

Table 20 Stem diameter and leaf yield at different plant spacing

Spacing (m^2)	Stem diameter (mm)	Leaf yield (kg/ha)
1.0 x 1.0	12.15 ab	291 a
1.5 x 1.5	10.98 b	112 b
2.0 x 2.0	13.58 a	70 b
2.5 x 2.5	12.22 ab	26 b
SEm ±	1.24	86 b

FLOWER CROPS

ORNAMENTAL ROSE (*Rosa spp.*)

Breeding

Hybridization among ornamental roses was undertaken to generate new floral variations. Inter-specific hybridization was also carried out among 6 different rose species (*Rosa bourboniana*, *R. banksiae*, *R. brunonii*, *R. centifolia*, *R. rugosa* and *R. chinensis minima*) to generate desirable variations for flower, fruit and essential oil characters. Intervarietal crosses involving reciprocals were attempted in *R. damascena* and *R. rugosa*, respectively. Overall, 1666 seeds were obtained from 1104 pollinations in crosses involving ornamental roses, 908 seeds from 622 pollinations in back-crosses, 133 seeds from 126 pollinations in inter-varietal crosses and 156 seeds from 90 pollinations in inter-specific crosses.

Evaluation of selected rose germplasm

Rooted plants of registered rose germplasm accessions CSIR-IHBT-WR-16 (*Rosa brunonii*), CSIR-IHBT-WR-21 (*R. alba*), CSIR-IHBT-WR-23 (*R. cathayensis*) and CSIR-IHBT-WR-24 (*R. multiflora*) were evaluated for plant survival under warm weather conditions at Chandigarh (**Fig. 85**). Based on pooled data of the two locations, maximum survival was observed in CSIR-IHBT-WR-16 (48.38%), followed by CSIR-IHBT-WR-23 (45.16%), CSIR-IHBT-WR-24 (38.70%) and CSIR-IHBT-WR-21 (25.80%).

Fig. 85 Flower images of registered germplasm (Germplasm registration number/National Identity Number in parentheses): a) CSIR-IHBT- WR-24 (INGR 08066/ IC549905); b) CSIR-IHBT- WR-16 (INGR 08067/IC549906); c) CSIR-IHBT- WR-23 (INGR 08068/IC549907); d) CSIR-IHBT- WR-21 (INGR 08069/IC549908)

The thornless bud sports of cut flower rose of the exotic cultivar cv First Red were multiplied *in vivo* and *in vitro* and evaluated under polyhouse conditions. Early flowering was observed in the budded plants as compared to the *in vitro* plants. The budded plants also produced long flowering shoots.

GERBERA (*Gerbera* spp.)

Breeding

Generation of variability and its characterization

Variability was generated and characterized for improvement of floral traits in *G. jamesonii* through a hybridization program involving a potential inter-varietal cross CSIR-IHBT Gr4 x CSIR-

IHBT Gr5. Considerable variations were observed for flower colour, which ranged from white, yellow, orange, red, maroon and pink; shape (single and semi-double), diameter, disc colour, scape length, disc diameter, ray floret width and ray floret number among the F_1 progeny (**Fig. 86**).

Fig. 86 Gerbera flower colour variations

The flower shape and disc colour were observed to be qualitative traits whereas the flower colour, scape length, flower diameter, disc diameter, ray floret width and ray floret number had quantitative inheritance. Analysis of variance revealed high heritability of scape length, flower diameter, disc diameter and ray floret number, and moderate heritability of ray floret width (**Table 21**).

Table 21 Analysis of variance of metric floral traits in gerbera genotypes

Source of variation	Degrees of freedom	Mean sum of squares				
		Scape length	Flower diameter	Disc diameter	Ray floret width	Ray floret number
Replications	2	8.2	0.29	0.32	0.026	3.345
Genotypes	6	177.4*	1.77*	4.89*	0.242*	150.05*
Error	12	2.48	0.076	0.2	0.032	8.89
SE d (±)		1.28	0.225	0.103	0.146	2.43
H (%)		95.92	88.13	94.33	68.62	84.10

*significant at p≤ 0.05

Image analysis for flower colour variation

In order to quantify the colour variations in *G. jamesonii*, the image analysis was performed on ligules of 211 progenies and 7 parental accessions. Multivariate clustering of genotypes based on red, green and blue (RGB) hue and saturation (HS) colour variables determined the relative position of genotypes in paired group clusters. The genotypes grouped into different clusters representing distinct colour sub-groups were distinguishable from each other (**Fig. 87**). Two major clusters which corresponded to the flavonoid and carotenoid pigments

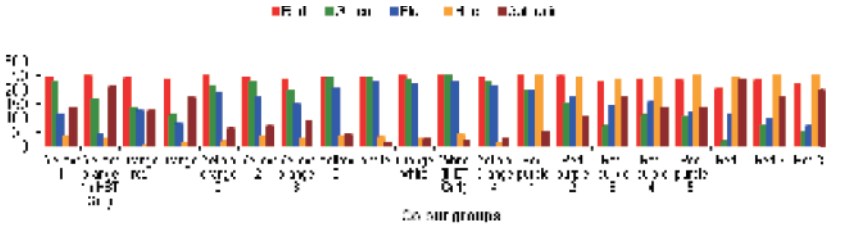


Fig. 87 Mean values of RGB and HS colour channels for different colour group clusters

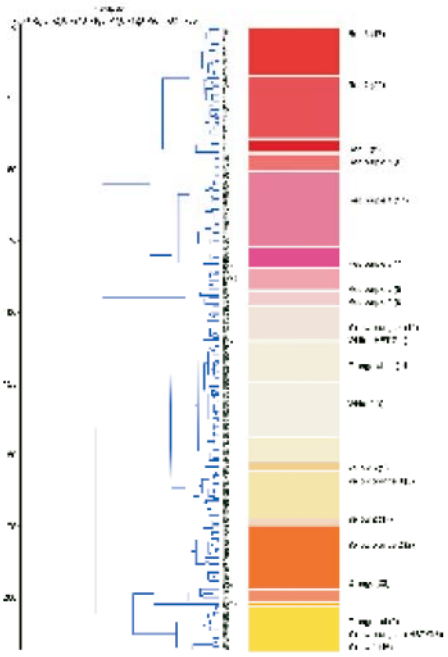


Fig. 88 Multivariate clustering and distinction of different colour groups based on image analysis of ligule colour in gerbera (no. of genotypes in parentheses)

contributed to the flower colour variations (**Fig. 88**). Analysis of variance among the genotypes within each colour cluster revealed significant variations for ligule colour implying high degree of polymorphism for the trait but the extent of variation was lower in comparision to the variations among the clusters.

In vitro culture

Different explants of the cv Orange Colour viz., flower bud, peduncle, leaf base, leaf blade and shoot tip were evaluated for regeneration on MS medium. Their efficiency varied from 50-62.5% with the flower buds of 8 pieces showing the maximum regeneration. In mass multiplication, 5.66 nos. of shoots/explant were recorded with 3.61 nos of leaves and 3.32 cm of plant height. Maximum rooting of 95% was observed on half strength MS medium (**Fig. 89**).

Fig. 89 *In vitro* culture of gerbera cv. Orange Colour

GLADIOLUS (*Gladiolus hybridus*)

The performance of the cultivars (10 nos) procured from Indian Agricultural Research Institute (Pusa), New Delhi were evaluated under field conditions at Palampur from 2009-2011. The results indicated that the maximum spike length of 127.88 cm was observed in the cv Shabnam. The cv Dhanvantri produced the maximum number of florets (16.87/spike/year) with the longest *in planta* shelf life of 17.26 days for the spike.

CHRYSANTHEMUM (*Chrysanthemum* spp.)

Chrysanthemum is extensively grown all over the world for cut flowers with excellent vase life. Performance of thirty three dwarf cultivars procured from CSIR-NBRI, Lucknow were evaluated under polyhouse conditions at Palampur from 2010. The ratoon crop data revealed maximum number (430.66 / plant/year) of flowers in the cv Y2K, whereas, the cv. Sijuka produced the maximum number (33.73 /plant/year) of flowering shoots.

In another study, *in vitro* cultures were established from nodal explants of the cvs. White Star and Atlantus (**Fig. 90**). MS

Fig. 90 *In vitro* culture of chrysanthemum cv. White Star

medium amended with 1.00 mgl^{-1} BAP, 0.025 mgl^{-1} NAA and 0.025 mgl^{-1} IBA was found to be ideal for proliferation.

LILIUM (*Lilium* spp.)

Lilies are one of the top ten cut flower crops of the world producing beautiful, attractive and bright flowers with a long shelf life. In standardizing the commercial bulb size of Asiatic hybrid lily cultivars, the cv Parato produced the maximum bulb circumference (14.70 cm) with the mother bulbs having a circumference of 8-10 cm.

Table 22 Effects of time of planting and cold treatment on flowering of Asiatic hybrid lily

Time of planting and duration of cold treatment	Day required for flowering		
	cv Grand Paradisso	cv Novecento	cv Adelina
1st week October (90 d)	148.00	152.00	165.00
1st week November (120 d)	135.00	141.00	148.00
1st week December (150 d)	95.00	102.00	112.00
1st week January (180 d)	83.00	86.00	94.00

The effects of time of planting and cold treatment on the bulbs of Asiatic hybrid lily (90, 120, 150, 180 days at 5°C) were investigated in Palampur conditions. The number of days to flowering was increased by shorter periods of cold treatment and early planting (**Table 22**).

CARNATION (*Dianthus caryophyllus*)

Comparative economic analysis

Carnation is the most important cut flower crop having high demand for its beautiful charming flowers and excellent vase life. Its economic viability for cultivation in 500 m^2 polyhouse area with and without subsidy was analyzed with retrospect to capsicum, a highly remunerative vegetable crop widely cultivated in Himachal Pradesh. In case of subsidy, 74.16, 145.44, 171.93 and 78% difference in income were recorded for the cultivation in comparison to capsicum for farm business, family labour, net and farm investment, respectively. However, the differences in income for carnation were 64, 162, 209.68 and 66.62% for farm business, family labour, net and farm investment, respectively without subsidy. The analyses revealed that the cultivation of carnation is profitable over capsicum cultivation under both the conditions.

MICROBIOLOGY AND PLANT PROTECTION

Exploitation of India's rich microbial diversity (NWP006)

A total of fresh 1080 cultures of bacteria, actinomycetes and fungi were isolated from cold habitats of the Indian trans-Himalayas and preserved. Culture extracts of 205 bacteria, 120 actinomycetes and 25 fungal cultures were tested for antimicrobial activity. Seventy five isolates were found active against one or more test organisms, out of which, 22 bacteria, seven actinomycetes and four fungal cultures showed broad-spectrum activity against *Bacillus subtilis*, *Candida albicans*, *Escherichia coli*, *Klebsiella planticola*, *Micrococcus luteus*, *Pseudomonas aeruginosa*, *Staphylococcus aureus* MLS16 and *S. aureus*. Antimicrobial potential of 30 *Paenibacillus* spp. isolates from the CSIR-IHBT microbial culture collection was studied against a panel of microbes. Nine isolates were active against 3-4 test organisms and one culture showed broad spectrum activity against 6 test pathogens. All isolates were identified by 16S rRNA gene sequencing. Their phenotypic fingerprinting (BIOLOG™) and whole-cell fatty acid profiling elucidated intra-species polymorphism.

Twenty one active bacterial, actinomycetes and fungal cultures were screened for antimicrobial activity against clinical strains, including the bacterial pathogens methicillin-resistant *S. aureus* (MRSA), vancomycin-resistant *Entrerococcus* (VRE), *C. albicans* (FCZ^r), *P. aeruginosa* and *Aspergillus fumigatus* at the Clinical Microbiology Unit, Indian Institute of Integrative Medicine, Jammu. Antimicrobial activity was found in 16 cultures against MRSA, 14 cultures against VRE, 11 cultures *P. aeruginosa,* 10 cultures against *C. albicans* (FCZ^r), and 6 cultures against *Aspergillus fumigatus.* The cultures showing broad-spectrum activity against drug resistant strains were identified as *Streptomyces netropsis, Janthinobacterium lividum, Lentinula edodes, S. sioyaensis, Ulocladium tuberculatum, S. blastomyceticus, Brevibacterium frigoritolerans, S. avidinii, S. aureus, Bacillus subtilis, B. aryabhattai, B.amyloliquefaciens* and *P. poae.*

In studies on screening of microbial cultures for other biological activities, 1600 culture extracts were prepared. Of these, 29, 19 and 16 extracts showed inhibition of β-lactamase (NIIST), AChE and α-glucosidase (CFTRI), respectively. Fifty two, eight and five extract showed cytotoxicity against HuT-78 cells, anti-NIK1 activity (IMTECH) and PDF inhibition, respectively. Isolates IHB B 3081 (*Bacillus aryabhattai*) and IHB B 2302 (*Brevibacterium frigoritolerans*) showing broad spectrum activity were processed for fermentation (Bioreactor), purification (TLC, Flash chromatography) and NMR characterization.

A total of 152 bacteria were isolated, preserved and screened for protease, cellulase, amylase and lipase production. Among these, 44 isolates for protease, 39 for CMCase, 6 for amylase and 24 for lipase were found positive at 28°C. At 5°C, 25 isolates were found positive for protease, 19 for cellulase, 2 for amylase and 23 for lipase production. The isolates which showed protease production at 5°C were further screened for enzyme production at alkaline pH.

Among 82 and 55 isolates showing protease production at 5 °C and pH 10, 22 isolates showed larger zone of clearance and these were characterized by 16S rRNA gene sequencing. The

isolates were affiliated with the genera, *Arthrobacter*, *Bacillus, Exiguobacterium, Paenibacillus, Planomicrobium*, *Pseudomonas*, and *Stenotrophomonas*. The maximum number of bacteria belonged to the class *Bacilli* (14) followed by *Gammaproteobacteria* (5) and *Actinobacteria* (3). The partially purified (ammonium sulphate precipitated) proteases from 22 isolates showed activity at wide range of alkaline pH and temperature.

Four promising isolates IHB B 3393, IHB B 3460, IHB B 3571 and IHB B 3577 were characterized for CMCase activity at pH 4-12. Three isolates showed more than 60% activity at pH 12 and the fourth one (IHB B 3393) showed 60% activity at pH 9. Eight isolates belonging to genus *Paenibacillus* were used for partial purification of CMCase and the enzyme activity was analyzed using zymography.

Hydroxystyrenes (vinylguaiacol, vinylphenol, canolol and other hydroxylated styrenes) are among the most extensively explored bioactive compounds, owing to their wide-ranging applications in food and alcoholic beverages, flavoring substances, and as intermediates in the preparation of various bioactive molecules. Studies were conducted for synthesis of hydroxystyrenes via biocatalytic decarboxylation/deacetylation and 38 bacterial strains isolated from cold environments were screened for ferulic acid decarboxylation into vinylguaiacol. Two strains (KJLPB4 and KJPB2) showing optimum conversion were subsequently identified as *P. agglomerans* (EMBL # FN263077 and EMBL # FN263076, respectively) and deposited with the CSIR-Institute of Microbial Technology, Chandigarh, under MTCC 10409 and MTCC 10062, respectively. Using KJLPB4, vinylguaiacol (98% yield) was selectively obtained from 2.0 $g L^{-1}$ ferulic acid at 28 °C after 48 h incubation. KJPB2 provided vanillic acid in 85% yield after 72 h of incubation.

Evolutionary relationships of 120 root-nodulating bacteria isolated from the nodules of *Pisum sativum* cultivated at 22 different locations of the trans-Himalayan valleys of Lahaul and Spiti (HP) were studied using 16S rRNA gene PCR-RFLP, ERIC-PCR, sequencing of 16S rRNA, *atpD*, *recA*, *nodC* and *nifH* genes, carbon-source utilization pattern (BIOLOG™), and whole-cell fatty acid profiling. The results demonstrated that all the isolates belonged to *Rhizobium leguminosarum* symbiovar *viciae* (*Rlv*). Isolates from the two valleys were clearly separated on the basis of ERIC fingerprints, carbon-source utilization pattern, and whole-cell fatty acid methyl esters. Phylogenetic analysis of *atpD*, *recA*, *nodC* and *nifH* genes revealed a common *Rlv* sublineage in Spiti valley. Lahaul valley isolates were represented by 3 sequence types of *atpD* and *recA* genes, and four sequence types of *nodC* and *nifH* genes. Genotypes from the two valleys were completely distinct, except for two Lahaul isolates that shared *nodC* and *nifH* sequences with Spiti isolates but were otherwise more similar to other Lahaul isolates. Isolates from the two highest Spiti valley sites (above 4000m) had a distinctive whole-cell fatty acid profile. The distribution of *Rlv* strains reflects the geography and earlier history of this region. Spiti valley isolates are closely related to *Rlv* sublineages from Xinjiang and Shanxi provinces in China, while Lahaul valley isolates resemble cosmopolitan strains of the western world. The high mountain pass between these valleys represents a boundary between two distinct

microbial populations. It is tempting to assert that the bleak and arduous Kunzum Pass that separates these valleys is the place where East meets West, or rather, where East and West come very close but fail to meet.

Table 25 BLASTn search results of tea rhizobacteria strains based on 16S rRNA gene sequencing

Isolate	Best match
IHB B 1033	*Citrobacter farmeri* CDC 2991-81(T) AF025371
IHB B 1064	*Burkholderia arboris* R-24201(T) AM747630
IHB B 1032	*Pseudomonas protegens* AJ417073
IHB B 1663	*Burkholderia stabilis* LMG 14294(T) AF148554
IHB B 1070	*Enterobacter asburiae* JCM6051(T) AB004744
IHB B 1544	*Pseudomonas plecoglossicida* FPC951(T) AB009457
IHB B 1076	*Citrobacter farmeri* CDC 2991-81(T) AF025371
IHB B 1045	*Bacillus altitudinis* FM955870
IHB B 1069	*Burkholderia stabilis* AF148554
IHB B 1518	*Enterobacter ludwigii*
IHB B 1644	*Bacillus altitudinis* FM955870
IHB B 1647	*Bacillus cereus* AY138271
IHB B 1715	*Burkholderia cepacia* AF097533
IHB B 1719	*Burkholderia stabilis* AF148554
IHB B 1059	*Pseudomonas frederiksbergensis* PSB37
IHB B 1071	Pseudomonas putida
IHB B 1019	*Cupriavidus basilensis* strain T103
IHB B 1008	*Chryseobacterium* sp T5
IHB B 1011	*Citrobacter* sp. PM2
IHB B 1018	*Pantoea aqqlomerans*
IHB B 1013	*Hafnia alvei*
IHB B 1016	*Lysinibacillus sphaericus*
IHB B T5B3	*Enterobacter asburiae*
IHB B 1062	*Burkholderia stabilis*
IHB B 1065	*Burkholderia ambifaria*
IHB B 1073	*Burkholderia ambifaria* AMMD
IHB B 1509	*Enterobacter ludwigii* strain K9
IHB B 1510	*Enterobacter asburiae*
IHB B 1516	*Bacillus subtilis*
IHB B 1517	*Citrobacter amalonaticus* strain SA01
IHB B 1530	*Citrobacter* sp. 36-4CPA
IHB B 1538	*Burkholderia cepacia*
IHB B 1653	*Bacillus cereus* strain VITSN04

Isolate	Best match
IHB B 1669	*Burkholderia ambifaria* MC40-6
IHB B 1702	*Bacillus cereus*
IHB B 1719	*Burkholderia cepacia* strain ATCC 27515
IHB B 1008	*Chryseobacterium* sp TM3_8
IHB B 1011	*Citrobacter* sp. PM2
IHB B 1013	*Hafnia alvei*
IHB B 1016	*Lysinibacillus sphaericus*
IHB B 1018	Pantoea aqqlomerans
IHB B 1019	*Cupriavidus basilensis* strain T103
IHB B 1059	*Pseudomonas frederiksbergensis* PSB37
IHB B 1062	*Burkholderia stabilis*
IHB B 1065	*Burkholderia ambifaria*
IHB B 1071	Pseudomonas putida
IHB B 1073	*Burkholderia ambifaria* AMMD
IHB B 1397	*Bacillus subtilis* strain WD23
IHB B 1509	*Enterobacter ludwigii* strain K9
IHB B 1510	*Enterobacter asburiae*
IHB B 1516	Bacillus subtilis
IHB B 1517	*Citrobacter amalonaticus* strain SA01
IHB B 1530	*Citrobacter* sp. 36-4CPA
IHB B 1538	*Burkholderia cepacia*
IHB B 1653	*Bacillus cereus* strain VITSN04
IHB B 1669	*Burkholderia ambifaria* MC40-6
IHB B 1702	*Bacillus cereus*
IHB B 1719	*Burkholderia cepacia* strain ATCC 27515
IHB B 1720	*Bacillus* sp. 34386ABRRJ
IHB B 1721	*Bacillus subtilis* subsp. *subtilis* strain SB 3130
IHB B 4110	*Bacillus* sp. DAU101
IHB B 4114	*Bacillus simplex* strain N25
IHB B 4053	*Bacillus atrophaeus* 1942
IHB B 4058	*Bacillus simplex* strain RC18
IHB B 4272	*Bacillus subtilis* strain NBY44
IHB B 4273	*Bacillus pumilus* strain SB 3182
IHB B 5223	*Bacillus subtilis* strain NB-01B

Isolate	Best match
IHB B 6507	*Alcanigenes* sp. F78
IHB B 6508	*Bacillus cereus* strain 7
IHB B 6511	*Bacillus cereus* strain TAUG5
IHB B 6512	*Bacillaceae* bacterium KVD-ink-53
IHB B 6513	*Alcaligenes* sp. F78
IHB B 6515	*Bacillus cereus* strain H1439
IHB B 6516	*Bacillus megaterium* strain HDDMG 02
IHB B 6523	*Bacillus thuringenesis* serovar chinensis CT-43
IHB B 6524	*Bacillus thuringiensis* strain BNA-2
IHB B 6525	*Bacillus* sp. R21S
IHB B 6526	Acinetobacter sp. G30
IHB B 6528	*Bacillus simplex* strain N25
IHB B 6529	*Bacillus subtilis* isolate C8-4
IHB B 6534	*Lysinibacillus fusiformis* strain DSM 2898
IHB B 6535	*Bacillus thuringiensis* serovar chinensis CT-43
IHB B 6537	*Bacillus* sp. strain TKSP21
IHB B 6543	*Bacillus cereus* strain G8639
IHB B 6544	*Bacillus samanii* strain CI
IHB B 6545	*Paenibacillus* sp. HC1
IHB B 6546	*Sporosarcina aquimarina* strain SF237
IHB B 6549	*Bacillus cereus* strain HN
IHB B 6550	*Bacillus* sp. strain:TKSP21
IHB B 6551	Uncultured bacterium clone 5s8
IHB B 6052	*Bacillus subtilis* A97
IHB B 6553	*Staphylococcus* sp. TUT1203
IHB B 6558	*Acinetobacter baumannii* 1656-2
IHB B 6561	Uncultured *Bacillus* sp. clone Filt.98
IHB B 6562	*Bacillus chitinolyticus* IFO 15660
IHB B 6571	*Bacillus pumilus* isolate ZB13
IHB B 6573	Uncultured compost bacterium
IHB B 6576	*Lysinibacillus* sp. DT3
IHB B 6581	Uncultured bacterium clone 7s4
IHB B 6593	*Bacillus subtilis* subsp. subtilis str.
IHB B 6504	*Bacillus cereus* strain 7
IHB B 6505	*Lysinibacillus fusiformis* isolate CCM1B
IHB B 6506	*Bacillus thuringenesis* HLSSD-5
IHB F 1853	*Penicillium citrinum* strain S36
IHB F 1857	*Trichoderma tomentosum* strain DAOM 229898
IHB F 1876	*Emericella nidulans* isolate UOA/HCPF 10647
IHB F 1881	*Humicola fuscoatra* strain YQ19
IHB F 1884	*Aspergillus niger* strain WM10.70

Isolate	Best match
IHB F 1887	*Penicillium* sp. BE
IHB F 1903	*Bionectria* sp. Papochf 04
IHB F 1937	*Staphylotrichum coccosporum* strain: NBRC 31817
IHB F 1946	*Trichoderma* sp. SQR582
IHB F 1954	*Bionectria ochroleuca* isolate XSD-B42
IHB F 1001	*Trichoderma longibrachiatum* isolate ZJ-2008019
IHB F 1801	*Emericella rugulosa* strain SRRC 92
IHB F 1805	*Penicillium oxalicum* strain KUC1674
IHB F 1807	*Aspergillus niger* strain LB1
IHB F 1810	*Penicillium pinophilum* strain TP80
IHB F 1820	Fungal sp. 3514
IHB F 1830	*Penicillium citrinum* strain MA-14
IHB F 1831	*Aspergillus niger* strain TA12
IHB F 1834	*Penicillium janthinellum* isolate P16
IHB F 1837	*Penicillium verruculosum* isolate CY196
IHB F 1847	*Arthrinium phaeospermum* isolate T57
IHB F 1849	*Penicillium ochrochloron* strain UWFP 720
IHB F 1723	*Aspergillus* sp. B-8
IHB F 1781	*Penicillium pinophilum* isolate H4284
IHB F 2002	*Trichoderma longibrachiatum* isolate T50
IHB F 2006	*Trichoderma longibrachiatum* isolate T61
IHB F 2007	*Trichoderma* sp. AH-Group-2 isolate
IHB F 2043	*Schizophyllum commune* IFM 45818
IHB F 1726	*Eurotium rubrum* isolate UPM A14
IHB F 1745	*Lycoperdon perlatum* isolate NW470
IHB F 1751	*Trichoderma* sp. SQR582
IHB F 1759	*Stachybotrys microspora* ATCC 18852
IHB F 1796	*Eurotium rubrum* isolate UPM A14
IHB F 2005	*Trichoderma* sp. SQR582
IHB F 2023	*Irpex lacteus* isolate T60
IHB F 2030	*Trichoderma koningiopsis* strain DMC 795b
IHB F 2065	*Aspergillus nomius* strain NRRL 6552
IHB F 2075	*Fusarium solani* isolate S-0900
IHB F 2045	*Lycoperdon perlatum* isolate NW470
IHB F 2011	Fungal sp. ARIZ L488cla
IHB F 2053	*Fusarium merismoides* var. violaceum strain
IHB F 1722	*Cladophialophora devriesii* strain CBS 118720
IHB F 2074	*Echinodontium taxodii* isolate wb372
IHB F 2058	*Fusarium merismoides*
IHB F 2053	*Fusarium merismoides* var. violaceum

Study of some of gaps in the technology transfer of SHIITAKE (*Lentinula edodes*) on pilot scale and multi-locational testing of strains and substrate

The work was initiated with 9 strains of Shiitake mushroom (P-DBT-01, PDBT-02, P-DBT-03, P-DBT-04, P-DBT-06, P-DBT-07, P-DBT-08, P-DBT-09, P-DBT-10) acquired from Udaipur, 14 strains (Le-oe-02, Le-oe-08, Le-oe-09, Le-oe-16, Le-oe-17, Le (S) 5, Le (G), Le (B) 1, Le (B)2, Le (B)3, Le-oe-38, Le-oe-142, Le-oe-442, Le-oe-443) acquired from NRCM, Solan and 1 strain Le-2005 acquired from CSK HPKV, Palampur. No significant difference in growth was observed among the strains. Phylogenetic analysis based on ITS sequences confirmed the identity of all strains as *Lentinula edodes*. Nine lentinula isolates acquired from Udaipur differed in the utilization of the carbon sources recorded using Biolog system and were positive for the utilization of D-ribose and D-xylose. Majority of the strains utilized D-arabinose, L-arabinose and p-hydroxy phenyl acetic acid . In assessment of genetic variability of the strains, ten out of a total of 40 RAPD primers produced distinct, reproducible and polymorphic profiles were selected. A total of 1168 bands were recorded and the primer OPH03 generated maximum polymorphism producing 173 bands. The primer OPA17 revealed least polymorphism producing 40 bands. UPGMA dendrogram based on the RAPD matrix revealed 24 strains in five major clusters at 20% dissimilarity level (**Fig. 91**)

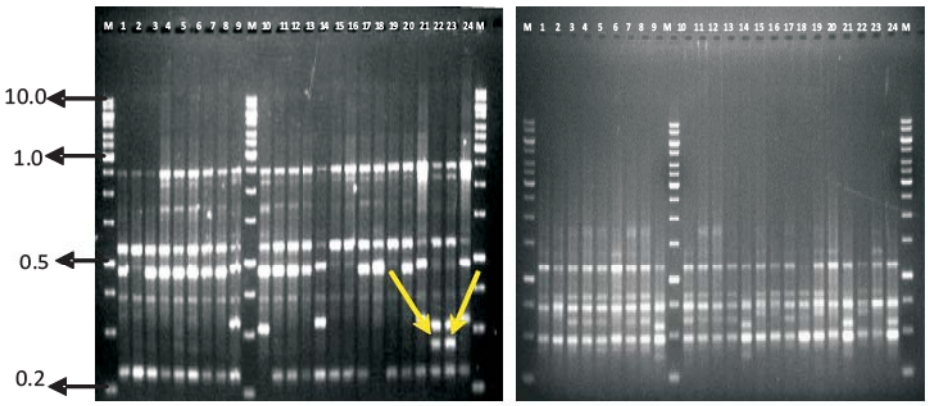


Fig. 91 RAPD kit Primers using genomic DNA of *Lentinula edodes* Lane M-1: kb DNA ladder, 1:P-DBT-01, 2:PDBT-02, 3:P-DBT-03, 4:P-DBT-04, 5:P-DBT-06, 6:P-DBT-07, 7:P-DBT-08, 8:P-DBT09, 9:PDBT-10, 10:Le(G), 11:Le(B)2, 12:Le(B)3, 13:Le(S)5, 14:Le-oe-02, 15:Le-oe-08, 16:Le-oe-09, 17:Le-oe-16, 18:Le-oe-17, 19:Le(B)1, 20:Le-oe-38, 21:Le-oe-142, 22:Le-oe-442, 23:Le-oe-443, 24:Le-oe-2005

Characterisation of a bi-functional glycosyl hydrolase (GH) from an antagonistic *Pseudomonas putida* strain P3 (4)

A GH family 5 gene (947 bp) cloned earlier from a *Pseudomonas putida* isolate P3(4) was overexpressed in *E.coli* and the recombinant protein was characterised. The purified enzyme was homogenous, as examined by SDS-PAGE and was visualized as a single fluorescent band in native gel assays with 4-methylumbelliferyl-*N*-acetyl-β-D-glucosaminide and glycol chitosan, respectively. For hydrolysis of 4-nitrophenyl-*N*-acetyl-β-D-glucosaminide (pNP-(GlcNAc) and colloidal chitosan, the enzyme had an optimal temperature of 40 °C, and was stable within the temperature range of 10 to 40 °C. The enzyme showed an optimal pH of 3.5, with maximum stabilities at 5.0 and 5.5 for hydrolysis of pNP-(GlcNAc) and colloidal chitosan, respectively.

Fe^{3+} and Cu^{2+} stimulated chitinase and chitosanase activities by 74.2 and 51.4%, respectively. The purified GH displayed 70 and 45% inhibition of spore germination of the pathogenic fungi, *Fusarium oxysporum* f.sp. *dianthi* and *Alternaria solani*, respectively (**Fig. 92**).

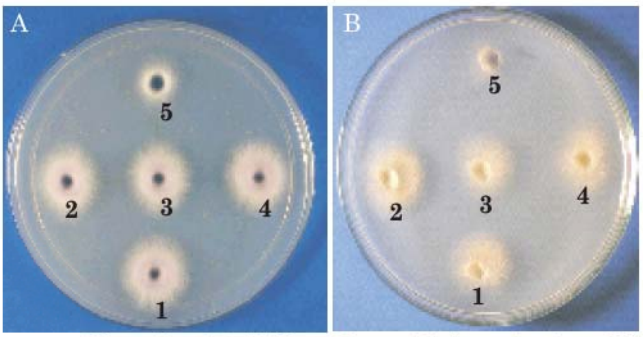


Fig. 92 Effect of purified GH on the conidial germination of A) *Fusarium oxysporum* f.sp. *dianthi* and B) *Alternaria solani* 1&2-sterile distilled water; 3&4-native elution buffer, 5-purified protein

Purification and characterization of an extracellular 24 kDa chitobiosidase from the mycoparasitic fungus *Trichoderma saturnisporum*

A *T.saturnisporum* Hamill isolate GITX-Panog (C) exhibiting strong chitinolytic and antifungal activity against *Fo.* f.sp. *dianthi*, the causal agent of vascular wilt in carnation was used to purify extracellular chitobiosidase using Czapek-Dox broth amended with the fungal mycelium as the carbon source. The protein was purified by precipitation with ammonium sulphate, followed by DEAE-Cellulose anion-exchange and Sephacryl S-200 high resolution gel filtration chromatography. The purity of the enzyme was determined by SDS-PAGE, with an estimated molecular mass of 24 kDa (**Fig. 93**). In native gel assay with 4-*methylumbelliferyl*-N, N' diacetyl- β-D-chitobioside (4-Mu-$(GluNAc)_2$, the purified chitobiosidase was visualized as single fluorescent band (**Fig. 94**). The enzyme was active up to 60 °C and at pH 4.0, and displayed maximum stability at 50 °C. Mn^{2+} and Zn^{2+} stimulated the enzyme activity by 63% and 41%, respectively. The *Km* and *Vmax* values of the purified enzyme for 4-Mu-$(GluNAc)_2$ were 338.9 μM ml^{-1} and 0.119 μM ml^{-1} min^{-1}, respectively. This appears to be the first report of characterization of a chitobiosidase from antagonistic *T. saturnisporum*.

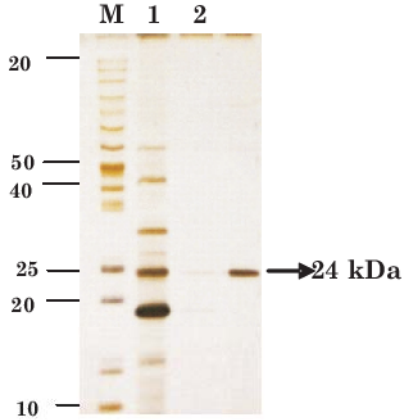


Fig. 93 SDS-PAGE analysis of extracellular proteins purified from *Trichoderma saturnisporum* GITX-Panog (C) M: Protein markers (Fermentas) in kilodaltons Lanes 1: ammonium sulphate precipitated protein (5 μg) 2: Ion exchange purified protein (0.1 μg) 3: Sephacryl S-200 purified chitobiosidase (0.1 μg)

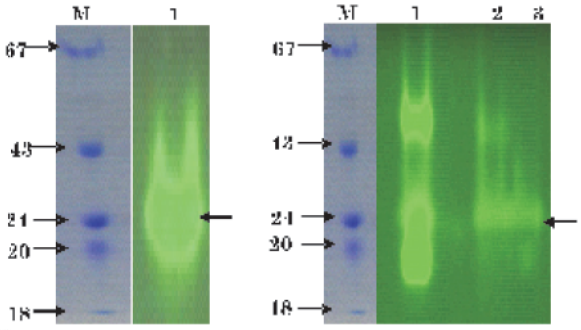


Fig. 94 Zymograms of extracellular proteins purified from *Trichoderma saturnisporum* GITX-Panog (C)
(a): Sephacryl S-200 purified chitobiosidase (0.1 μg) was detected with the substrate, [4-MU-$(GlcNAc)_2$]
(b) Substrate specificity of purified protein using mixture of 4-MU-(GlcNAc), [4-MU-$(GlcNAc)_2$] and [4-MU-$(GlcNAc)_3$] Lanes M: Native protein marker (Genei) 1. ammonium sulphate precipitated crude protein (5μg) 2. ion exchange purified protein (0.1μg) 3: Sephacryl S-200 purified chitobiosidase (0.1μg)

Insect and mite pests of different ecosystems in high altitudes (Lahaul valley)

During August 2011, field survey was undertaken to study insect diversity in different agro-ecosystems. Infestation of aphid, *Myzus persicae* and thrips on leaves was observed in capsicum grown under greenhouse; cabbage butterfly, *Pieris brassicae* larve on cabbage head, mirid bugs on leaves of Chinese cabbage and potato leaves; grasshoppers on potato leaves; thrips on apple leaves, wooly aphid on stems/shoots, leaf roller larva, snout beetles feeding on leaves of apple, pentatomid bug, *Nezara viridula* on leaves of apple; two spotted spider mite, *Tetranychus* sp. on leaves of hops; blue beetle feeding on leaves of manu, *Inula*; insect galls on leaves of seabuckthorn; blue and snout beetles and plant bug feeding on leaves of *Polygonum* spp.; blue beetles on leaves of *Rumex* spp; mirid bug on leaves of *Chenopodium*; chrysomelid beetles, gall insects and aphid, *Tuberolachnus salignus* on *Salix*. Infestation of insect pests were not observed in oriental lily, Asiatic lily, *Picrorhiza, Trifolium fratens* and *Trifolium repens*.

Identification of a new host record for *Helicoverpa armigera* (Hübner)

American bollworm, *H. armigera* (Lepidoptera : Noctuidae) is a widespread pest species of world-wide economic importance. It attacks many agricultural and horticultural crops. A medicinal and aromatic crop, *Salvia sclarea* L. (Lamiaceae) was reported as a new host plant for *H armigera*. The bollworm attacked flowers of *Salvia* during March-April.

Discovery and development of pest management agents from herbal sources (NWP 0037)

In development of plant based biopesticides, a total of 296 plant extracts were evaluated against the insects, *Aphis craccivora*, *Plutella xylostella, Spodoptera litura* and *Helicoverpa armigera,* and the mite pest *Tetranychus urticae*. Four extracts, NCL 2788 P14 A002, NCL 2741 P14 A001, IHB 1455 P14 A001 and RJM 2718 P08 A001 showed promising activity against the aphid, *A. craccivora*.

Bioefficacy of acaricides and insecticides against mites and aphids

Six new acaricides and one commercial neem formulation (azadirachtin 0.15%) were evaluated at recommended doses against two-spotted spider mite, *Tetranychus urticae* in chrysanthemum under greenhouse conditions and the efficacy was compared with dicofol. Abamectin was found to be more effective in controlling the mites followed by hexythiazox, bifenazate, azadirachtin 0.15%, spiromesifen, fenpyroximate and chlofenapyr.

Six synthetic insecticides and one commercial neem formulation at recommended doses were evaluated against aphids in damask rose under field conditions. Deltamethrin was found more effective in controlling aphid population followed by dimethoate, imidacloprid, thiamethoxam, azadirachtin 0.15%, fipronil and thiacloprid.

RURAL DEVELOPMENT

CSIR-800 MISSION

Mission at CSIR-IHBT, Palampur

Societal development activities were carried out on field for production and value addition of tea, bamboo plantation, commercial floriculture, horticulture and medicinal and aromatic plants. Major activities included supply of quality planting materials, nursery and plantation establishments, on site value addition, showcase of technologies in rural exhibitions, hands on training, process demonstration, awareness visits, development and circulation of technical bulletins, TV shows, radio broadcastings, website content and direct interactions with the visitors for knowledge sharing and counseling based on exclusive technologies developed at the institute.

Farmers, the rural community, essential oil and phytochemical industries, ayurveda sector, people involved in biodiversity conservation, consumers etc. were directly benefitted from this project. Know-how as well as planting materials were provided to biotechnology, horticulture, agriculture, forest departments and district rural development agencies on their demand. NGOs from hilly states such as Uttarakhand, Himachal Pradesh, Jammu & Kashmir and north-east states like Sikkim, Mizoram and Arunanchal Pradesh were also the major beneficiaries of these activities.

TEA

Farm mechanization

Mechanical plucking and skiffing of mature leaves from china hybrid tea bushes on planter's tea gardens was demonstrated to individual farmers and self help groups of Kangra district of HP. Fourteen planters were exposed to different tea machineries, safety features and operations. This enabled two self help groups of Bir and Dharamshala (HP) to skiff their tea gardens covering more than 3 ha area. These trainings also helped the planters to resolve the labour problems of their gardens to some extent.

Harvesting and skiffing of tea leaves

Tea Advisory Services

Advisory services were extended to the growers of all tea zones on weekly interval for advising them on flush-to-flush garden management practices leading to better yield and quality. Details of the advisory visits are as below:

Field visits

Advisory services	Tea Zones	No. of visits
Fertilizer application, quality plucking, tipping, control measure against pests, foliar application of nutrients, pruning and skiffing operations, mechanisation of farm operations and management of young tea.	Palampur & Dharamshala	52
	Baijnath & Bir-Jogindernagar	47

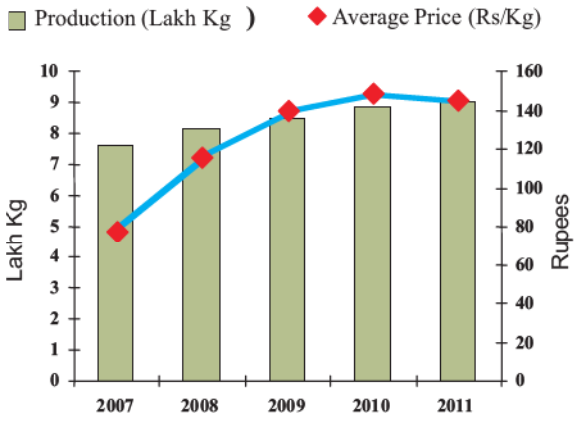
Training-cum-demonstration programmes organized

Theme	Coordinator: Team	Venue	Date	No. of participants
Handling of first flush crop to obtain better productivity and quality	R.K Sud: HP Singh, VS Dhadwal and Khushal Katoch	Chowki Tea Estate, Palampur	08.04.2011	75
Modern technologies of tea culture	R.K Sud: Arvind Gulati, R.D Singh, HP Singh, Ashu Gulati, Amita Bhatacharya, Girish Nadda, YB Pakade, Om Parkash, VS Dhadwal and Khushal Katoch	Field staff of the Tea wing of State Agriculture Department	23-27.05.2011	5
Garden management practices in the lull period of first flush	R.K Sud: HP Singh, Khushal Katoch and VS Dhadwal	Sungal Tea Estate	23.05.2011	40
Demonstration and training of two-men tea leaf harvesting	KK Singh and VS Dhadwal	M/s Hoodle tea Estate	08.08.2011	4
Training-cum-demonstration on garden management practices	R.K Sud: Bhushan Kumar and Rajani Devi	farmers of Uttrakhand	14.10.2011	17
Training-cum-demonstration on mechanization	R.K Sud: VS Dhadwal, Khushal Katoch, Bhushan Gupta and Rajani Devi	Tea growers	08.11.2011	07
Garden management practices during winter season to obtain better productivity and quality	R.K Sud: HP Singh, Khushal Katoch and VS Dhadwal	Raipur Tea Estate	07.12.2011	46
		Chauntra, Bir	27.12.2011	48
		Baijnath, Samlotu	29.12.2011	50
		Chambi Tea Estate, Dharamshala	09.01.2012	28

Theme	Coordinator: Team	Venue	Date	No. of participants
Demonstration and training of tea skiffing to the Planters of SHGs	KK Singh and VS Dhadwal	Zikkar area	08.02.2012	4
Demonstration and training of tea skiffing to the Planters of SHGs	VS Dhadwal	Zikkar area	14.02.2012	2
Demonstration and training of tea skiffing to the Planters of SHGs		Zikkar area	16.02.2012	2
Exposure to tea plantation management	RK Sud: Ashu Gulati, VS Dhadwal and Rajani Devi	Tea growers	22.02.2012	5
Demonstration and training of tea skiffing to the Planters of SHGs	KK Singh and VS Dhadwal	Zikkar area	24.02.2012	2
Production of quality tea in the first flush	RK Sud: HP Singh, Girish Nadda, Khushal Katoch and VS Dhadwal	Sangrai Tea Estate, Bir	22.03.2012	38
Training programme cum discussion on production of quality tea in the first flush		Kangra Valley Tea Estate, Gopalpur	26.03.2012	31
Training programme on tea garden management practices for higher productivity and quality		Thandole Tea Estate, Palampur	29.03.2012	33
Production of quality tea in the first flush		Baijnath zone, Sakri	30.03.2012	70

Impact of the advisory services

Consistent improvement in tea production and average price of Kangra tea was recorded as a result of these advisory services.



Annual production and average price of tea in Kangra valley

Glimpses of the tea growers' training programmes

Trainees from Ethiopia

Trainees from Ethio-Agri CEFT, Ethiopia being exposed to tea management

Trainees from State Agriculture Department, HP being exposed to tea R&D interaction with tea growers of Baijnath zone for development of tea plantations

FLORICULTURE

Raising of *in vitro* culture

In vitro cultures of orange coloured gerbera was established using unopened flower buds. Shoot initiation efficiency varied from 50-62.5% in different repetitions when these shoots were multiplied on MS media containing BAP, NAA, IBA and sucrose.

Efficient *in vitro* cultures of an average of 5.66 nos. of shoots cvs/ explant with an average of 3.61 leaves were obtained. The rooting percentage was found to be 95% on ½-strength MS medium containing BAP and IBA.

Chrysanthemum viz. White star and Atlantus were established *in vitro* on MS media amended with BAP, NAA and IBA. The plants were rooted *in vitro,* hardened and maintained under polyhouse conditions.

Hardening of *in vitro* raised plants in field

In vitro raised plants of gerbera (10000 nos.), chrysanthemum (2500 nos.) and lilium (6400 nos.) were planted for hardening in field conditions. Successful hardening percentages of gerbera, chrysanthemum and lilium varied from 50- 85%.

Transfer of production technology and advisory services

To promote commercial floriculture, demonstration plots were set up at farmers' field. Advisory visits and trainings were also imparted. As a result, the area under commercial floriculture was extended.

Advisory visits to rose and carnation plantations in HP

Advisory visits to gerbera plantations in Punjab

Advisory visits to gladiolus plantations in HP

Extension of area under commercial floriculture crops

Crop	Area (ha)	District covered
Lilium	2	Kangra, Lahaul & Spiti, Mandi, Kullu and Solan
Chrysanthemum	0.4	Kangra, Mandi and Solan
Marigold	6	Kangra, Mandi, Chamba and Una
Alstroemeria	0.1	Kangra, Chamba and Shimla
Agapanthus	0.1	Kangra
Bird of paradise	0.1	Kangra, Kullu and Shimla
Gladiolus	2.5	Kangra, Mandi, Kullu and Una
Carnation	1.5	Bilaspur, Kangra, Kullu and Solan

Multiplication and distribution of planting materials

Planting materials of commercially important cut flower crops viz., chrysanthemum, lilium, gerbera, alstroemeria, bird of paradise, gladiolus, agapanthus and marigold were multiplied and distributed to growers of different district of HP.

Details of distribution of planting material of floriculture crops

Crop	Form of planting material	Qty./No. distributed	Location of supply
Lilium	Bulbs	35317	Kangra, Lahaul & Spiti, Mandi, Kullu and Solan
Chrysanthemum	Cuttings	8130	Kangra, Mandi and Solan
Marigold	Seedling Seeds	20383 4.10 kg	Kangra, Mandi, Chamba and Una
Alstroemeria	Plants	700	Kangra, Chamba and Shimla
Agapanthus	Plants	993	Kangra
Bird of Paradise	Plants	476	Kangra, Kullu and Shimla
Gladiolus	Corms Cormels	691 2.0 kg	Kangra, Mandi , Kullu and Una

Demonstration plots

Demonstration plots of lilium in Lahaul & Spiti, chrysanthemum and marigold in Chamba, alstroemeria, bird of paradise and rose in Kangra (HP) were established.


Demonstration plots of lilium in Lahaul & Spiti

Training programmes organized

Details of the training	Coordinator:Team	Photographs
Workshop on development of floriculture in Himachal Pradesh, sponsored by APEDA, Govt. of India, May 13, 2011: 65 Participants	Markandey Singh: Markandey Singh: D Dhyani, Sanat Sujat Singh and Raja Ram	
Demonstration-cum-training programme on "Cultivation and post harvest technology of commercially important cut flower crops", 22-24 June, 2011: 19 participants	Markandey Singh: Markandey Singh: D Dhyani, Sanat Sujat Singh and Raja Ram	 
Demonstration-cum-training programme on "Cultivation and post harvest technology of commercially important cut flower crops", 28-30 June, 2011: 22 participants	Markandey Singh: D Dhyani,Vipin Hallan, Sanat Sujat Singh and Raja Ram	

Details of the training	Coordinator:Team	Photographs
Demonstration-cum-training programme on "Cultivation and post harvest technology of commercially important cut flower crops", 6 September, 2011: 28 participants	Markandey Singh: D Dhyani,Vipin Hallan, Sanat Sujat Singh and Raja Ram	
Demonstration- cum-training on "Cultivation and post harvest technology of lilium" at village Jagla, Lahual & Spiti. 26 August, 2011:5 participants	Markandey Singh	
Demonstration- cum-training on "Cultivation and post harvest technology of lilium" at village Khining, Lahual & Spiti. 28 August, 2011: 4 participants	Markandey Singh	

Six hundred and three farmers and students visited the demonstration plots of commercially important cut flower crops at CSIR-IHBT.

CSIR-IHBT and other state departments along with local farmers participated in one day meeting on "Revival of floriculture of Kangra (HP)" held on 31 May, 2011 at Flower Faderation, Darang, Kangra (HP) organized by District Rural Development Agency (DRDA), Kangra (HP).

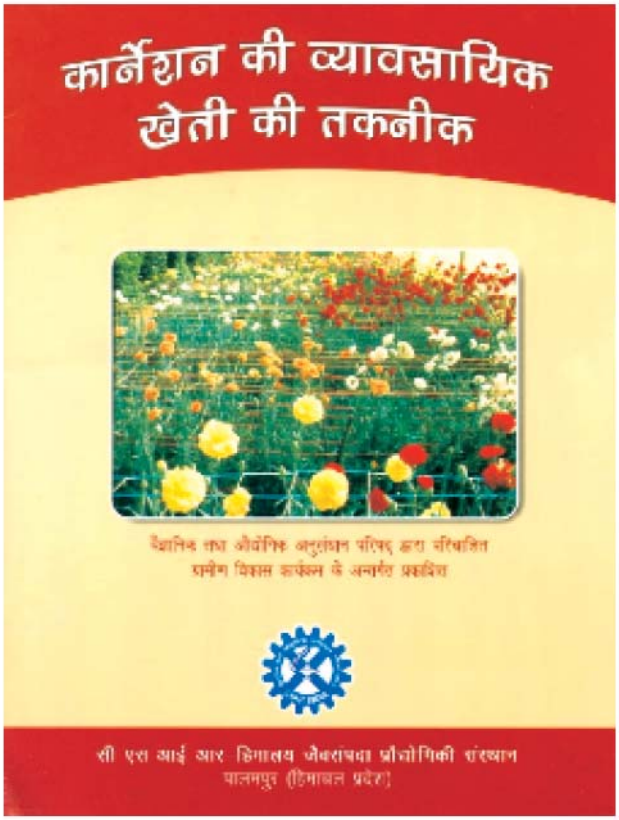
Exhibition participation

CSIR-IHBT participated and exhibited technologies in "Science & Technology Expo, 2011, 4th Destination, Himachal Pradesh, Dharmshala" from 2-4 June, 2011, organized by the Creative Centre for Rural Development (CCRD), New Delhi. More than 300 farmers and students visited the CSIR-IHBT stall and showed interest in commercial cultivation of flowers, medicinal and aromatic crops.

Holi mela exhibition was held at Pragati Maidan, Palampur during 5-9 March, 2012. CSIR-IHBT displayed its technologies like flowers, essential oils, bamboo charcoal, vanillin, tea products etc.

TECHNICAL BULLETIN

Technical bulletin published under CSIR-800 rural development programme.



MEDICINAL AND AROMATIC PLANTS

Major thrust was directed towards promotion of large scale cultivation of medicinal, aromatic and other high value crops under this activity. CSIR-IHBT provided complete packages of production technology from seed to primary product. New plantations of Damask rose were established in Kangra valley Himachal Pradesh and Uttarakhand on an area of more than 10 ha. Cultivation of rosemary, chamomile, muskbala and wild marigold was extended in Uttarakhand and Himachal Pradesh. A number of specialized and general trainings were conducted for skill enhancement and capacity building of the involved stakeholders in this sector.

Demonstration of *Curcuma* and *Hedychium* cultivation in agro-forestry system (RSP-0021)

Demonstration plots for cultivation of *Curcuma aromatica* and *Hedychium spicatum* in forestry system with community participation were laid at 5 locations *viz*.,Ahla (Dalhousie forest division, Chamba), Nayagram (Bharmour forest division, Chamba), Dhargala (Churah forest division, Chamba), Bagdhar (Dalhousie forest division, Chamba), and Billing (Uhl forest range, Kangra), covering a total 6.2 ha area.

The growth of crops at all the five demonstration plots was assessed during October-November 2011. The observations were recorded on plant density, plant height, number of tillers/hill and number of leaves per tiller of the crops.

The *C. aromatica* crop at Bagdhar (Dalhousie) and Dhargala (Salooni) demonstration plots did not show any improvement as compared to that observed in October 2010. At Billing demonstration plot, *Curcuma* could not withstand the micro-climatic conditions viz., dense forest growth and temperate climate.

At Ahla (Dalhousie) demonstration plot, there was no sprouting of *H. spicatum* crop in 2011. Thus, the crop has gradually disappeared as it could not withstand the low sun-shine hours and temperate micro-climatic conditions at Ahla. At Nayagram (Holi) and Billing demonstration plots, *Hedychium* crop showed no distinct improvement from the growth in October 2010. It appeared that the dense upper storey is not favourable for *H. spicatum* crop. In Dhargala, however, the growth of *Hedychium* was better at the spots getting sunlight for longer duration. In general, growth of the crop was better than that recorded last year at Dhargala. It was resolved that the crops can be harvested this year.

At Bagdhar and Dhargala demonstration plots, yield of the crop was assessed in February 2012. In general, weight of fresh rhizome from 10 plants of both crops, was recorded in three replicates, Samples of the rhizomes were taken for chemical analysis in lab.

Commencement of learning programme

A specialized 3 days awareness-cum-exposure camp was organized on cultivation and value addition of medicinal and aromatic plants during 13-15 October, 2011 at CSIR-IHBT, Palampur for

farmers from Purola, Uttarkashi (Uttarakhand) on call from District Management Unit-Livelihood Improvement Project for Himalaya, Purola and Uttarkashi. Nineteen farmers attended the programme.

The third specialized 7 days national technology demonstration-cum-training course was organized on cultivation and processing of medicinal and aromatic plants from 18-24 March, 2012. The specialized course was demanded by Indian Council of Forestry Research and Education, Dehradun (Uttarakhand) for 3 of their scientists.

A participant is giving his feedback on National Training Programme

Participant of group in National Training Programme

Specialized trainings

A specialized Training-cum-Orientation workshop was organized as per the demand of District Watershed Development Agency, Shimla (HP) for rural community participants from Theog Development Block of Shimla. Aim of this training was to extend the know-how on sustainable utilization of regional bioresources for enhancing livelihood options. The subject content dealt with medicinal, aromatic and floriculture plant production and utilization techniques. A total of 220 trainees were participated in 10 batches as per the following details:

Batch No.	Duration	No. of participants
1	November 21-23, 2011	26
2	November 28-30, 2011	20
3	December 12-14, 2011	21
4	December 19-21, 2011	24
5	December 27-29, 2011	24
6	January 03-05, 2012	24
7	January 18-20, 2012	15
8	February 01-03, 2012	23
9	February 14-16, 2012	20
10	March 13-15, 2012	23
Total		**220**

A farmer is expressing his learning during training

The opening session of the skill learning experience programme

A group of farmers is learning techniques for the establishment of *Ginkgo bioloba*

Training programme organised

Details of the training	Coordinator: Team	Date	No. of Participants
Training on "Prospects and issues of medicinal and aromatic crop production" and "Cultivation of muskbala (*Valeriana jatamansi*)", Production of major aromatic crops with emphasis on Damask rose and stevia.	Dr. R.D Singh	May 2, 2011	1
Training programme on "Processing of aromatic plants through distillation for production of essential oils"	Dr.Virender Singh	October 15, 2011	25
Two day training –cum-demonstration, on "Production of rose oil, rose water, *gulkand* etc.", was conducted for the public at Chandpur farm	Er. Garikapati Dyva Kiran Babu	April 27-28, 2011	18
Training program on "Production of major aromatic crops with emphasis on Damask rose and stevia cultivation."	Dr. Rakesh Kumar.	May 3-4, 2011	1 (Rishipora, Budgam, MD, Scion Herbal Extractor Pvt. Ltd. Kashmir, J & K)
A training program on "Processing of aromatic plants through distillation for production of essential oils"	Er. Garikapati Dyva Kiran Babu	October 15, 2011	25 farmers of Uttarakhand

Services Rendered

Rose-hip oil was extracted by Supercritical carbon dioxide. The samples were analyzed for a community based organization working towards enhancement of livelihood of poor rural women of Jagriti, Vill. Badah, PO Mohal, Distt. Kullu-175126 (HP) on trial basis for exploring its application/ potential use in cosmetic industry.

Details of other training programmes conducted on MAPs

Theme	Duration/ date	Participants	Venue
Production of major aromatic crops with emphasis on Damask rose and stevia cultivation	2-4.05.2011	Trainer from NGO (1 no.)	CSIR-IHBT
Open day exposure on Damask rose flower plucking and post harvest processing	27-28.04.2011	Local farmers (10 nos.)	CSIR-IHBT
Organic farming and propagation techniques of medicinal plants	15-17.09.2011	Farmers from different parts of HP (42 nos.)	R.I. in ISM Jogindernagar, Distt. Mandi-(HP)
	19-21.09.2011	Farmers from different parts of HP (27 nos.)	R.I. in ISM Jogindernagar, Distt. Mandi-(HP)
	26-28.09.2011	Farmers from different parts of HP (24 nos.)	R.I. in ISM Jogindernagar, Distt. Mandi- (HP)
Awareness and exposure on Medicinal & Aromatic Plants	01.11.2011	Farmers from J&K under NHM scheme (17 nos.)	CSIR-IHBT
	16.11.2011	Farmers from J&k under RKVY and NHM scheme (36 nos.)	CSIR-IHBT
	28.11.2011	Farmers under NHM scheme from Distt. Baramulla, J&K (45 nos.)	CSIR-IHBT

Distribution of seeds and planting materials of MAPs

Crop	Form of material supplied	Qty./No. distributed	Area equivalent (ha)	Location of supply (State)
Damask rose	Sapling (No.) Cutting	70639 320	7.06	HP, UK, Mizoram, Punjab, J&K
Stevia	Seedling(No.)	9287	0.188	HP, Punjab, UK, J&K, Delhi, Karnataka, Mizoram, Orissa
	Seed (kg)	4.155	8.30	
Ashwagandha	Plant (No.)	222	Garden	HP, Punjab
Lavender	Sapling (No.) Cutting	471	Nursery	HP, WB, Punjab, Mizoram
Wild marigold	Seed (kg)	17.1	5.7	HP, UK
Rosemary	Sapling (No.) Cutting	229 1000	Nursery	HP, UK, Mizoram, Punjab

Crop	Form of material supplied	Qty./No. distributed	Area equivalent (ha)	Location of supply (State)
Scented Geranium	Sapling (No.) Cutting	266	Nursery	HP, Mizoram, Punjab, UK
Aloe vera	Suckers/ plants	59	Garden	HP, Punjab
Ginkgo	Sapling (No.)	56	0.12	HP, Punjab, AP
Muskbala	Sapling (No.) Seed (kg)	5976	0.08	HP, UK
Eucalyptus citriodora	Seedling (No.)	55	Garden	HP
Baccopa monnieri	Seedling (Kg.)	2.5	Nursery	HP, Punjab
Jasmine	Seedling (No.)	35	Garden	HP, Punjab
Viola	Seedling (No.)	25	Nursery	Punjab
Taxus	Sapling (No.)	10	Garden	AP
Crataegus	Seed (Kg)	5kg	Nursery	UP

Demonstration of mobile essential oil distillation unit

A four day demonstration-cum-training on mobile distillation unit was imparted to farmers of Village Sarna, Distt. Gurdaspur (Punjab) during 28-31 May, 2011. Seven batches (200 kg each) of *Tagetes minuta* were distilled to produce 4.47 l oil with 0.32 % (v/w) yield.

Farmers operating the mobile essential oil distillation unit at Village Sarna, Gurdaspur (Punjab)

Demonstration-cum-training of mobile distillation unit on lavender distillation was imparted to farmers of Village Sei-Kothi (Tissa), Distt. Chamba (HP) during 23-25 June, 2011.

Farmers distilling the lavender crop on mobile essential oil distillation unit at Village Saikothi, Distt. Chamba (HP)

Utilization of locally available plant raw materials

Aescin production technology from *Aesculus* seeds was standardized at pilot scale with 1-2% yield. The purity of aescin was evaluated to be > 90 % by HPTLC.

Utilization of wild marigold (*Tagetes minuta*) for the production of essential oil was encouraged and demonstrated to the farmers/ entrepreneurs.

A lab scale process was standardized for production of lutein from *Tagetes erecta* with yield of 17% w/w. Standardization of production on pilot scale is under process.

Fatty acid composition of wild growing rose name *Rosa moschata*, *R. brunonii*, *R. multiflora* and *R. alba* was profiled by GCMS.

Science & Technology Expo-2011 was held at Community Hall, Dharamshala (HP) from 2-4 June 2011. Exhibits such as the mini distillation unit, essential oils, flowers, GEPROTED, plant virus detection kit (ELISA kit) etc. were displayed. DST, DRDO, Ministry of Environment and Forests, NGOs etc. participated.

Exhibition held at Agriculture Engineering Department, HPKV, Palampur on 16th November, 2011. The main focus of the exhibition was on showcasing of the engineering technologies. Truck mounted mobile distillation unit, tea plucking machine, pruning machines, mini distillation apparatus, steriflow etc. were displayed. The State Agriculture Department and many private engineering companies participated in the exhibition.

State-Level Children Science Congress (HP) exhibition was held at DAV Senior Secondary School, Una during 24-26 November, 2011. Truck mounted mobile distillation unit, essential oils, flowers, GEPROTED, plant virus detection kit (ELISA kit), tea products etc. were displayed. Science competition based on land resources was also judged by Dr. Neeraj Kumar and Mr. Sukhjinder Singh.

Virus tested planting material production technology for apple, plum and cherry (RSP 20)

In vitro culture establishment

In cultures of apple rootstock M9 and variety Lal Ambri, a minimum of 70% explants showed growth initiation after 25 days of inoculation. Links have been established with some tissue culture firms in Himachal Pradesh viz., Neva plantations (Gopalpur, Kangra), Rajat Biotech (Ghumarwin, Bilaspur), Monal Biotech (Una) for supply of planting material. MM106 apple rootstock (virus tested) was sold to the firms. About 90,000 plants were sold to farmers sufficient to cover 8-10 hectare area under apple orchards.

Development of Tube capture RT-PCR for detection of infecting viruses from *in vitro* apple cultures

A simple and easy protocol for the detection of viruses from *in vitro* apple cultures was developed.

In this protocol the need of extracting total RNA from the sample was eliminated. Using this protocol all the major known pathogens of apple viz. ASPV, ASGV, ACLSV, APMV and ASSVd were detected in a single multiplexed reaction. Starting from 500 mg of sample crushed in 5 ml PBS buffer (pH 7.4) amplicons corresponding to selected genomic portions of the above mentioned viruses were obtained up to dilutions of 20^{-6}.

Completion and handing over of tissue culture labs on turnkey basis

Two Commercial Tissue Culture Labs were set up on turnkey basis for the Departments of District Rural Development Agency, Mandi at Chauntra and another for the Haryana State Forest Department, Panchkula at Seonthi in Kurukshetra. Designs for the laboratory layout was provided, help was extended in equipping the laboratories, requisites personnel were trained and mother stock cultures were provided. Besides completing the work in both the laboratories to client satisfaction, help in trouble-shooting was provided from time to time. The total out-lay for the project at Chauntra Lab was Rs. 49,86,276/- and for that at Seonthi Lab was Rs. 35,27,341/-.

Tissue Culture Labs at Chauntra, Mandi

Tissue Culture Labs at Seonthi in Kurukshetra

Assistance to tissue culture units in HP

in vitro raised virus tested cultures of apple rootstocks were also supplied to the following tissue culture units in HP.

1. Rajat Biotech, Ghumarvin
2. Neva Plantations, Kangra
3. Kunal Biotech, Mandi

After mass multiplying the apple rootstock cultures these industries are providing hardened rootstocks to the farmers and nurserymen.

Promotion and utilization of bamboos

In order to show case the versatility of this remarkable bio-resource, a state of art bamboo museum covering an area of about 3,600 sq.ft. was built at CSIR-IHBT premises using the locally available bamboos, *D. hamiltonii*.

The design of the said museum was entrusted to a M/s SD Sharma Associates, Chandigarh. The construction work was executed by the Uttaranchal Bamboo and Fiber Board. A lot of effort was directed towards the selection and procurement of the suitable material for display in the museum.

Bamboo museum at CSIR-IHBT

Inner view of museum

Training on making bamboo candies

In order to pupolarise the nutraceutical virtues of bamboos like lowering of cholesterol in the blood, high proteins/fibers and low ash contents, novel edible products are being produced. In this context, a two day training to 10 women participants from the local NGOs already working on bamboo pickling were imparted training in 'How to make Bamboo Candies'? using the newly emerged shoots. The product had mint, ginger flavors and the Zonal Manger of UCO Bank Dharamshala placed an immediate supply order for 100 kg of the product for distribution during Dewali festival.

A view of candy making training

Bamboo candies

Monitoring of annual progress of CSIR- REWNET 800 projects

The fourth review meeting of was organised during May 30-31, 2011 at CSIR-IICT, Hyderabad for monitoring the annual progress of CSIR-800 on Rural, SC/ST, Women, North East & Tribal (RSWNET) Sector, under the chairmanship of Dr. PS Ahuja, Director, CSIR-IHBT. The investigators of 36 projects and Dr. PG Rao, the Cluster Director, and Mr. AK Kundalia, the head quarter representative participated.

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 यह संस्थान भारत सरकार की राजभाषा नीति के कार्यान्वयन एवं हिंदी भाषा के माध्यम से विज्ञान के प्रचार–प्रसार में सतत् प्रयासरत है। इस दिशा में संस्थान अपने अनुसंधान एवं विकास से संबन्धित 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 उद्यमियों तक पहुंचाने के लिए समाचारपत्रों, पत्रिकाओं, रेडियो तथा दूरदर्शन के माध्यम से राजभाषा हिन्दी 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 हिन्दी के माध्यम से किए जा रहे हैं। वर्ष 2011–12 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 शुरु करने का निर्णय लिया था। संस्थान की गतिविधियों, समारोहों तथा उपलब्धियों को जन–सामान्य की सूचना के लिए इसे प्रकाशित किया गया। इस क्रम में इसके अब तक 12 अंक संस्थान की वेबसाइट में उपलब्ध है।

वेबसाइट अद्यतनीकरण

संस्थान की हिन्दी वेबसाइट का अद्यतनीकरण किया गया तथा सामग्री को यूनिकोड किया गया और इसको संस्थान की वेबसाइट उपलब्ध कराया गया।

पुस्तकें, पत्रिकाएं एवं संदर्भ सामग्रियों को उपलब्ध कराना

राजभाषा विभाग, भारत सरकार एवं परिषद् मुख्यालय द्वारा समय–समय पर जारी निर्देशों के अनुरूप हिन्दी में कार्य करने के लिए उचित वातावरण बनाने और राजभाषा हिन्दी में मूल रूप से कार्य करने को प्रोत्साहित करने के लिए हिन्दी में प्रकाशित सहायक सामग्रियों जैसे पुस्तकें, कोश, पत्रिकाएं और अन्य संदर्भ साहित्य संस्थान में उपलब्ध करवाया जाता है।

संस्थान में वैज्ञानिक एवं सामान्य विषयों पर विभिन्न हिन्दी पत्रिकाओं को उपलब्ध कराया गया है। इसके अतिरिक्त विभिन्न प्रयोगशालाओं/संस्थानों द्वारा प्रकाशित पत्रिकाओं को भी संस्थान में उपलब्ध कराया गया।

वैज्ञानिक प्रशिक्षण

32 वैज्ञानिक प्रशिक्षण कार्यक्रम मिली–जुली भाषा में आयोजित किए गये। 10 तकनीकी मैनुअल मिली जुली भाषा में तैयार किए गए।

प्रशिक्षण एवं संगोष्ठी में प्रतिभागिता

वरिष्ठ अनुवादक श्री संजय कुमार ने 27 फरवरी–3 मार्च, 2012 तक केन्द्रीय अनुवाद ब्यूरो, गृह मंत्रालय, भारत सरकार, नई दिल्ली में उच्चस्तरीय अनुवाद प्रशिक्षण पाठ्यक्रम में प्रतिभागिता की, ताकि संस्थान में

राजभाषा नीति के अनुपालन को गति प्रदान की जा सके। वैज्ञानिक तथा तकनीकी शब्दावली आयोग, भारत सरकार के स्वर्ण जयंती वर्ष के उपलक्ष में विज्ञान भवन, नई दिल्ली में 27–29 अप्रैल 2011 को आयोजित 'भारतीय भाषाओं में तकनीकी शब्दावली का विकास' विषय पर राष्ट्रीय संगोष्ठी में संस्थान की ओर से वरिष्ठ अनुवादक श्री संजय कुमार ने प्रतिभागिता की, ताकि संस्थान की वैज्ञानिक व तकनीकी सामग्री को हिंदी भाषा में उपलब्ध कराया जा सके।

लोकप्रिय विज्ञान लेखन तथा प्रकाशन

संस्थान की ओर से इस अवधि में 4 लोकप्रिय विज्ञान लेख ''विज्ञान प्रगति' पत्रिका में तथा कुछ लेख दैनिक समाचार पत्रों में प्रकाशित हुए। 'कार्नेशन की व्यावसायिक खेती की तकनीक' पर एक हिंदी में तथा 'सेब, आलूबुखारा एवं चेरी के फलों के विषाणु और वायरायड रोगों का प्रबन्धन' पर द्विभाषी तकनीकी ब्रोशर तैयार किए गए।

दूरदर्शन वार्ता

वर्ष के दौरान दूरदर्शन के शिमला केन्द्र से कृषि दर्शन कार्यक्रम के अन्तर्गत 10 वार्ताएं प्रसारित हुईं। इन वार्ताओं के मुख्य विषय इस प्रकार हैं: गुणवत्तायुक्त परम्परागत काली चाय का उत्पादन; जिनकों बाइलोबा का महत्व, पौधशाला एवं उत्पादन; केसर की खेती; औषधीय एवं सगंध पौधों की खेतीः पूर्व स्थिति एवं भविष्य के लिए संभावनाएं; उतर पश्चिमी हिमाचल क्षेत्र में बड़ी इलाइची की खेती; बांस : ग्रामीण विकास का आधार; गुणवत्ता युक्त चाय उत्पादन के लिए बागानों में सर्द ऋतु में किए जाने वाले कार्य; मूल्यवर्धित उत्पाद सेब अवशेष का उपयोग; हिमाचल प्रदेश के दूर्गम एवं कठिन स्थलों में बीज पेलेटिंग तकनीक द्वारा पुनः स्थापन और बेहतर उत्पादकता के लिए विषाणुमुक्त रोपण सामग्री तैयार करना।

हिंदी दिवस समारोह

संस्थान में हिन्दी दिवस समारोह के अन्तर्गत 14 सितम्बर 2011 को निदेशक महोदय ने सभी स्टाफ सदस्यों को कार्यालय में हिंदी में कार्य करने का संदेश दिया। हिन्दी सप्ताह के अन्तर्गत वैज्ञानिकों एवं तकनीकी कर्मचारियों के लिए हिन्दी में लोकप्रिय विज्ञान लेखन, प्रशासनिक कर्मचारियों के लिए हिन्दी टिप्पण एवं पत्र लेखन एवं स्थानीय ग्रामीण क्षेत्र के विद्यालयों के विद्यार्थयों के लिए वाद–विवाद प्रतियोगिता का आयोजन किया गया। सभी प्रतियोगिताओं के विजेताओं को प्रथम पुरस्कार के रूप में 1000 रुपये, द्वितीय पुरस्कार के रूप में 700 रुपये तथा तृतीय पुरस्कार के रूप में 500 रुपये तथा प्रमाणपत्र प्रदान किया गया। इसके अतिरिक्त हिन्दी टिप्पण प्रोत्साहन योजना के अन्तर्गत भी कर्मचारियों को पुरस्कृत किया गया।

वाद–विवाद भाषण प्रतियोगिता

आई.एच.बी.टी. में शायरों और गायकों का संवाद

संस्थान ने दिनांक 6 सितम्बर 2011 को हिमाचल कला संस्कृति भाषा अकादमी, शिमला के साथ मिलकर संस्थान में ''गज़ल की एक शाम'' कार्यक्रम का आयोजन किया। कार्यक्रम का उद्घाटन संस्थान के निदेशक डा. परमवीर सिंह आहूजा ने दीप प्रज्वलन के साथ किया। अपने संबोधन में डा. आहूजा ने कहा कि वैज्ञानिक भी कलाओं का सान्धिय चाहते हैं तथा रोजमर्रा की जिन्दगी से कुछ लम्हे निकाल कर इस प्रकार के कार्यक्रमों से तरोताजा होकर अपने दैनिक काम–काज में गति ला सकते हैं। अकादमी के सचिव डा. तुलसी रमण ने सभी कलाकारों का परिचय करवाया तथा अकादमी की गतिविधियों की जानकारी भी प्रदान की। उन्होंने बताया कि अकादमी के इस कार्यक्रम का उद्देश्य न केवल मनोरंजन, अपितु शायरों और गज़ल गायकों को परस्पर संवाद करने के लिए मंच प्रदान करना भी है। यह अपने आप में प्रदेश स्तर पर पहला प्रयास था।

इस आयोजन को दो सत्रों में बांटा गया। पहले सत्र में प्रदेश के हिंदी, उर्दू, पहाड़ी के गज़लकार प्रो. ओम अवस्थी, चन्द्ररेखा डढवाल, द्विजेन्द्र द्विज, जाहिद अबरोल, नवनीत शर्मा, पवनेन्द्र पवन तथा प्रीतम आलमपुरी ने अपनी गज़लें प्रस्तुत की। दूसरे सत्र में गज़ल गायक के रूप में श्री प्रवीण जरेट, सुश्री कृतिका ने अपनी गज़लों से समां बांधा। कार्यक्रम का संचालन सुप्रसिद्ध शायर श्री नवनीत शर्मा ने 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। संस्थान में विभिन्न गतिविधियों को जन–सामान्य की सूचना के लिए समय–समय पर हिंदी में प्रकाशित होन वाले समाचार पत्रों में प्रकाशित कराया गया। इसके साथ ही संस्थान द्वारा आयोजित किए जाने वाले विभिन्न समारोहों जैसे सतर्कता जागरुकता सप्ताह, कौमी एकता सप्ताह, सद्भावना दिवस, कार्यशालाओं के आयोजनों, निमंत्रण पत्र, विज्ञापन, प्रेस नोट आदि को तैयार करने में भी अनुभाग ने सक्रिय योगदान दिया।

FACILITIES AND SUPPORT SERVICES

State of the Art Processing Facilities for Extraction

A nutraceutical pilot plant facility was created to house chemical processing units used for upscalling the processes developed on laboratory scale to pilot scale for techno-economical evaluation of technologies. Mostly green processes are being employed for the extraction and production of natural products from plant (botanicals), which includes high intensity natural sweeteners, natural colours and dyes, pharmaceutical drugs etc. The equipments used in different unit operations are of multipurpose and generic in nature such as water purification unit capacity 250 lit/h, basket-type centrifuge machine, capacity 48 inch dia., sparkler-type filtration units, capacity 24 inch dia. x 18 Nos., essential oil fractional distillation unit, capacity 10 lit/batch, essential oil mobile distillation unit, capacity 200 kg/batch etc.

Basket type centrifuge

Water purification system

Sparkler type filterpress

Engineering Services Unit

Bamboo Museum

To highlight the importance of bamboo, a unique museum with a total plinth area of 400 sqm was constructed in the campus using bamboo as the building material. The walls, roof and the floors of the museum are made of treated bamboos and bamboo panels. The opening in the ceiling is aesthetically fitted with fiberglass to allow sunlight for natural lighting. The articles and products made of bamboos are displayed in the museum.

Studio for Computational Biology & Bioinformatics (SCBB)

The centre has specialisation in next generation sequencing, genomics and noncoding biology, regulomics, computational epigenomics and parallel computing, all with proven expertise at national level. The centre is conscidered among the few expert groups in the area of NGS and non-coding biology. Besides this, the centre has made a mark for being a central player in several inter-institutional collaborative projects including Ayurgenomics. At present the Studio is equipped with several high performance workstations and two high performance servers and one storage system.

Project Planning, Monitoring & Evaluation Cell

- Facilitated in compilation and strengthening of XIIth Five Year Plan Projects.
- Compiled information for CSIR Annual Reports. Significant achievements of the institute were sent to CSIR HQ on monthly basis.
- A web based system was designed for NABL customers for downloading sample analysis report. Also, designed a system for internal record keeping and tracking of test samples received under NABL.
- A new feature was added into the "scientist login" in Intranet facilitating each scientist to view their project details including patents, publication, progress report, utilization certificate, equipments sanctioned etc.
- As per CSIR Open Access Policy, Institutional Repository of the CSIR-IHBT was developed and hosted at Central Harvester maintained by URDIP. The repository has information of all the full length papers published in last 10 years, granted patents and project reports carried out by trainees.
- Carried out monitoring of institutional performance w.r.t. publication, ECF, patent and technology transfer. Also, implemented ISO 9001:2008.
- Facilitated resource monitoring for smooth implementation of projects.
- Supported the Directorate in convening strategic meetings and discussions for strengthening research and forging new collaborations.
- As a part of routine activity, carried out maintenance of database and regularly updated information pertaining to project, staff, paper, patent, ECF, royalty, MoU etc.
- Prepared cases for distribution of royalties and intellectual fees.
- Conducted 47th meeting of the Research Council of the institute on 17th December, 2011 at Delhi.
- Handled queries of about 250 students for project training and also facilitated the training of 38 students (winter and summer trainees) in different divisions of the institute.
- Arranged visit of over one thousand school, college and university students to popularize science among them.
- Focused on the use of Hindi by preparing notices, circulars in Hindi and furnishing replies in Hindi to category "A" states.
- Furnished information on 18 cases under RTI Act and filed quarterly report to RTI portal www.rti.gov.in.

- Organized the celebrations of National Technology Day, CSIR-IHBT Foundation Day, CSIR Foundation Day and National Science Day.
- Organized CSIR programme on Youth for Leadership in Science (CPYLS) for 50 students during 24-25, January 2012.
- Under DBT sponsored project entitled Establishment of bioinformatics infrastructure facility for biology teaching through bioinformatics (BIF-BTBI) under the BTISnet the bioinformatics facility was created and A "Workshop on Network Biology" was organized during 30-31st March, 2012. Fifteen participants along with guest faculties participated in the training.
- Regularly updated the informations in CSIR-IHBT website and intranet.

CSIR-IHBT-Knowledge Resource Centre (CSIR-IHBT-KRC)

Library continued to support all research and academic activities of the institute. It played significant role in facilitating creation and dissemination of knowledge by providing a range of services including reference and consultation, circulation, document delivery, resource sharing, information alert, user awareness using ICTs for web based library management and services.

Information on impact factor of journals, publishers' guidelines to authors and publishing policy of journals were communicated to S&T staff for deciding on journals for publication of their research articles. Citation reports on research papers and authors were prepared and provided on demand.

Collection development: Collection is one of the major functions of the library that supports research and academic projects of the scientists, scholars, students, staff and other users. Books, journals, theses, reports, standards and other reading material in science and technology were added to existing library collection. A committee including scientists visited the International World Book Fair, Pragati Maidan, New Delhi during March 1-2, 2012. Several publications relevant to the research and education activities of the institute were selected and procured. The library was enriched with new additions of 253 scientific and technical books.

Current awareness and up-keeping: A list of new additions of books, journals, reports etc. were prepared and made available on the library home page. Library has developed a system of sending email alerts to members for overdue documents, announcement on new arrivals and latest information of interest. Besides these services, the necessary care was also taken to facilitate users to locate the desired document.

Web site and eResources: Library has its own homepage (http://library.ihbt.res.in) and provides web-based access to its resources. As a result, CSIR-IHBT staffs can access over 4500 electronic journals and databases in biological and chemical sciences under NKRC of CSIR-DST Consortium in addition to 155 journals in print mode. The library is a part of the institute-wide network and has adequate computing infrastructure to cater to the needs of the users.

On-line catalogue: The On-line Public Access Catalogue (OPAC) is accessible round the clock via the link on library web site. It allows on-line reservation, renewal and recommendation for new titles, besides indicating status of a particular document. It is searchable by keywords, author, title, accession number, subject etc.

Reference, referral and documentation: Reference service was provided to users in locating information or document of their choice. More than 6960 visitors including scientists, students, research scholars, faculty members from several academic and R&D institutions consulted library resources. The library loaned 1564 books and other documents to its members during the year. Photocopying/ laser printing service was one of important services offered by the library and provided more than 3 lakhs of pages of photocopies/ printing to the scientists, research scholars and staff of the institute.

User orientation: Orientation to new users on access of online journals and databases was provided enabling them to use resources more widely and effectively.

Computer Cell

CSIR-IHBT has campus wide network facilities for more than 280 data nodes over the fiber backbone, wi-fi, videoconferencing, with a fleet of servers from HP and IBM. Dedicated 1Gbps leased line under the National Knowledge Network was provided for internet facility throughout the campus including hostel and faculty residences. Network security hardware like Unified Threat Management Solutions, IDS, IPS, Centralized Anti-Virus on client server based model and SMTP spam/virus protection software etc, and its policies have been deployed to protect CSIR-IHBT e-resources centrally.

Constant support was lent for in-house management of DNS (Domain Name Server), WEB, Email and Proxy servers on Linux. Also facilitated Video-Conferencing with CSIR and other labs.

The cell also constantly extends services related to network, computers and peripherals over Local Area Network in the campus.

Photography Unit

This unit provides comprehensive photographic and videography services to all the scientists and scholars of the institute. It includes recording of research results both in the labs as well as in the demonstration plots.

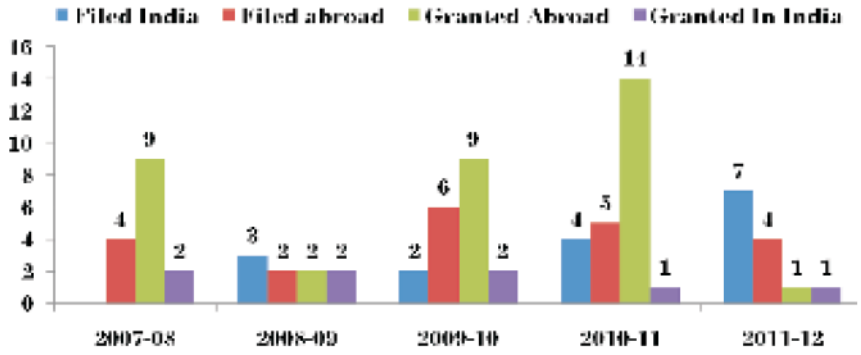
Photographic images including photographs of field trials at different intervals as well as special video graphs of field experiments were collected and preserved. Besides providing direct support to research and development, the unit covered activities relating to official functions, trainings, workshops, conferences and symposia organised in the institute.

It also catered to different requirements for television programmes by scientists depicting their field & lab activities, demonstration/ experimental plots and field surveys along with interviews with farmers and entrepreneurs on technologies provided by CSIR-IHBT.

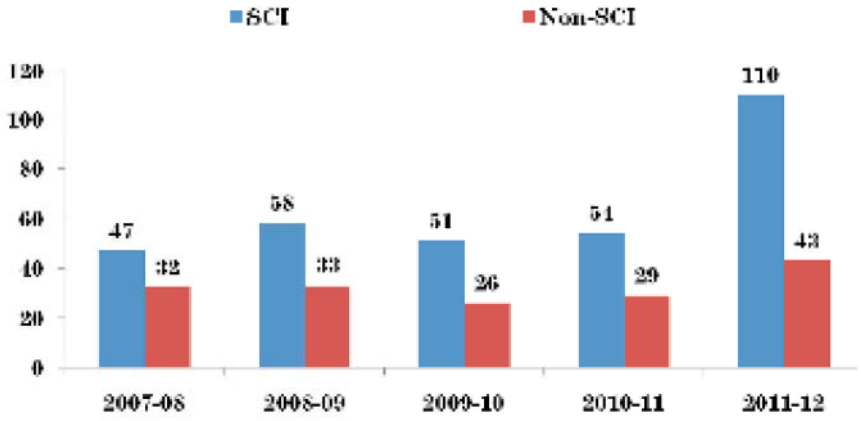
The unit contributed significantly towards designing of the cover page of annual reports, brochures of processing technologies, in-house magazine "Manthan", book on tissue culture, banners & certificates to the participants of various trainings, workshops, conferences, symposia, invitations & greeting cards, posters of research activities and labels for lab products.

PATENTS, PUBLICATIONS, HUMAN RESOURCES AND PUBLICITY

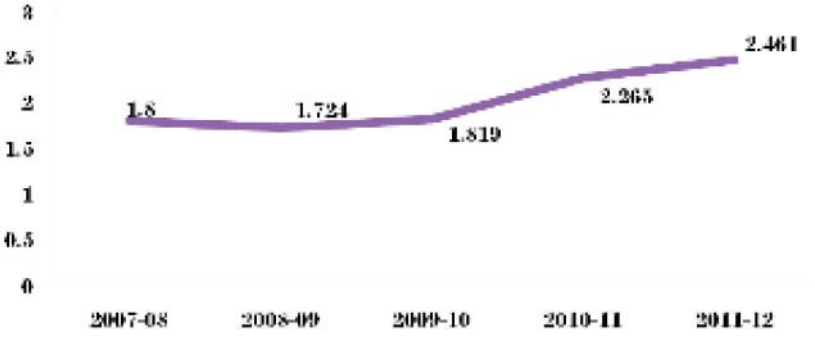
PATENTS



PUBLICATIONS



IMPACT FACTOR



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PATENT FILED

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Arun Kumar, Som Dutt, Paramvir Singh Ahuja and **Sanjay Kumar:** An autoclave stable recombinant Cu/Zn superoxide dismutase with enhanced thermoflexibility, 0050NF2011/IN dated 11/4/2011

Bikram Singh, Suvro Chatterjee, Neeraj Kumar and **Upendra Sharma:** N-substituted phthalimide derivatives as potential angiogenesis inhibitors, 0051NF2011/IN dated 05/08/2011

Harsh Pratap Singh and **Ajay Rana:** An economical process for purification of bio amino acids, 0135NF2011/IN dated 10/02/2012

Harsh Pratap Singh and **Ajay Rana:** An improved process for the selective production of theaflavin digallates, a method for enhancing status of carbon, nitrogen, biomass and yield of plants, 0058NF2011/IN dated 12/08/2011

Shashi Bhushan, Sakshi Gupta, Garikapati Dyva Kiran Babu, Mohit Sharma and **Paramvir Singh Ahuja:** Method and apparatus for the separation of seeds from fruit pulp/ slurry/ pomace. Patent Application No. 3175DEL2011/IN dated 09/11/2011

Vijai Kant Agnihotri, Bikram Singh, Garikapati Dyva Kiran Babu, Gopi Chand, Rakesh Deosharan Singh and **Paramvir Singh Ahuja:** Process for development of value added fragrances from *Curcuma aromatica* essential oil, 0866/DEL/2011 dated 15/12/2011

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Arun Kumar Sinha, Abhishek Sharma, Rakesh Kumar and **Naina Sharma:** Microwave induced single step green synthesis of some novel 2-Aryl Aldehydes and their analogues, 0091NF2008/US dated 24/08/2011

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Abhishek Sharma, Arun Kumar Sinha, Rakesh Kumar and **Naina Sharma:** One pot multicomponent synthesis of hydroxy stilbene derivatives under microwave irradiation, 0090NF2008/US dated 28/09/2011

PATENT GRANTED

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Sud RK (2012) Recent advances and future strategies for management of tea diseases, In: Second National workshop on "Plant protection in tea", TRA Kolkata, February 21.

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Yadav AK, Singh S and **Arya RK** (2012) Disease problems in Stevia- An overview. In: Seminar on "New perspectives in aromatic and medicinal plants", organized by MAUUP Section, Department of Genetics and Plant Breeding, CCS HAU, Hisar, February 8-9.

Yadav PK, Kumar P and **Chawla A** (2012) Vegetation cover mapping of Lahaul valley using remote sensing and GIS, In: National seminar on "Plant biodiversity: retrospect and prospects", Government PG College, Dharamshala, February 25-26.

दूरदर्शन केन्द्र शिमला द्वारा प्रसारित कृषि दर्शन कार्यक्रम के अन्तर्गत

विषय	दिनांक	विशेषज्ञ
गूणवत्तायुक्त परम्परागत काली चाय का उत्पादन	19.04.2011	डा. आर. के. सूद
जिन्कगो बाइलोबा का महत्व, पौधाशाला एवं उत्पादन	06.05.2011	डा. गोपीचन्द
केसर की खेती	25.05.2011	डा. मधु शर्मा एवं डा. आर. के. सूद
औषधीय एवं सगंध पौधों की खेतीः पूर्व स्थिति एवं भविष्य के लिए संभावनाएं	25.08.2011	डा. वीरेन्द्र सिंह एवं डा. आर. के. सूद
उतर पश्चिमी हिमाचल क्षेत्र में बड़ी इलाइची की खेती	30.08.2011	डा. आर. के. सूद
बांस : ग्रामीण विकास का आधार	19.01.2012	डा. अनिल सूद
गुणवत्ता युक्त चाय उत्पादन के लिए बागानों में सर्द ऋतु में किए जाने वाले कार्य	20.01.2012	डा. आर. के. सूद
मूल्यवर्धित उत्पाद सेब अवशेष का उपयोग	13.02.2012	डा. शशी भूषण एवं डा. परमवीर सिंह आहूजा
हिमाचल प्रदेश के दुर्गम एवं कठिन स्थलों में बीज पेलेटिंग तकनीक द्वारा पुनः स्थापन	09.03.2012	डा आर. के. ओगरा
बेहतर उत्पादकता के लिए विषाणुमुक्त रोपण सामग्री तैयार करना	23.03.2012	डा. विपन हल्लन एवं डा. राजा राम

AWARD/ HONOUR/ RECOGNITION

Award

Dr. P.D. Sethi Award-2011: N Sharma, UK Sharma, AP Gupta and **AK Sinha;** for the best HPTLC Research paper entitled "Simultaneous determination of epicatechin, syringic acid, quercetin-3-O-galactoside and quercitrin in the leaves of *Rhododendron* species by using a validated HPTLC method", (*J. Food Comp. Anal.*, 2010, 23, 214-219).

Best poster award

R Kumar, Saima, A Shard, N Sharma, R Kumar and **AK Sinha: Best poster award,** entitled "Metal and base free Activation of H_2O_2: A synergistic blend of Ionic. Liquid with biocatalyst/microwave for the Oxidation of Aryl alcohol derivatives", Chemical Research Society of India (CRSI), North Zone Meeting, University of Jammu, September 22-24, 2011.

Nominated Member

Dr. Anil Sood: Nominated member of Board of Studies (Biotechnology), HP University, shimla, w.e.f 20-04-2011

Dr. Anil Sood: Nominated member of Executive Body of the Vanaspati Van Society, HP, under the Dept. of Ayurveda, Govt. of HP, Shimla.

Dr. PS Ahuja: Nominated member of Governing Body of the Vanaspati Van Society, HP. functioning under the Dept. of Ayurveda, Govt. of HP, Shimla.

Dr. RK Sud: Nominated Member of National Working Group on Plant Protection in Tea (NWPPT).

Dr. SK Vats: Member working group on National Mission on Himalayan Eco-system, Department of Environment, Science and Technology, Govt. of Himachal Pradesh. Env., S&T(F).

Dr. Sanjay Kumar: Invited by the scientific organizing committee for XVIII International Botanical Congress-2011 to contribute to developing a proposal for the symposium on "Plants in human health" and to deliver a talk, held in Melbourne, Australia during July 23-30, 2011.

Dr. Sanjay Kumar: Member working group on National Mission on Himalayan Eco-system, Department of Environment, Science and Technology, Govt. of HP, Env., S&T(F).

Dr. SK Uniyal: Member of the curriculum development committee of the Central University, Himachal Pradesh for formulating the syllabus of M. Sc. Environmental Sciences, June 23-24, 2011.

Chief Guest

Dr. PS Ahuja: Chief guest, INSPIRE Seminar, CSK HPKV, Palampur (HP), June 27, 2011.

Dr. PS Ahuja: Chief guest, INSPIRE Internship Camp, CSK HPKV, Palampur (HP), October 18, 2011.

Dr. PS Ahuja: Chief guest, National seminar, GGSDS College, Rajpur, Palampur (HP), Decemebr 16-17, 2011.

Chaired in Conference/ Seminar/ Meeting

Dr. AK Sinha: Co-chaired a session at the National Conference on Seabuckthron: Emerging Trends in R & D on Health Protection & Environmental Conservation, CSK HPKV, Palampur, HP, December 1-3, 2011.

Dr. Bikram Singh: Chaired a technical session in "Green Processes with Hyphenated Techniques for Analysis of Natural Products and Catalytic Synthetic Methods Development", In: International symposium on " Recent advances in green chemistry and chromatographic techniques", Manav Rachna International University, Faridabad, January 12-14, 2012.

Dr. Brij Lal, **Dr. Alka Kumari** and **Dr. Som Dutt:** Chaired three separate sessions of the National Seminar on "Plant Biodiversity: Retrospect and Prospects", Government PG College, Dharamshala, HP, February 25-26, 2012.

Dr. Madhu Sharma: Chaired a session on "Stress Tolerance and Plant tissue Culture" at National Symposium on "Impact of plant tissue culture on advances in plant biology", 33rd PTCA (I) Annual Meet, St. Xavier's College, Ahmedabad, January 19-21, 2012.

Dr. PS Ahuja: Chaired the meeting on "Priority areas for tea research for 12th five year plan", Tea Board of India, Kolkata, September 29, 2011.

Evaluator/ Judge

Dr. Amita Bhattacharya: Judge for poster presentations of graduate and post-graduate students at National Symposium on Impact of Plant Tissue Culture on Advances in Plant Biology, 33rd PTCA (I) Annual Meet, St. Xavier's College, Ahmedabad, 19th to 21st January, 2012.

Dr. V Shanmugam: Chief Evaluator for best young researchers presentations, National Symposium on "Biology of infection, immunity and diseases control in pathogen- plant interaction", University of Hyderabad, Hyderabad, December 2-4, 2011.

Felicitation by CSIR-IHBT

Dr. AK Sinha: Felicitation by CSIR-IHBT on National Science Day (28 Feb. 2012) for publishing a paper in international journal of high repute (Angew. Chem. Int. Ed. with I.F. 12.74)

THESIS/ DISSERTATION/ REPORT SUPERVISED

Ph.D. Awarded

Awardees	Title of Thesis	Supervisor	University/ Institute
Nandini Sharma	Chemical and biotransformation studies of some bioactive phenolics and heterocyclic compounds	Dr. AK Sinha	GNDU, Amritsar
Naosekpam Ajit Singh	Molecular cloning, expression and characterization of chitinase from Antagonistic *Pseudomona putida* trevisan	Dr. V Shanmugam	GNDU, Amritsar
Pamita Bhandari	Studies on bioactive phytochemicals from Bacopa, Picrorhiza and Swertia sp. and synthetic modifications of major constituents	Dr. Bikram Singh	HP University, Shimla
Vikas Jaitak	Chemical investigation of medicinal and aromatic plants and synthetic modifications of organic molecules by chemical and enzymatic processes	Dr. VK Kaul	GNDU, Amritsar
Pankaj Bhardwaj	Development of molecular markers for evaluation of genetic diversity in *Camellia sinensis* (L.) O. Kuntze	Dr. Ram Kumar Sharma	PU, Chandigarh
Pradeep Kumar	Bioprospecting low temperature related genes from the flora of western Himalayas	Dr. Sanjay Kumar	PU, Chandigarh
Prashant Mohanpuria	Studies on expression and silencing of caffeine synthase in *Camellia sinensis* (L.) O. Kuntze	Dr. Sudesh Kumar	GNDU, Amritsar
Pratibha Vyas	Selection and biodiversity analysis of plant growth promoting Rhizobacteria from the cold desert of Lahaul and Spiti	Dr. Arvind Gulati	GNDU, Amritsar
Rakesh Kumar	Green synthesis of bioactive phenolics employing ionic liquids and microwave assisted approaches	Dr. AK Sinha	GNDU, Amritsar
Tanuja Rana	Molecular characterization and diagnostic development for *Apple Chlorotic leaf spot virus*	Dr. AA Zaidi	GNDU, Amritsar
Tejpal Gill	Expression analysis and performance of certain genes encoding antioxidant enzymes in *Arabidopsis thaliana*	Dr. PS Ahuja	GNDU, Amritsar

Awardees	Title of Thesis	Supervisor	University/ Institute
Upendra Kumar Sharma	Chemical investigation of some biologically active natural and non-natural Phenolics (C_6-C_1 to C_6-C_3 employing green methodologies	Dr. AK Sinha	GNDU, Amritsar
Yogesh Kumar	Genome organization and mechanism of RNA silencing suppression of *Begomoviruses* infecting some solanaceous crops	Dr. Vipin Hallan	GNDU, Amritsar

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

Awardees	Title of Thesis/ Dissertation/ Project	Supervisor	University/ Institute
Abhishek Gandhi	Quantification, purification and characterization of phytoconstituents from *Allium caroliniannum, Elaegnus umbellata* and *Rosa webbiana*	Dr. Ashu Gulati	Gyan Vihar School of Pharmacy, Jaipur
Akriti Sharma	Epigenetic pattern of a drought sensitive and a resistant variety of Horsegram (Macrotyloma uniflorum)	Dr. Sudesh K Yadav	Baba Ghulam Shah Badshah University, Rajouri
Anu	Diagnostic technique to detect plant virus	Dr. Vipin Hallan	Punjabi University, Patiala
Arti	Pesticide residue analysis in tea and apple using gas chromatography	Dr. Yogesh B Pakade	PU, Chandigarh
Ayushi Verma	Production purification of a-Amylase from paenibacillus GTPB4 and its gene cloning	Dr. Som Dutt	NIT Karnataka, Surathkal
Bharat Bhushan	Diagnostic technique to detect plant virus	Dr. Vipin Hallan	GNDU, Amritsar
Bharti Sharma	Characterization of promotor trap lines in *Arabiopsis thaliana* (L.)	Dr. Y Sreenivasulu	Baba Ghulam Shah Badshah University, Rajouri
Chandni Sidhu	MSAP: A tool to evaluate DNA methylation in horsegram	Dr. Sudesh K Yadav	GNDU, Amritsar
Daljeet Kour Walia	Information transfer mechanisms within protein structures	Dr. Ganesh Bagler	GNDU, Amritsar
Deepika Nag	Selection and characterization of microbes antagonistic to a fungal pathogen of *Stevia rebaudiana*	Dr. V Shanmugam	PU, Chandigarh
Divya Gupta	Chemical investigation of essential oil of *Eucalyptus cinerea*	Dr. Vijay K Agnihotri	Dr. BR Ambedkar NIT, Jalandhar
Geetika Verma	Cloning of partial gene fragment of apple into T&A cloning vector	Dr. Gopaljee Jha	Punjabi University, Patiala
Gurinder Kour	Refinement of microRNA target prediction using NK cells mediated cytotoxicity pathway	Dr. Ravi Shanker	GNDU, Amritsar
Jatinder Pal Singh	Basic techniques in molecular biology	Dr. Y Sreenivasulu	GNDU, Amritsar
Minakshi Puri	Microbiology: Tool and techniques	Dr. Ramesh C Kasana	PU, Chandigarh
More Prashant Digambar	Genome organization and infectious clone construction of a *Geminivirus* causing yellow vein mosic in Okra	Dr. Vipin Hallan	CSK HPKV, Palampur

Awardees	Title of Thesis/ Dissertation/ Project	Supervisor	University/ Institute
Neha Agarwal	Investigation of antioxidants from *Emblica officinalis*	Dr. Partha Ghosh	BIS College of Pharmacy, (Gagra)
Parul Chadha	Profiling of ginger rhizosphere microbial communities as a strategy for rhizome rot biocontrol	Dr.V Shanmugam	PU, Chandigarh
Piyush Kumar	Remote sensing and ecological studies in Lahaul valley, western Himalaya, India	Dr. Amit Chawla	BHU,Varanasi
Priya	Approaches for management of serious plant pathogens	Dr.V Shanmugam	GNDU, Amritsar
Sakshi Chawla	Diagonostic techniques for plant virus	Dr.Vipin Hallan	Thapar University, Patiala
Sashi Kant Sharma	Isolation characterization and quantification of some natural phenolics: Evaluation of antioxident activity	Dr. AK Sinha	Rayat Institute of Pharmacy, Railmajra, Ropar(Punjab)
Shabnam Rajput	Molecular characterization of transgenic tea, *Camellia sinensis* LO Kuntze	Dr. Amita Bhattacharya	Baba Ghulam Shah Badshah University, Rajouri
Sheezan Rasool	To study the performance of transgenic plants (*Nicotiana benthamiana*) expressing stress related gene (MYB)	Dr. Sanjay Kumar	Baba Ghulam Shah Badshah University, Rajouri
Shipra Singh	Expression and purification of recombinant superoxide dismustase	Dr. Sanjay Kumar	Thapar University, Patiala
Shivani,	Polyphasic characterization of thermophilic bacteria from hot water springs of north-westeren Himalayas.	Dr. Arvind Gulati	GNDU, Amritsar
Shreya Sood	An introduction to microRNA prediction next generation sequencing basics	Dr. Ravi Shankar	PU, Chandigarh
Simmi Badgal	Validation of genomic SSR markers in tea	Dr. Ram Kumar Sharma	GNDU, Amritsar
Sonia Virk	Characterization of novel SSR markers derived from enriched genomic libraries in tea	Dr. Ram Kumar Sharma	Punjabi University, Patiala
Subhash Chand Verma	Molecular characterization and infectious clone construction of viroids infecting commonly important crops of Himachal Pradesh	Dr.Vipin Hallan	CSK HPKV, Palampur
Sukhpal	Diversity analysis of thermophilic bacteria from hot water springs of Himachal Pradesh	Dr. Arvind Gulati	PU, Chandigarh
Tanuja Kumari,	Screening of bacterial isolates for industrially important enzymes	Dr. Ramesh C Kasana	Mody Institute of Technology and Science, Sikar, Rajasthan
Vinay	Studies on polyphenols from *Juglans regia*	Dr. Partha Ghosh	Dr. BR Ambedkar NIT, Jalandhar
Yuvraj Ghaly	Role of long-range interactions in inteins and ankyrin-repeat proteins using network analysis	Dr. Ganesh Bagler	GNDU, Amritsar

B. Tech.

Awardees	Title of Thesis/ Dissertation/ Project	Supervisor	University/ Institute
Aditya Sood	To clone gene of translation initiation factor and to express the cloned gene in heterologous system	Dr. Som Dutt	Lovely Professional University, Jalandhar
Ashray Gupta	Extraction of volatiles from *Lavandula angustifolia* using conventional and modern techniques	Er. GD Kiranbabu	Beant College of Engineering & Technology, Gurdaspur Punjab,
Komal Gupta	Production of napthoquinone metabolite through cell culture of Arnebia sp & scale up in bioreactor	Dr. Shashi Bhushan	NIT Karnataka, Surathkal
Madhuri Agarwal	In vitro culture initiation of chrysanthemum *cvs* discovery	Dr. Raja Ram	UIET Panjab University, Chandigarh
Navkiran Sidhu	Biotechnological improvement and conservation of economically improvements crops	Dr. Amita Bhattacharya	Thapar University, Patiala
Upasana Goyal	Regeneration and agrobacterium mediated genetic transformation in *Picrorhiza Kurrooa* Royle ex Benth	Dr. Madhu Sharma	Thapar University, Patiala

LECTURES DELIVERED

AK Sinha: Relevance of green approaches in chemistry & synthesis of some bioactive natural & non –natural phenolics, INDO –US workshop on "Green chemistry for environments and sustainable development", HNB Garhwal University, Dehradun, March 10-13, 2012.

AK Sinha: Environmentally benign chemical and biocatalytic routes for the synthesis of bioactive phenolics, International conference on "Advances in Applied Chemical Sciences and Innovative Materials (ACSAIM)" Department of Chemistry, I.I.T. Delhi, August 10-12, 2011.

AK Sinha: Environmentally benign chemical routes for the synthesis of bioactive phenolics, National symposium on "Chemistry in 21st century", Department of Chemistry, GNDU, Amritsar, December 23-24, 2011.

AK Sinha: Horizons of green chemistry in synthetic and natural phenolic compounds, North zone meeting of Chemical Research Society of India (CRSI), Department of Chemistry, University of Jammu, Jammu, September 22-24, 2011.

Arvind Gulati: Plant growth promoting microbial inoculants for improving agriculture productivity, 80th SBC (I0 Meeting, CSIR-CIMAP, Lucknow), in the session "Microbial Technology", November 12-14, 2011.

Bikram Singh: Green processes with hyphenated techniques for analysis of natural products and catalytic synthetic methods development, International symposium on "Recent advances in green chemistry and chromatographic techniques", Manav Rachna International University, Faridabad, January 12-14, 2012.

Brij Lal: Conservation and utilization of biological diversity: in Himalayan perspectives, INSPIRE programme, CSK HPKV, Palampur, October 22, 2011.

Brij Lal: Exploring potential plant resources of cold deserts in western Himalaya, National seminar on "Plant biodiversity: retrospect and prospects", Government PG College, Dharamshala, February 25, 2012.

Lakhmir Singh: Gene silencing and its suppression by plant viruses, UGC Networking Resource Centre in Biological Sciences (UGC-NRCBS) winter school on the theme of "Plant Viruses as tools in Biotechnology", School of Biological Sciences, Madurai Kamaraj University, November1-15, 2011.

MK Singh: Cultivation and post harvest technologies of high value cut flower crops, training entrepreneurship skill development programme in the area of medicinal, aromatic, floriculture and horticulture plants, CSIR-IIIM, Srinagar, September 28, 2011.

MK Singh: Cultivation and post harvest technologies of lilium and gerbera, training programme for farmers, Department of Horticulture, Hoshiarpur (Punjab), July 19, 2011.

MK Singh: Cultivation and post harvest technologies of Lilium as a cut flower, training programme for farmers, Department of Horticulture at Panchayat Ghar Bhager, Bilaspur, September 8, 2011.

MK Singh: Cultivation and post harvest technologies of Lilium as a cut flower, training programme for farmers, Department of Water Shade Development, Shimla at Panchayat Ghar Cheog, Shimla, March 3, 2012.

Neeraj Kumar: Chemistry and life, INSPIRE internship camp, sponsored by Department of Science & Technology, Govt. of India, organized by Department of Microbiology, CSK Himachal Pradesh Agricultural University, Palampur (HP), June 28, 2011.

Pralay Das: Green chemistry: A global challenge for green nation, Fakirchand College, Kolkata, September 25, 2011.

PS Ahuja: Biodiversity and genome, INSPIRE Seminar, CSK HPKV, Palampur (HP), June 27, 2011.

PS Ahuja: Ecology, biodiversity and sustainability, IIT Mandi, Mandi (HP), September 05, 2011.

PS Ahuja: Bioprospecting biodiversityfor food security and improving quality of life, INSPIRE Internship Camp, CSK HPKV, Palampur (HP), October 18, 2011.

PS Ahuja: Genome to genomics, Science Fest- 2011, Science City, Kapurthala (Pb), Novemebr 19, 2011.

PS Ahuja: Understanding metabolic pathways in camellia, arnebia, stevia and picrorhiza for nutrition and health, Indo-Taiwan workshop on genomic approaches for functional food and nutritional Improvement of crop plants, Delhi University, December 13-14, 2011.

PS Ahuja: Knowledge management: Trends challenges and opportunities for educational institutions, National seminar, GGSDS College, Rajpur, Palampur (HP), Decemebr 16-17, 2011.

PS Ahuja: Sustainabale utilization of bioresources of western Himalayas, 19th National Children Science Congress, Jaipur National University, Jaipur (Raj), December 27-28, 2011

RK Sharma: Molecular marker approaches for genetic improvement in plants, National Symposium on "Biochemistry & Biotechnology", Jiwaji University, Gwalior, March 16-17, 2012.

Sanjay Kumar: Bioprospecting flavonoid and terpenoid pathways in target plants tea, picrorhiza and arnebia, XVIII International Botanical Congress 2011, Melbourne, Australia in symposium 159 entitled "Plants in human health and well-being". July 26, 2011.

Sanjay Kumar: Molecular basis of biosynthesis of flavonoids and terpenoids: case studies on *Camellia sinensis* and *Picrorhiza kurrooa,* National Seminar on "Current trends in secondary plant metabolite research" (March 19 to March 20,2012), Jamia Hamdard, New Delhi, March 19, 2012.

Sanjay Kumar: Transcriptome analysis: understanding and utilizing the functionality of genome, National symposium on "Genomics for sustainable food and nutritional security", CPRI, Shimla, November 26, 2011.

Sanjay Kumar: Utilizing genomic and metabolic plasticity at varying altitude for plant improvement, 80th Annual Meeting of the SBC(I) on "Metabolic pathway modulations-applications in health and agriculture", CIMAP, Lucknow, November 15, 2011.

Sanjay Kumar: What have we learnt from altitude?, BIOTECHNIKA–2011: National symposium on "Current Perspectives in Biotechnology" & Talent Hunt under the aegis of UGC-SAP & NASI, Panjab University, Chandigarh, October 13, 2011.

SK Uniyal: Biodiversity: what is it, why we need it and how to conserve it?, Government High School, Dehan, Kangra, Himachal Pradesh, April 11, 2011.

SK Uniyal: Forest biodiversity, International Day for Biological Biodiversity, CSK HPKV, Palampur, Himachal Pradesh, May 21, 2011.

V Shanmugam: Plant-fungal interaction: Detection of a novel small molecule plant signal by a fungal pathogen, National Symposium on "Biology of infection, immunity and diseases control in pathogen- plant interaction", University of Hyderabad, Hyderabad, December 2-4, 2011.

Vijai K Agnihotri: Recent trends in essential oil sciences, International conference & Expo 2012 on "Essential oils in changing global scenario", Hotel Clarks, Khajuraho, MP, February 18, 2012.

GUEST LECTURES

Dr. Gayatri Singhal: Indian Program Manager and **Mr. Syed Khalid Jamal:** Technology and Multimedia Manager, Education Advising Services United States-India Educational Foundation (USIEF), Fulbright Commission in India: Fulbright Fellowship Opportunities to the US, April 26, 2011.

Dr. Mylswamy Annadurai: Project Director, Chandrayaan-2: Role of parents in inculcating scientific temperament among children, June 17, 2011.

Prof. RK Mahajan: Dean, Faculty of Science and Controller of Examination, Guru Nanak Dev, University, Amritsar: Chemical sensors based on new ionophones, August 8, 2011.

Dr. Pankaj Kumar Joshi: Sigma Aldrich: Plant Biotechnology and Transgenics, August 18, 2011.

Dr. Mahtab S Bamji: INSA Hon. Scientist, Dangoria Charitable Trust, Hyderabad: Nutrition security of India, October 10, 2011.

Prof. Akhilesh K Tyagi: National Institute of Plant Genome Research, New Delhi: What have we learnt from Rice Genome, October 11, 2011.

Dr. Amit Ghosh: National Institute of Cholera and Enteric Diseases, Kolkata: Creativity & Out of Box Thinking, October 11, 2011.

Dr. G Marimuthu: FNA, Dept. of Animal Behaviour & Physiology, School of Biological Sciences, Madurai Kamaraj University, Madurai: What can one learn from chemicals, October 11, 2011.

Prof. MRN Murthy: Molecular Biophysics Unit, Indian Institute of Science, Bangalore: Understanding plant viruses through structural Biology, October 11, 2011.

Prof. Amar Kumar: Department of Botany, Delhi University: Plant Nematode Interaction: the battle underground, September 19, 2011.

Dr. RK Sood: Professor & Head, Disaster Management Centre, Himachal Institute of Public Administration, Shimla: Hazard vulnerability of Himachal Pradesh on Seventh "Dr. Hans Raj Negi Memorial Lecture", November 9, 2011.

Prof. KE Gonsalves: Visiting Distinguished Professor, School of Basic Sciences, IIT-Mandi : An integrated approach to nanoscale science & technology, January 17, 2012.

Dr. Ram Laxman: Vice-President, PAC Bio: PAC Bio - Revealing True Biology, February 07, 2012.

Prof. SC Verma: A renowned Pteridologist and former Head of the Department of Botany, Panjab University, Chandigarh: Fathoming the pteridophytes genome: Challenges & opportunities, March 30, 2012.

WORKSHOP/ TRAINING/ CONFORENCE/ MEETING ORGANISED

Period	Theme	Coordinator & Faculty	Participant (No.)
February 09- May 05, 2011	Training on "Isolation of molecules from *Terminalia catappa*; and *Vitex doniana*"	Coordinator: **Vijai K Agnihotri**	Dr. Oyindamola Olajumoke Abiodun, Ladoke Akintola University of Technology, Nigeria, INSA-JRD TATA fellowship
May 23-27, 2011	Training on "Modern technologies of tea culture"	Coordinator: **RK Sud** & Faculty: RD Singh, HP Singh, Ashu Gulati, Amita Bhattacharya, RK Sud, Gireesh Nadda, YB Pakade, CS Mitra, Ramdeen Prasad, VS Dadhwal, Khushal Katoch	TOT Officials (5)
May 30-June 7, 2011	Training on "Electron microscopy"	Coordinator: **Madhu Sharma**	CSIR-IHBT S&T staff (11)
June 7-July 2, 2011	Training on "Tea agrotechnology and tea processing"	Coordinator: **Arvind Gulati**, & Faculty: Anil Sood, RD Singh, Bikram Singh, HP Singh, KK Singh, Ashu Gulati, Amita Bhattacharya, GDK Babu, RK Sud, G Nadda, SS Singh, Rakesh Kumar, PK Pal, YB Pakade, Mohit Sharma	Two personnel (Mr. Wondayan Seifu Teferi, Ms. Fantu Getachew Degefu and Mr. Abay Habte Gunje) from M/s Ethio Agri-CEFT, Ethiopia
June 15-17, 2011	National workshop on "Scientific temper - science and nation building: Revisiting Nehruvian agenda", organized by CSIR-NISCAIR, New Delhi in association with Vigyan Prasar, New Delhi & CSIR-IHBT, Palampur (HP)	Coordinator: **SK Vats**	Participants (120)
August 29-30, 2011	Two days training on "How to make bamboo candies"	Coordinator: **Anil Sood**	Women from local NGO (10)
October 10-11, 2011	77th Annual general body meeting of Indian National Science Academy (INSA)	Coordinator: **HP Singh**	Delegates (19)
October 17-18, 2011	Two week training on "Plant tissue culture techniques"	Coordinator: **Anil Sood**	Mr. Rommel Patial, Consultants, M/s Sai Steel Co., Hamirpur
March 30-31, 2012	Workshop on "Network Biology"	Coordinator: **Ganesh Baglar**	Trainees (15)

VISIT ABROAD

Abha Chaudhary: To Participate in 4th International Conference on Drug Discovery & Therapy, at Dubai, UAE, February 12-15, 2012.

Gopaljee Jha: Visiting Scientist the Sainsbury Laboratory, John Innes Centre, Norwich, UK, July 2010-2011.

Rahul Kumar: To participate in VIPCA-I Conference on "Molecular Mapping and Marker Assisted Selection", Vienna, Austria, February 8-11, 2012.

Ram Kumar Sharma: Visited Buckler's Lab, Institute of Genomic Diversity, Cornell University, Ithaca, New York, USA, under Indo-US Science and Technology Research Fellowship, October 20, 2010 - October 17, 2011.

Sanjay Kumar: To attend XVIII International Botanical Congress-2011, Melbourne, Australia, July 23-30, 2011.

Y Sreenivasulu: To perform and learn advances in biotechnological techniques, U.S.A, October 31- November 09, 2011.

TRAINING IMPARTED

Thirty-eight students from different Institutes/ Universities:

- Thapar University, Patiala (Punjab)
- Dr. H.S. Gour Univ., Sagar (Madhya Pradesh)
- Guru Nanak Dev University, Amritsar (Punjab)
- Dr. B.R. Ambedkar NIT, Jalandhar (Punjab)
- Panjab University, Chandigarh (UT)
- Punjabi University, Patiala (Punjab)
- University Institute of Engineering & Technology, Panjab University, Chandigarh
- Suresh Gyan Vihar University, Jaipur (Rajasthan)
- Baba Isher Singh College of Pharmacy, Gagra-Moga (Punjab).
- Baba Ghulam Shah Badshah University, Rajouri (Jammu & Kashmir)
- Institute of Technology and Science, Sikar (Rajasthan)
- Lovely Professional University, Jalandhar (Punjab)
- National Institute of Technology, Karnataka-Surathkal (Karnataka)
- Rayat Institute of Pharmacy, Railmajra, Ropar (Punjab)

LINKAGES

International

- CRA-Centro di Ricerca per la Patologia Vegetale, Roma, Italy
- Ethio Agri-CEFT Plc, Ethiopia
- Institute of Chemistry and Dynamics of the Geosphere, ICG-3: Phytosphere, Forschungszentrum Jülich GmbH, Jülich, Germany
- Instituto *de Bioquímica y Biología Molecular* (IBBM), Facultad de Ciencias Exactas, Calles 47 y115, 1900 La Plata, Argentina
- Pannon University, H-8200 Veszprem, Egyetem u. 10, Hungary
- Procter & Gamble, England, UK

National

Government/ Autonomous/ PSU

- Biotech Consortium India Ltd., New Delhi
- Botanical Survey of India, Dehradun, Uttarakhand
- Commission for Scientific and Technical Terminology, Govt. of India, New Delhi
- CSK Himachal Pradesh Krishi Vishwavidyalaya, Palampur, Himachal Pradesh.
- District Rural Development Agency, Mandi, Himachal Prdaesh
- Dr.YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Prdaesh
- Guru Nank Dev University, Amritsar, Punjab

- Himachal Pradesh Horticultural Produce Marketing & Processing Corporation Limited (HPMC), Shimla, Himachal Pradesh
- Indo-Soviet Friendship College of Pharmacy, Moga, Punjab
- National Dairy Research Institute, Karnal, Haryana
- National Hydroelectric Power Corporation Ltd, Faridabad, Haryana
- Panjab University, Chandigarh (UT)
- Punjab Agricultural University, Ludhiana, Punjab
- Punjabi University, Patiala, Punjab
- Space Applications Centre (SAC), ISRO, Ahmedabad, Gujarat
- Tea Research Association, Tocklai, Assam
- The Chief Conservator of Forests (Admn.) cum Project Director, Panchkula, Haryana
- TN Medical College & BYL Nair Ch. Hospital, Mumbai Central, Mumbai
- United Planters Association of South India (UPASI), Valparai, Tamil Nadu
- Uttarakhand Bamboo and Fiber Development Board (UBFDB), Dehradun, Uttarakhand

Private

- Andel Equipment Pvt. Ltd., Mohali, Punjab
- Aroma Aromatics and Flavours, Baddi, Solan, Himachal Prdaesh
- Baba Ghulam Shah Badshah University, Rajouri, Jammu & Kashmir
- Crystal Phosphate, Karnal, Haryana
- Kanan Devan Hills Plantation Pvt. Ltd., Munnar, Kerala
- Krishidhan Research Foundation Pvt. Ltd., Indore, Madhya Pradesh
- Krishna Food & Seeds Processors, Gurdaspur, Punjab
- Mahindra Shubhlabh Services Ltd., Mohali, Punjab
- Merck Specialties Pvt. Ltd., Bengaluru, Karnataka
- MESCO Equipments Pvt. Ltd., Kolkata, West Bengal
- Multiplex Bio-Tech Pvt. Ltd., Bangaluru, Karnataka
- Namiex Chemicals Pvt. Ltd., Pathankot, Punjab
- National Masala Mills (J&K) Pvt. Ltd., Anantnag, Jammu & Kashmir
- Panacea Biotec Ltd., New Delhi
- Panacea Biotec Pvt. Ltd., Lalru, Punjab
- Rescholar Equipment, Ambala Cantt., Haryana
- Thapar University, Patiala, Punjab
- Thirumalai Chemicals Pvt. Ltd., Vellore, Tamil Nadu

NGO

- Yog Manav Vikas Trust, Banikhet, Himachal Pradesh
- Farmer First Foundation, New Delhi

MEMORANDUM OF UNDERSTANDING (MoU)

Date	Agreement with	Purpose
8-April-11	Guru Nanak Dev University, Amritshar	Revalidation
5-July-11	The Society for Development of Vanaspati Van having registered Office at the Directorate of Ayurveda, SDA Complex, Kasumpti, Shimla, HP	For construction and modification of research laboratory blocks at R.I. in ISM, Joginder Nagar, Distt – Mandi (H.P.) and equipping the same
8-July-11	M/s Rajat Biotech Farm, Vill.- Padyalag P.O.- Dadhol, Teh. Ghumarwin, Distt- Bilaspur (HP)	Material transfer agreement for cultures of gerbera and apple root stocks.
6-Aug-11	Chaudhary Sarwan Kumar, HP Krishi Vishvavidyala, Palampur	For collaboration in M.Sc. Agricultural Biotechnology course.
2-Sept-11	M/s Kunal Bio-tech, V.P.O Nagwaine, Sub. Tehsil-Aut. Distt. Mandi (HP)	Material transfer agreement for aseptic cultures of apple root stocks
14-Sept-11	M/s Neva Plantation, Gopalpur, Kangra (HP)	For cultivation and post harvest technology of lilium of bulb production.
26-Sept-11	Indian Institute of Technology, Mandi, HP	For collaborative research work
27-Sept -11	CV Raman College of Engineering, Bhubaneswar, Orissa	Processing of Stevia leaves for production of Steviol glycosides
14-Oct-11	Chaudhary Sarwan Kumar Himachal Pradesh Krishi Vishvavidyalaya, Palampur	For implementation of DBT funded masters programme in agricultural biotech and on Development of transgenic crop plants
19-Oct-11	M/s Neva Plantation, Gopalpur, Kangra	Material transfer agreement for aseptic cultures of apple root stocks
16-Feb-12	M/s Golden Falcon Foundation and Research Center, Haryana	Supplying and raising plantation of 20,000 bamboo plants in area surrounding Delhi, Gurgaon

TRAINING/ CONFERENCE/ WORKSHOP/ MEETING ATTENDED

Name	Training/ Workshop/ Conference/ Meeting	Organiser & Venue	Period
Alka Kumari	Consultation programme on "Fly ash utilization"	Organized by Shriram Institute for Industrial Research, Delhi, in association with Dept. of S&T and Ministry of Env. & Forest, at University of Delhi, North Campus, Delhi	July 21-22, 2011
Amit Chawla and Mahesh Gupta	Training on "Achieving excellence @ workplace"	CSIR-HRDC, Ghaziabad	Jan 30-Feb 1, 2012
Amit Chawla,	Induction training programme for Scientists	CSIR-HRDC, Ghaziabad	Mar 18-27, 2012
Anil Sood and RD Singh	Meeting of the theme coordinators for CSIR-800 XII five year plan	CSIR- C-MMACS, Bengaluru	Jan 13, 2012
Anil Sood, RD Singh, Virendra Singh, RK Sud and Markandey Singh	CSIR-800 technology workshop	CSIR- C-MMACS, Bengaluru	Jan 28-31, 2012
Anil Sood	Training programme on "Technology development"	CUTS International and DST (Govt. of India), New Delhi	No 14-18, 2011
Aparna Maitra Pati	CSIR open access	CSIR-NIO, Goa	Oct 19, 2011
Aparna Maitra Pati	Workshop on "HR development in CSIR"	CSIR-HRDC, Ghaziabad	Feb 22-24, 2012
Brij Lal	Task force meeting of Comprehensive Traditional Knowledge Digital Library (CTKDL; NWP-0040)	CSIR-HRDC, Ghaziabad	Jul 12, 2011
Brij Lal	Brain storming session on "Web portal of wealth of India for 12th five year plan"	CSIR-NISCAIR, New Delhi	Dec 15, 2011
Madhu Sharma and MK Singh	Brain storming on saffron	Kashmir University, Srinagar	Oct 17, 2011
Mohit Sharma	Five day SERC school on "Nonlinear programming and soft computing techniques for chemical engineering"	Chemical Engineering Department, NIT Durgapur, West Bengal (Sponsored by DST)	Dec 12-16, 2011
Om Parkash	Training on "Methods and approaches in plant systematic"	CSIR-NBRI, Lucknow	Dec 5-14, 2011.
PS Ahuja and RK Sud	The meeting on "Priority areas for tea research for 12th five year plan"	Tea Board of India, Kolkata	Sep 29, 2011
Rakesh Kumar	National conference on "Seabuckthorn: emerging trends in R & D on health protection & environmental conservation"	CSK HPKV, Palampur	Dec 1-3, 2011
RC Kasana, Mohinder Pal and Shashi Kiran	10 days national training on "Metagenomics: a practical approach to molecular taxonomic profiling"	National Bureau of Agriculturally Important Microorganisms Kusmaur, Nath Bhanjan	Nov 22 –Dec 1, 2011

Name	Training/ Workshop/ Conference/ Meeting	Organiser & Venue	Period
RD Singh	Training on "Research methodology and statistical methods: multivariate methods of analysis"	CSIR-HRDC, Ghaziabad	July 4-8, 2011
RK Sud	Two week training programme on "Technology valorization & management"	Administrative Staff College of India, Hyderabad	July 4-15, 2011
RK Sud	Intellectual property rights: drafting, interpretation of patent specifications and claims	College of Technology and Engineering, Udaipur Rajasthan	Mar 14-17, 2012
RK Sud and SG Eswara Reddy	2nd national workshop on "Plant protection in tea"	TRA, Kolkata	Feb 21, 2012
Sanjay Kumar and SK Vats	Brainstorming on "Scientific collaboration in the field of climate change"	Organized by Himachal Pradesh Climate Change Centre, SCST&E and Climate Change Development Division, Embassy of Switzerland in India, Shimla	May 24, 2011
Sanjay Kumar and SK Vats	Second Meeting of panel of experts to carry out the peer review of climate change strategy and action plan	Shimla, Himachal Pradesh	Mar 29, 2012
SK Uniyal	Workshop on "Forest and climate change"	Himalayan Forest Research Institute, Shimla	Aug 17, 2011
SK Uniyal	Brainstorming meeting on "Biodiversity standards and end user queries with respect to bioresource information centers"	Indian Institute of Remote Sensing, Dehradun	Dec 26-27, 2011
SK Uniyal	Brain storming session on "Precision farming technologies for mitigating effects of climate change"	YS Parmar University, Solan	Feb 24-25, 2012
Som Dutt	Bangalore India Bio 2011	Bangalore International Exhibition Centre, Bangalore	May 4-6, 2011
YB Pakade	Meeting on "Research on Pesticide Residue in XII Plan"	TRA, Kolkata	Mar 13, 2012

PARTICIPATION IN EXHIBITION

Sukhjinder Singh and Sanjay Kumar: Science and Technology Expo- 2011, Dharamshala, June 2- 4, 2011

KK Singh, Sukhjinder Singh, Sanjay Kumar, Arvind K Verma and **Khushal Katoch:** Exhibition at Agril Engineering Dept., CSK HPKV, Palampur, November 16, 2011

Neeraj Kumar, Sukhjinder Singh, Khushal Katoch and **VS Dhadwal:** State level Science Congress Exhibition, Una, Himachal Pradesh, November 24- 26, 2011.

Sukhjinder Singh, Sanjay Kumar and **Ajay Parmar:** Holi mela exhibition at Pragati Maidan, Palampur March 5- 9, 2012.

DISTINGUISHED VISITORS

- Dr. Gayatri Singhal, Indian Program Manager and Mr. Syed Khalid Jamal: Technology and Multimedia Manager, Education Advising Services United States-India Educational Foundation (USIEF), Fulbright Commission in India: Fulbright Fellowship Opportunities to the US, April 26, 2011
- Dr. S. Ayyappan, DG, ICAR, New Delhi, May 11, 2011
- Dr. Girish Sahni, Director, CSIR-IMTECH, Chandigarh, June 10, 2011
- Prof. Varun Sahni, Vice Chancellor, Jammu University, Jammu, June 10, 2011
- Dr. Gangan Prathap, Director, CSIR-NISCAIR, New Delhi, June 15, 2011
- Prof. O Siddiqi, Hon. Professor, TIFR National Centre for Biological Sciences, Bangalore, June 15, 2011
- Prof. PM Bhargava, Founder & Former Director, CCMB, India, June 15, 2011
- Sh Amar Rattan Kohli, Former Governor of Mizoram. June 17, 2011
- Dr. Mylswamy Annadurai, Project Director, Chandrayaan-2, ISRO, June 17, 2011
- Dr. Pankaj Kumar Joshi, Sigma Aldrich, August 8, 2011
- Prof RK Mahajan, Dean, Faculty of Science and Controller of Examination, GNDU, Amritsar, August 8, 2011
- Prof. Amar Kumar, Department of Botany, Delhi University, September 19, 2011
- Dr. Narendra Tuteja, Associate Scientist, International Centre for Genetic Engineering & Biotechnology (ICGEB), September 26, 2011
- Dr. Renu Tuteja, Scientist, International Centre for Genetic Engineering & Biotechnology (ICGEB), September 26, 2011
- Prof. T. A. Gonsalves, Director IIT Mandi, September 26, 2011
- Dr. Mahtab S Bamji, INSA Hon. Scientist, Dangoria Charitable Trust, Hyderabad, October 10, 2011
- Dr. Amit Ghosh, National Institute of Cholera and Enteric Diseases, Kolkata, October 11, 2011
- Prof. Akhilesh K Tyagi, National Institute of Plant Genome Research, New Delhi, October 11, 2011
- Dr. G Marimuthu, FNA, Dept. of Animal Behaviour & Physiology, School of Biological Sciences, Madurai Kamaraj University, Madurai, October 11, 2011
- Prof. MRN Murthy, Molecular Biophysics Unit, Indian Institute of Science, Bangalore, October 11, 2011
- Hon'ble Justice Kurian Joseph, Chief Justice, High Court of Himachal Pradesh, November 5-6, 2011

- Dr. RK Sood, Professor & Head, Disaster Management Centre, Himachal Institute of Public Administration, Shimla, November 9, 2011
- Dr. BL Saabarao, Ex Scientist, Hyderabad, November 18, 2011
- Prof. KE Gonsalves, Visiting Distinguished Professor, School of Basic Sciences, IIT-Mandi, January 17, 2012.
- Prof. Pat Heslop-Harrison, Dept. of Biology, University of Leicester, UK, February 14, 2012
- Dr. Trude Schwarzacher, Dept. of Biology, University of Leicester, UK, February 14, 2012
- Dr. Ram Laxman, Vice-President. PAC Bio, February 7, 2012
- Prof. SC Verma, a renowned Pteridologist and former Head, Department of Botany, Panjab University, Chandigarh, March 30, 2012

GROUP VISITORS

Visitors	No. of Visitors
Students from Educational Institutes	936
Farmers, NGOs, and Govt. Officials	1095
Total Visitors	**2031**

National Workshop on Scientific Temper

National Workshop on Scientific Temper-Science and Nation Building: Revisiting Nehruvian Agenda at CSIR-IHBT, Palampur

Organized by CSIR-NISCAIR, New Delhi in association with Vigyan Prasar, New Delhi and CSIR-IHBT, Palampur (HP) during 15-17, June 2011

Scientific Temper Statement Revisited-2011
The Palampur Declaration

Recapitulation of the 1980s Spirit

The concept of Scientific Temper was articulated first by Pandit Jawaharlal Nehru in 1946 in his book *Discovery of India,* referring to it as "a way of life, a process of thinking, a method of acting and associating with our fellowmen". The tradition of skepticism and humanism is not new to Indian intellectual tradition. Such notions go back to antiquity–Jain, Sankya, and Buddhist traditions have repeatedly emphasized the spirit of enquiry. During the Indian renaissance many leaders popularised the notion of scientific enquiry and gradually it became part of the Indian ethos.

Nehru was instrumental in laying the foundations for building the infrastructure for science and technology in India–the Universities, the IITs, the CSIR labs, etc. These became the 'hardware' of science and technology in India, while Scientific Temper among the people of India was to be the 'software'. In 1976, India became the first country to include in its Constitution 'Scientific Temper with humanism' as a fundamental duty of all citizens of the country (Article 51-A(h)).

Four years later, in October 1980, a group of academicians and intellectuals deliberated for four days at Coonoor, near Ooty, on the state of Scientific Temper in the country. Out of those deliberations was born 'A Statement on Scientific Temper', which was released on 19 July 1981. This document articulated the need to inculcate the values of Scientific Temper in the Indian society to rid the country of its socio-economic ills at that time. The Statement was expected to usher in a movement–a second Indian Renaissance–in India to 'provide the necessary fillip for restructuring our country embodying the aspirations of our people'. Broadly, the statement extolled the virtues of the scientific method as an antidote to the traditional religious and/or superstitious dogmas that prevail in our country. In recent times, the hold of such antiquarian beliefs has become greatly widespread in the country through television channels, and lately, through the Internet.

The preamble to the statement noted the continuous accumulation of knowledge allowed mankind to exercise control over the environment. However, the spread and adoption of mankind's knowledge has been uneven due to prevalent schisms across the world and control over such knowledge by the elites. In such a bleak situation, fatalism prevails, reinforcing obscurantism, irrationalism and a retreat from reason. To advance in the scientific age, we must understand the meanings and imperatives of scientific temper– which in essence is 'humanity's assertion of being in charge of its destiny and not a passive victim of malevolence of stars'. Scientific Temper thus becomes an imperative for a brighter future for our country.

The Statement goes on to include in its definition of Scientific Temper the method of science that encompasses all human knowledge cutting across the natural sciences and the social sciences. 'The spirit of inquiry and the acceptance of the right to question and be questioned are fundamental in scientific temper.' It considers knowledge as open ended and ever evolving. Scientific Temper is incompatible with theological and metaphysical beliefs. While science is universal, religions and their dogmas are divisive. Scientific Temper cannot flourish in a grossly inegalitarian society where 50 per cent of the population lives below the poverty line and almost 70 per cent of our people, especially women, are functionally illiterate. Social justice, widespread education and unrestricted communication are pre-requisites for the spread of Scientific Temper and, therefore, optimizing the results of science and technology becomes imperative.

The Statement called for a major role of Scientific Temper in reviving confidence and hope and dispelling a fatalistic outlook. The campaign to promote Scientific Temper must inculcate values like equality and dignity of labour and social accountability of one's actions. The Statement also cautioned against using scientific and technological solutions as 'magic bullets' for every problem in the country. 'The nature of social stratification and the power structure in a society prevents the acceptance of such solutions. Technologically, one may be able to grow enough food for everyone, but the pattern of income distribution prevents the benefits of increased food production reaching large segments of the population. When the social structure and stratification prevent the application of rational and scientifically proven solutions, the role of Scientific Temper is to lay bare the anatomy of such social barriers.'

The debates and discussions on Scientific Temper that the Statement envisaged initially, have not continued in India towards ushering a second renaissance, at least to the extent that the signatories wished. Scientific Temper remained largely confined to rhetorical statements. Sadly, even social scientists did not make an effort to refine this concept or operationalise the concept

for measuring/gauging Scientific Temper. It behoves us to retrieve this concept before it is lost in the cacophony triggered by the changing scientific, technological and economic order. Thus, there is a need to revisit the 1981 Statement.

The intellectual space left untapped by academicians and the state structures has been to an extent occupied by various voluntary organisations (also called NGOs and Civil Society organisations). Since the 1980s, there has been a substantial growth in the number of these organisations. What impact these various efforts have had on the inculcation of Scientific Temper in the population is yet to be studied, but what is clear is that these efforts, though commendable, have not been able to change the direction of the tide of irrationality.

Ever since the 1981 Statement was released, two opposite, and yet synchronous, changes have been observed in the country. It should be noted with some satisfaction that the combined effect of efforts made to propagate scientific ideas in the country, to which people's science movements and scientific institutions have contributed in a large measure, have definitely made a difference, however small it may be. Such efforts had modest impact as in the case of bringing out large numbers of people to watch the 'total solar eclipse' during 1995 or critically appraising public policies as in the case of the Silent Valley Project.

But, at the same time, during the past 30 years there has been a marked increase in public display of religious and sectarian identities, ascendance of irrational cults, glorification of obscurantist practices, religiosity and wielding of religious symbols. This has provided the ideological basis for, at times, brutal unscientific actions in both public and personal domains. Discrimination based on caste, gender and ethnic identities, perpetuated on the basis of irrational beliefs and superstitions are still widely prevalent, and are a blot on our society. Privatisation of electronic media has also had the undesirable effect of providing increased space for forces responsible for the spread of irrationality and undermining Scientific Temper.

Changing World Order

During the last two decades many parts of the world also witnessed new and large-scale social movements against the new world order—often described as neo-liberal regimes advocating market fundamentalism and withdrawal of the state from economic and social sectors. These movements were ostensibly mobilised on the basis of rational objective knowledge on issues facing different sections of the populations.

The most significant development in the world during the past two decades has been the accelerated globalisation of trade and services aided by the extensive penetration of Information and Communication Technologies (ICTs). The ushering in of the Internet and the World Wide Web paved the way for consolidation of economic hegemony of transnational companies (and TNCs) all over the world and its natural resources.

On the other hand, neo-liberal regimes also laid the ground for organised international resistance against such hegemonies. Creation of large cyber spaces has revolutionised the storing, searching and retrieval of electronic documents, including scientific publications. The barriers that confined scientific knowledge among a few have been broken, empowering researchers in developing countries by making scientific corpora available to them with considerably reduced lag period. Today, a possibility exists for non-experts to access scientific knowledge on varied subjects with

a click of a button. This process is causing erosion of the 'almost religious authority' that science experts exercised hitherto. The democratic, open, transparent and egalitarian nature of science is reasserting itself on a much bigger scale today.

It is needless to overemphasize that this cyber space is also available to those who spread occult and unscientific ideas. In fact, using this space they are meticulously trying to enlarge their constituency. In India, efforts to counter these forces by making use of the same cyber space has, unfortunately, been found wanting.

Developments in biotechnology have also had a profound impact on all spheres of human existence. It has started bringing new research insights into almost all conventional disciplines of natural and social sciences. It has also generated heated public debates all over the globe and has given birth to resistance movements.

The above developments are likely to have a profound impact not only on social relations but may also intensely influence man-nature relationships.

Current State of Science and Technology

In the last two decades there has been an unprecedented increase in the World's stocks and flows of human resources and research output, in terms of academic publications and patents. The world has witnessed a shift from an industrial economy to a 'knowledge economy'. In this changed world order, India is struggling to increase its scientific and economic share. However, with its still high rate of illiteracy and lack of universal education the relevant questions such as 'what constitutes education?', 'what does knowledge society mean in the Indian context?' and 'whose knowledge counts in this knowledge society?' assume importance.

The character and nature of scientific praxis has also changed during the last 20 years or so. For a long time production of scientific knowledge and its application and relevance were not separated and science was expected to serve the state in respect to the security and welfare of its citizens. Thus, S&T served well in the growth of industrial economies of both the capitalist and the socialist countries. Unfortunately, the neo-liberal regimes of many countries (including India) have changed this social contract of science in favour of markets and corporate entities.

The privatization of research and academic institutions through IPRs has resulted in blurring the boundaries of basic and applied research and their relation to technology, such as in biology. In the academic and policy circles science is being replaced by 'innovation'—which is a mix of science, technology, management, marketing, organisations, and a host of other things. It is innovation studies or innovation policies and competition among firms and nations that now dominate the intellectual and policy space. It is innovation that is used as a benchmark of economic growth and development. For ordinary citizens technology and gadgets are today the most tangible manifestations of 'science'.

The fast pace of technological intrusion, without essential back-up support of scientific knowledge base, introduces cultural and social distortions within traditional cognitive structures. Lack of effort at providing the necessary complementary scientific knowledge base for the population at large is consolidating these distortions resulting in the corrosion of democratic structures. Moreover, technology-driven modernisation creates a cognitive gap due to loss of traditional knowledge, which is being filled in by religiosity in new forms.

Relevance of Scientific Temper in Today's World

In view of the concerns expressed above, we feel that Scientific Temper should be strengthened and diffused widely in our society. In some sense, Scientific Temper can be equated to application of the scientific method based on logic and evidence. Scientific Temper in this sense is also privileged and seen as antithetical to 'revealed knowledge', evidence for which does not go beyond religious scriptures or superstitious beliefs. Science, on the other hand, holds that life, mind and universe can be understood without invoking the supernatural and revealed knowledge. Scientific knowledge is thus universal and is reliable in contradistinction to the so-called revealed knowledge and the diverse metaphysical interpretations of life and the universe, which form the basis of the various religions and associated superstitious beliefs.

Scientific Temper is essentially a world-view, an outlook, enabling ordinary citizens to choose efficient and reliable knowledge while making decisions in their individual and social domains. It is not the content or extent of knowledge base of one or other domain of scientific corpus that a citizen acquires, but rather the pursuit of rational enquiry, which is the hallmark of Scientific Temper.

Social phenomena do not easily lend to experimentation or verification. Thus, if Scientific Temper were to be diffused to 'solve mundane problems' of ordinary citizens, the methods of science would have to be enlarged and re-defined in inter-disciplinary perspectives. "The understanding of the social phenomena and human behaviour, knowledge about the social process and its determinants are essential for designing policies to promote social change and to produce a dynamic society capable of absorbing and utilizing the scientific and technological developments for the welfare of human beings" (VKRV Rao).

Science and technology have contributed at a macro level to the socioeconomic development of India and the world at large. India could ward off famines and import of food grains in the 1960s largely through the Green Revolution, which also had the unfortunate effect of causing income disparities and environmental degradation. The solution to these problems will come from new scientific and technological initiatives and people-oriented policies.

The average life span of Indians increased due to availability of antibiotics against some common diseases. Similarly, communication facilities have expanded with the advent of the TV, mobile phones and the penetration of computers and Internet. Yet disparities in the availability and access to education continue to grow, and fruits of science and technology do not reach across the regions, religious sects, gender, and castes. It may be worth gauging how far these economic and scientific achievements - and Scientific Temper - in India have percolated down to the common man. As scientific progress outstrips scientific understanding, citizens that are increasingly reliant on science and technology and yet largely ignorant of their workings, would be at a great disadvantage. Correspondingly, their participation in the democratic process would be increasingly marginalised. The growth of Scientific Temper is a measure of the extent to which the society applies the methods of science to solve its problems.

Advocates of Scientific Temper have often identified superstitions and religious beliefs as the main target of opposition. In this sense, Scientific Temper is an 'ideology' pitted against these religio-centric ideologies. Unfortunately, in India this process—termed as 'transmitter model' in literature—could not succeed in effecting changes in the people's attitudes or values. In fact, over

the years, there has been an increase in the public display of religious activities by public figures in all walks of life.

This situation is made worse when even scientists actively participate in such religio-centric rituals in the public domain. Many scientists publicly profess their faith in 'gurus' and 'babas' in India. With the spread of the electronic media—the TV and the Internet—these public (and private) activities are in constant public gaze and much of this content can also be stored and recalled. Such displays by scientists weaken their position as role models for the practice of Scientific Temper.

Public display of religious symbols, figures, images and artefacts in government offices, religious ceremonies in institutes and educational institutions and religious invocations during inaugurations of scientific conferences, mar the secular character of these institutions in particular and the Indian State in general. A number of these acts are legitimised in the garb of 'culture'. In order to secure its constitutional obligation, the State must forbid such displays within government owned spaces.

The recent spurt in providing legitimacy to the 'occult' by dubbing it as scientific is a disturbing phenomenon. Some may argue that it is in a way acceptance of supremacy of science over other forms of knowledge generation, but such acts not only discredit 'science' they also use science as a saleable commodity. It is necessary to create regulatory mechanisms against the dissemination of such unscientific and irrational messages and devise ways that enable corrective measures to be taken.

Modern education is the strongest determinant of scientific information, knowledge and attitude. It is true that over the years scientific information base in the country has enlarged, but it will be far from reality to assume that this information is getting transformed into knowledge thereby bringing a change in attitude. Unfortunately, our education system is still not sufficiently evolved to inculcate Scientific Temper in young minds.

The growth of mass media as a means of transmitting science related information started with the print media—academic journals to communicate the results of scientific research, newspapers and magazines to communicate science to citizens. Later radio broadcasts have added to these channels of communications. The biggest impact of mass media, however, came with television. It should be noted with utmost concern that TV has emerged as the most potent agency spreading anti-scientific temper in India. Freedom of expression is being used as freedom of propagating irrational, outmoded and antiquated ideas. Thus, ironically the latest technology is being used to propagate anti-science beliefs. Today, there are a large number of religious channels but there is not a single Indian science channel.

Fundamentalist forces selectively embrace technology and make use of these technologies to propagate outmoded ideas. It is propagation of modern scientific knowledge that hits at the core of irrationality and is therefore not acceptable to them.

A Strategy for Spread of Scientific Temper in India

Scientific Temper breeds within the confines of scientific information base. Therefore, it is imperative to make relevant scientifically generated latest information available to the common citizen. However, it will be erroneous to equate Scientific Temper with scientific information.

It has been repeatedly observed through survey studies that the thought structure of a common citizen is constituted by scientific as well as extra-scientific spaces. These two mutually exclusive spaces co-exist peacefully. Act of invocation of one or the other is a function of social, political or cultural calling. Those who consider spreading Scientific Temper as their fundamental duty must aim at enlarging the scientific spaces.

We call upon the people of India to be the vanguard of Scientific Temper.

Use of religious symbols and ceremonies with religious overtones performed in the garb of cultural activities must be stopped in government offices and institutions run with public funds.

A national monitoring system with powers to issue guidelines must be set up to continually monitor for unscientific content in the media channels and the education system, particularly up to school level.

Scientists and scientific institutions should not only function in a more transparent manner but also reach out to the public at large with an objective to instil confidence in science, scientists and scientific institutions.

A television channel dedicated to the spread of Scientific Temper should be operated with funding from the government.

Science communication activities mandated in the government agencies should focus more on rationality, inquiry and method apart from content.

India is a stratified country and cultural and religious minorities have special needs. Fundamentalist, unscientific and antiquated ideas are not prevalent only among the religious majority, these are also as rampant among the minority and marginalised sections of people. On the one hand, similar unscientific beliefs govern the lives of the minority; on the other hand, they are further marginalised because of lack of Scientific Temper among the majority community. It is necessary to identify their special needs and devise intervention policies.

Every one is born with a Scientific Temper. The child wants to touch, feel, experiment and explore everything on its own—the basic ingredients of Scientific Temper. However, somewhere down the line, owing to societal or traditional influences or due to the type of education being imparted in our schools, the child loses the tendency to ask questions and explore natural phenomena, leading to acceptance of notions forced upon it without putting them through the scientific rigour. Therefore, Scientific Temper needs to be incorporated into the school curriculum at all stages so that the spirit of scientific inquiry can be inculcated from a young age.

IMPORTANT EVENTS

National Technology Day

The Institute celebrated the National Technology Day on May 11, 2011 and Dr. S Ayyapan, DG, ICAR delivered the key note lecture on "Feeding Crores Forever". Prof. SK Sharma, VC, CSK HPKV, Palampur and Dr. Naresh Kumar, Scientist, CSIR were the Guest of Honour on this occasion. The function was presided over by Prof. VL Chopra, Former Member, Planning Commission, Govt. of India.

Dr. S Ayyapan, Prof.VL Chopra, Prof. SK Sharma and Dr. Naresh Kumar

CSIR-IHBT Foundation Day

The institute celebrated its 29th Foundation Day on June 10, 2010. Dr. Girish Sahni, Director, CSIR-IMTech, Chandigarh delivered the foundation day lecture on "Seeking new opportunities in biotechnology: Some personal experiences and insights". Prof. Varun Sahni, Vice Chancellor, University of Jammu (J&K) presided over the function and spoke on "What's driving world politics today".

Release of CSIR-IHBT Annual Report-2010-11 by Prof. Varun Sahni

संसदीय स्थायी समिति दौरा

राज्यसभा सदस्य श्री शांता कुमार की अध्यक्षता में भारत सरकार के वाणिज्य मंत्रालय की संसदीय स्थायी समिति ने सोमवार दिनांक जुलाई 4, 2011 को आईएचबीटी, पालमपुर का दौरा किया। इस अवसर पर संस्थान के निदेशक डा. परमवीर सिंह आहूजा ने समिति को संस्थान में चल रहे शोध कार्यों तथा उपलब्धियों का ब्योरा दिया।

CSIR Foundation Day

CSIR Foundation Day celebration was organized on September 26, 2011. Dr. Narendra Tuteja, Senior Scientist, ICGEB, New Delhi delivered the foundation day lecture on "RNA splicing factor promotes crop improvement under drought and salinity stress". Prof. TA Gonsalves, Director, IIT Mandi presided over the function.

Dr. Anil Sood, Dr. Narendra Tuteja and Prof. TA Gonsalves on dais and Dr. PS Ahuja addressing the audience

Prof.TA Gonsalves presenting CSIR-IHBT Technology Adoption Award to Mr. Vinod Soni, MD, M/s Rajat Biotech, Ghumarwin, Distt. - Bilaspur (HP)

Prof.TA Gonsalves presenting CSIR-IHBT Technology Adoption Award to Technology Adoption award to Mr. Ranbir Singh Yarki, Distt. – Lahaul & Spiti (HP)

Dr. PS Ahuja presenting the First prize of Debate competition (Hindi Vaad Vivad pratiyogita) to Ms. Shilpa, Govt. Sr. Sec. School, Rajpur (HP)

National Science Day

The National Science Day was organized on February 28, 2012 in the institute. Dr. R Uma Shaanker, Deptt. of Physiology and School of Ecology & Conservation, University of Agricultural Sciences, GKVK, Bangalore delivered the Science Day lecture on "Why do plants have laxatives when they have no bowels to move?: An evolutionary perspective to bioprospecting".

Dr. Anil Sood, Dr. R Uma Shaanker and Dr. PS Ahuja

Felicitation of Dr. AK Sinha and his team members by Dr. P.S. Ahuja, Director, CSIR-IHBT for their research paper published in high Impact Factor (12.73) journal- "Angewandte Chemie"

WORKSHOPS

Workshop on "Development of Floriculture in Himachal Pradesh" sponsored by APEDA Govt. of India, was organized on May 13, 2011.

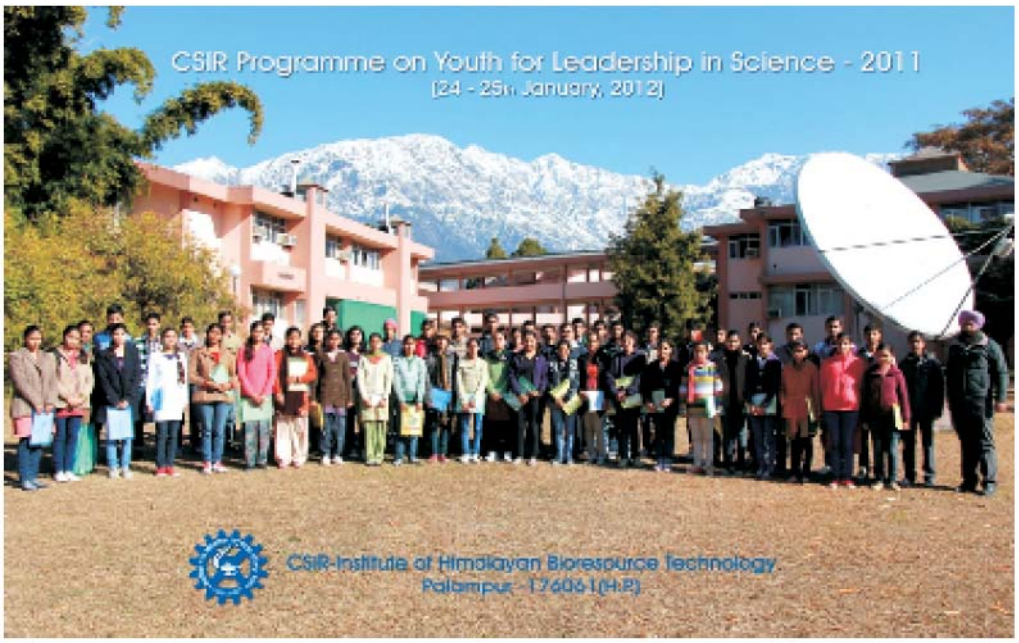
Workshop on "Network Biology" was organized during March 30-31, 2012. 15 participants along with guest faculties participated in the training.

MEETING

77th Annual General Body meeting of Indian National Science Academy (INSA) held during October 10-11, 2011 at CSIR-IHBT, Palampur(HP).

CPYLS

CSIR Programme on Youth for Leadership in Science (CPYLS) 2011 was organized during January 24-25, 2012 at this Institute. Fifty students along with parents and teachers participated in the institute.



RESEARCH COUNCIL

Chairman

Prof. Sudhir K Sopory, FNA
Vice Chancellor, Jawahar Lal Nehru University, New Mehrauli Road, New Delhi-110 067

Members

Prof. Deepak Pental
Director
Centre for Genetic Manipulation of Crop Plants, Delhi
University South Campus, New Delhi – 110021

Dr. S Natesh
Senior Advisor
& Head, International Collaboration
Department of Biotechnology
New Delhi - 110 003

Prof. JS Singh
Professor Emeritus
Centre for Advanced Study in Botany
Banaras Hindu University, Varanasi-221 005

Dr. Girish Sahni
Director
CSIR-Institute of Microbial Technology
Chandigarh-160 036

Prof. Alok Bhattacharya
Professor
School of Life Sciences,
Jawaharlal Nehru University,
New Delhi-110 067

Dr. Chandra Shekhar
Director
CSIR-Central Electronics Engineering Research Institute
Pilani-333 031

Prof. KN Ganesh
Director
Indian Institute of Science Education and Research,
Sutarwadi, Pashan, Pune- 411021

Dr. Rajesh Jain
Joint Managing Director
Panacea Biotec Ltd., New Delhi-110044

Permanent Invitee

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

Director

Dr. PS Ahuja
CSIR-Institute of Himalayan Bioresource Technology, Palampur-176 061 (HP)

Member Secretary

Dr. Aparna Maitra Pati
Principal Scientist
Planning Project Monitoring & Evaluation
CSIR-Institute of Himalayan Bioresource Technology, Palampur-176 061 (HP)

Management Council

(From 1-1-2012 to 31-12-2013)	(From 1-1-2010 to 31-12-2011)
Chairman	
Dr. PS Ahuja Director CSIR-IHBT, Palampur, HP	Dr. PS Ahuja Director CSIR-IHBT, Palampur, HP
Members	
Dr. Ram A Vishvakarma Director CSIR-IIIM, Jammu, J&K	Dr. Ram A Vishvakarma Director CSIR-IIIM, Jammu, J&K
Dr. Arvind Gulati Sr. Principal Scientist CSIR-IHBT, Palampur, HP	Dr. Bikram Singh Sr. Principal Scientist CSIR-IHBT, Palampur, HP
Dr. Aparna Maitra Pati Principal Scientist CSIR-IHBT, Palampur, HP	Dr. Sanjay Kumar Sr. Principal Scientist CSIR-IHBT, Palampur, HP
Dr. Markandey Singh Principal Scientist CSIR-IHBT, Palampur, HP	Dr. Aparna Maitra Pati Principal Scientist CSIR-IHBT, Palampur, HP
Dr. Ram Kumar Sharma Sr. Scientist CSIR-IHBT, Palampur, HP	Dr. Sanjay K Uniyal Sr. Scientist CSIR-IHBT, Palampur, HP
Dr. Parlay Dass Scientist CSIR-IHBT, Palampur, HP	Dr. Sudesh Yadav Scientist CSIR-IHBT, Palampur, HP
Sh. RK Bindal Principal Technical Officer CSIR-IHBT, Palampur, HP	Dr. Raja Ram Principal Technicial Officer CSIR-IHBT, Palampur, HP
Sh. Sunil Kumr Finance & Accounts Officer CSIR-IHBT, Palampur, HP	Sh. Sunil Kumr Finance & Accounts Officer CSIR-IHBT, Palampur, HP
Member Secretary	
Sh. Jaswant Rai Administrative Officer CSIR-IHBT, Palampur, HP	Sh. RK Dhar Controller of Administration CSIR-IHBT, Palampur, HP

STAFF

Scientific
Director

Dr. PS Ahuja

Chief Scientist

Dr. Anil Sood
Dr. RD Singh
Dr. Arvind Gulati
Dr. Bikram Singh

Senior Principal Scientist

Dr. AK Sinha
Dr. Virendra Singh
Dr. HP Singh
Dr. Sanjay Kumar
Dr. Madhu Sharma
Sh. D Dhyani

Principal Scientist

Er. KK Singh
Dr. Ashu Gulati
Dr. Brij Lal
Dr. RK Sud
Dr. Aparna Maitra Pati
Er. GD Kiran Babu
Dr. Amita Bhattacharya
Dr. Gopi Chand
Dr. SK Vats
Dr. Markandey Singh

Senior Scientist

Dr. V Shanmugam
Dr. Vipin Hallan
Dr. Sanjay K Uniyal
Dr. RK Sharma
Er. Amit Kumar
Dr. Y Sreenivasulu
Dr. Sudesh Kumar
Dr. Sanat Sujat Singh
Dr. Rakesh Kumar

Scientist

Dr. Som Dutt
Dr. Ramesh C Kasana
Dr. Shashi Bhushan
Dr. Gopaljee Jha
Dr. Gireesh Nadda
Dr. Neeraj Kumar
Dr. Chandrashekhar Seth
Dr. Pralay Das
Dr. Vijai Kant Agnihotri
Dr. Ravi Shankar
Dr. Probir Kumar Pal
Dr. Anil Kumar Singh

Junior Scientist

Er. Mohit Sharma
Dr. Ashok Kumar
Dr. Yogesh B Pakade

Technical
Principal Technical Officer

Er. RK Bindal
Dr. Raja Ram

Sr. Technical Officer (3)

Sh. Mukhtiar Singh
Dr. RK Ogra
Sh. Om Prakash

Sr. Technical Officer (2)

Dr. Kiran Kaul
Sh. RK Tandon
Sh. RS Shekhawat

Sr. Technical Officer (1)

Sh. Sukhjinder Singh
Dr. Avnesh Kumari
Sh. Sandeep Tripathi
Sh. Vikrant Gautam

Technical Officer

Sh. Ramdeen Prasad
Sh. JS Bisht
Sh. Rakesh Kumar
Sh. Anil Kumar
Sh. Vivesh Sood
Sh. Mahesh S

Technical Assistant

Sh. Ramjeelal Meena
Sh. Sanjay Kumar
Sh. Jasbeer Singh
Sh. Mukesh Gautam
Sh. Sanjoy Kumar Chanda
Sh. Om Parkash
Sh. Prashanta Kumar Behera
Mrs. Vijay Lata Pathania
Sh. Pabitra Gain
Sh. Shiv Kumar
Ms. Meenakshi
Sh. Arvind Kumar Verma

Sr. Technician(2)

Sh. Gian Chand
Sh. Janak Singh
Sh. VS Dhadwal
Sh. Khushal Chand
Sh. Dhruv Kumar
Sh. Ajay Parmar
Sh. Om Prakash
Sh. Karandeep

Sr. Technician(1)

Sh. Kewal Chand

Technician(2)

Sh. Bhushan Kumar
Sh. Harmesh Chand
Sh. Ramesh Kumar
Sh. Dharub Kumar
Sh. Parveen Kumar
Sh. Kuldip Singh

Technician(1)
Sh. Sanjay Kumar
Sh. Avinash C Rana
Sh. Sandeep Sood
Sh. Ranjeet Singh
Sh. Ajay Kumar
Sh. Sushil Kumar
Sh. Surjit Singh
Sh. Arvind Kant
Sh. Vikas Kumar
Ms. Jasveer Kaur

Lab Assistant
Sh. Naresh Kumar
Sh. Prem Parkash

Lab Attendant (1)
Sh. Baldev Singh
Sh. Shyam Lal
Ms. Rajni Devi Chettri
Sh. Rakesh Chand
Sh. Yam Bahadur Chettri
Sh. Uttam Chand
Sh. Balak Ram
Sh. Girja Nand
Sh. Deepak Sood
Sh. Kuldeep Singh
Sh. Balwant Raj
Ms Anupama Saini
Sh. Shamsher Singh

Administrative
Administrative Officer
Sh. Jaswant Rai

Finance & Accounts Officer
Sh. Sunil Kumar

Store & Purchase Officer
Sh. Surender Kumar

Section Officer (F&A)
Sh. Inderjit Singh

Private Secretary
Sh. JK Prashar

Senior Hindi Translator
Sh. Sanjay Kumar

Senior Stenographer
Sh. Didar Singh Patial

Assistant (GEN)
Sh. DR Mishra
Sh. Shanti Kumar
Sh. Raj Kumar
Sh. Lakshmi N Pandey
Sh. Parveen Singh
Sh. Kiran Kumar
Ms. Santosh Kumari
Sh. Baldev
Ms. Pooja Awasthi

Assistant (F&A)
Sh. Manoj Kumar
Sh. Vipan Kumar
Ms. Aruna Kumari

Assistant (S&P)
Ms. Vimla Devi
Sh. Rajeev Sood
Sh. Puneet Kumar

Coupon Clerk
Sh. Anand Sharma

Staff Car Driver
Sh. Pratap Chand
Sh. Brahma Dass

Cook
Sh. Oman Singh
Sh. Karan Singh

Chowkidar
Sh. Baleshwar Prasad
Sh. Parshotam Lal
Sh. Jagat Ram
Sh. Bahadur Ram
Sh. Ramesh Kumar
Sh. Kuldip Singh

Tea/Coffee Maker
Sh. Bipan Gurang

Others
Sh. Thaman Bahadur
Sh. Nand Lal
Ms. Krishna Devi
Sh. Shankar
Sh. Bipan Kumar
Ms. Rujala Devi

Newly Joined Staffs
Scientist
Dr. Amit Chawla
28.04.2011
Dr. SG Eswara Reddy
07.07.2011
Dr. Ganesh Bagler
04.10.2011
Dr. Mahesh Gupta
30.11.2011
Dr. Yogendra Shantaram Padwad
08.12.2011

Sr. Technical Officer (1)
Sh. Jai Prakash Dwivedi
15.12.2011
Dr. Kiran Saini
13.02.2012

Technical Officer
Sh. Mohit Kumar Swarnkar
04.05.2011

Technical Assistant
Sh. Dharmesh Kumar
11.04.2011

Security Assistant
Mr. Trilok Nath
17.01.2012

Superannuation
Sh. RP Sharma
31.01.2012

Transfer
Sh. RK Dhar (CoA)
05-03-2012
Sh. Rajesh Kumar (SO(G))
30-03-2012

Left the Institute
Dr. Amit Bafana (Scientist)
28.04.2011
Dr. Subhash C Yadav(Scientist)
09.11.2011
Dr.Vinayak S. Madnalwar (TO)
16.03.2012
Ms. Arti Katiyar (TA)
30.12.2011
Sh Karan Singh Guleria
(Security Asstt.)
15.07.2011

Principal Investigators
Dr. (Ms.) Alka Kumari
Dr. (Ms.) Jyoti Bhardwaj
Dr. Lakhmir Singh

Scientists Fellow
Dr. Aditi Sourabh
Dr.Vishal Acharya

CSIR-TWAS Fellow
Mr. Richard Chalo Mouki
(PG Fellow)

Senior Research Fellow
Mr.Vikas
Mr.Vikrant Jaryan
Ms. Bandna
Ms. Pushpinder Kaur
Ms. Abha Chaudhary
Mr. Upendra Sharma
Mr.Vinay Kumar
Mr.Vineet Kumar
Ms. Kanika Sood
Ms. Archana Thakur
Ms. Naina Sharma
Ms. Richa Salwan
Ms.Yashika Walia
Ms. Swati Sood
Ms. Monika Mahajan
Ms. Hena Dhar
Ms. Parul Gahlan
Mr. Sewa Singh
Ms. Reenu Kumari
Mr. Dharminder Sharma
Mr. Amit Sharad
Mr. Praveen Kumar
Ms. Shammi Bhatti
Mr. Rajesh Kumar
Ms. Rupali Jandrotia
Mr.Vishal Kumar
Ms. Prachi Awasthi
Mr. Ramdhan
Ms. Praveen Guleria
Ms. Rimpy Diman
Mr. Arun Kumar Shil

Junior Research Fellow
Mr. Anish Kaachra
Mr. Nitul Ranjan Guha
Mr.Yogesh Abaso Thopate
Ms. Pritu Pratibha
Mr. Sandeep Kumar
Mr. Mrigaya Mehra
Ms. Sushila Sharma
Mr. Andhare Nitin Hauserao
Mr. Aditya Kulshreshtha
Mr. Arunava Datta
Mr. Jai Parkash
Mr. Sandeep Kumar
Ms.Vandna Chawla
Ms. Shikha
Ms. Parul Goyal
Mr. C Balreddy
Mr. Manoranjan Kumar
Mr. Aditya Gandhidas Lavekar
Ms. Preeti
Ms. Monika Bhuria
Mr. Ashish Kumar
Ms. Poonam Roshan
Ms. Indu Gangwar
Ms. Shivalika Pathania
Mr. Surender Kumar
Ms. Kiran Mansingh Rawat
Ms. Amrina Shafi

Resigned/ Tenure completed

Scientists Fellow
Dr. Amit Chawla - Resigned on 27.4.2011
Dr. Shivani - Resigned on 22.12.2011
Dr. Ganesh B.Bagler - Resigned on 3.10.2011

Senior Research Fellow
Ms. Priyanka Sood - Tenure completed on 30.9.2011
Mr. Karan Acharya - Tenure completed on 30.9.2011
Mr. Pankaj Bhardwaj - Resigned on 2.5.2011
Ms. Kiran Devi - Tenure completed on 31.10.2011
Ms. Nandini Sharma - Resigned on 13.10.2011
Ms. Devinder Kaur - Tenure completed on 30.9.2011

Junior Research Fellow
Ms. Shalu - Resigned on 30.12.2011
Ms. Indu Barwal – Resigned on 17.02.2012
Mr. Fayaz Ahmed Mir - Resigned on 01.8.2011

Research Interns
Ms. Nidhi Aggarwal - Tenure completed on 19.7.2011
Ms. Tavleen Singh Mann - Tenure completed on 11.10.2011
Ms. Saima - Resigned on 30.6.2011

सारांश

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

हिमालय जैवसंपदा का लक्षणचित्रण एवं प्रबन्धन

पश्चिमी हिमालय की पुष्पीय संपदा एवं पादपीय संरक्षण के प्रलेखन के उद्देश्य से सर्वेक्षण किये गये।

सेपियम सेबीफेरम: सर्वेक्षण से यह पता चला कि पश्चिमी हिमालय क्षेत्र में हिमाचल प्रदेश के 8.28 % क्षेत्र में *सेपियम सेबीफेरम* पाया गया। यह पौधा समुद्र तल से 569 से 1632 मी. की ऊंचाई पर पाया गया। इसकी अधिक संख्या दक्षिण–पश्चिम ढलानों पर पाई गई। *सेपियम सेबीफेरम* के साथ 246 और पुष्पीय पौध प्रजातियां पाई गई। इसमें 78 प्रजातियां विदेशी मूल की हैं जिनमें अधिकतर अमेरिका (33 %) की हैं।

औषधीय पौधों का व्यापार : सर्वेक्षण में पाया गया कि धौलाधार के दुर्गम पर्वतीय क्षेत्रों में औषधीय पौधों के व्यापार का अत्याधिक दवाब है। फसल के समय (मई–जून से सितम्बर–अक्तूबर) में एक व्यक्ति द्वारा एक दिन में *प्रिकोराइजा कुरुआ* के औसतन 5.2 किलोग्राम ताजे पौधे एकत्रित किए जाते हैं जिससे परम्परागत तरीके से सुखाकर एक किलोग्राम सूखी पादप सामग्री प्राप्त की जाती है।

नृवानस्पतिक ज्ञान का प्रलेखन : हिमाचल प्रदेश के कांगड़ा जिले में 66 पौध प्रजातियां पारम्परिक औषधि के रूप में उपयोग में लाई जाती हैं। इनमें से 25 शाक, 23 वृक्ष, 10 बेलें तथा 8 झाड़ियां हैं। इनको 33 रोगों जैसे कि मोटापा प्रबन्धन, स्वस्थ खाद्य, केष देखभाल के लिए उपयोग में लाया जाता है। आठ पादप प्रजातियां जैसे कि *Achyranthes aspera*, *Aegle marmelos*, *Boerhavia diffusa*, *Carum copticum*, *Cassia fistula*, *Curcuma longa*, *Eupatorium adenophorum* and *Piper nigrum* को एक, दो को मिलाकर या दो से अधिक को मिलाकर प्रयोग में लाया जाता है। पौधों के भागों में से सबसे अधिक पत्ते (25%), फल (21%) और बीज (14%) प्रयोग में लाए जाते हैं अन्य भाग बहुत ही कम (1%) प्रयोग में लाए जाते हैं। इलाज के लिए मुख्यतः चूर्ण (28%), पेस्ट (21%) और काढ़ा (12%) उपयोग में लाया जाता है।

किन्नौर हिमाचल प्रदेश की संवहनी वनस्पतियाँ: किन्नौर हिमाचल प्रदेश की संवहनी वनस्पतियों की एक सूची तैयार की गई। इस सूची में 893 टेक्सा हैं जिनमें 881 एंजियोस्पर्म और शेष जिम्नोस्पर्म से संबन्धित हैं। एसटरेसी सबसे अधिक समृद्ध कुल है जिसमें 124 प्रजातियां हैं। इसके बाद पोएसी (68) और रोजेसी (58) लिग्युमिनेसी (49) और लैमिएसी (38) आती हैं। *आर्टिमीसिया* सबसे अधिक विविधता वाली जीनस है जिसकी 17 प्रजातियां है, इसके बाद *पोटेंटिला* 14, *सौसुरिया* 13, *पौलीगेनम* 11, एस्ट्रागेल्स 10, लोनीसेरा 10 तथा नेपिटा 10 प्रजातियों वाली है। 893 टेक्सा में से किन्नौर की वनस्पतिजात में 606 शाकीय, 108 झाड़िया, 38 बेलें, 67 घास तथा 21 सेज तथा जलबेंत हैं। पश्चिमी हिमालय में 108 प्रजातियां स्थानिक हैं और 27 IUCN ने लुप्तप्रायः/खतरे में की श्रेणी में रखा है।

लाहौल–स्पीति में भूमि उपयोग/भूमि आवरण का मानचित्रीकरण: अक्तूबर 2002 के IRS 1D LISS III उपग्रह चित्र के उपयोग के आधार पर लाहौल–स्पीति में भूमि उपयोग/भूमि आवरण का वर्गीकरण किया गया। वर्गीकृत मानचित्र को 9 भागों में (पर्यावास, कृषि/पौध, चट्टानी/बंजर, शैलीय, हिमोढ़, पर्वतीय झाड़ी, पर्वतीय चरागाह, बर्फानी ग्लेशियर, वन और नदी/झील) विभक्त किया गया। लाहौल–स्पीति के कुल भूक्षेत्र चट्टानी/बंजर (61%), पर्वतीय झाड़ी/चारागाह (17.9 %), बर्फानी ग्लेशियर, वन (1.5 %) पर्यावास (1.9 %), कृषि/ पौधे (0.2 %) तथा नदी/झील (0.9 %) के रूप में है। इसका 15.2 % स्थायी रूप से बर्फानी ग्लेशियर आवरण में आता है। लाहौल के तांदी रिबलिंग क्षेत्र में उच्च तुंगता जीवविज्ञान केन्द्र के स्थलों में पादप प्रजाति की विविधता को जानने के लिए सर्वेक्षण किया गया। दक्षिण–पश्चिमी ढलानों में चारागाह है, जिसमें अधिकतर घास है।

पश्चिमी हिमालयी में टेरेडोफाइट के वनस्थलों का आंकड़ा संचय : पश्चिमी हिमालयी में टेरेडोफाइट के वनस्थलों का आंकड़ा संचय तथा पर्यावास एवं मात्रा जानने के लिए चम्बा, कांगड़ा, मंडी तथा ऊना में प्रक्षेत्र सर्वेक्षण किया गया। टेरेडोफाइट के जीवित पौधों को संस्थान की फर्नरी में लगाने के लिए और पादपालय में रखने हेतु एकत्रित किया गया।

हिमाचल प्रदेश में टेरेडोफाइट के वितरण/मात्रा को जानने के लिए, ऐडिऐंटम और चेलनथेस प्रजातियों की जानकारी प्रकाशित प्रलेखों से एकत्रित की गई तथा एक मानचित्र बनाया गया।

फर्न स्पोरों का लक्षणचित्रण के उद्देश्य से संस्थान में स्पोर रेपोजेटरी स्थापित की गई। इस में 25 फर्न प्रजातियां तथा 2 फर्न सहायक प्रजातियों के स्पोरों को एकत्रित किया तथा संरक्षित किया गया।

धौलाधार वन्यजीव अभ्यारण, ग्रेट हिमालयन नेशनल पार्क, रुपी भावा वन्यजीव अभ्यारण और पिन वेली नेशनल पार्क का भौगोलिक सूचना पद्धति आधारित भौतिक, मृदा और भौगोलिक मानचित्र तैयार किया गया। यह मानचित्र मृदा और भूविज्ञान, मृदा वर्गिकी एवं लिथॉलौजिकल यूनिट की जानकारी प्रदान करता है।

नवम्बर 2000 के उपग्रह चित्र के उपयोग के आधार पर ग्रेट हिमालयन नेशनल पार्क के भूमि उपयोग/भूमि आवरण के वर्गीकरण में पाया गया कि शैलीय/पथरीली और बर्फानी वर्ग (44.37 प्रतिशत) में फैला था। MODIS उपग्रह के आधार पर वर्ष 2011 में औसतन वार्षिक नेट प्राइमरी प्रोडेक्टीविटी आंकी गई। पश्चिमी हिमालय क्षेत्र में 10 दीर्घकालीन पारिस्थिकीय अनुसंधान प्रक्षेत्र स्थापित किए गए। विभिन्न इकोसिस्टम से जैवसंपदा आकलन के लिए आधारभूत पर्यावरणीय आंकड़े एकत्रित किए गए जो पादप प्रजातियों के उपस्थिति और लुप्त होने की दृष्टि से महत्वपूर्ण हैं। रुपी भावा घाटी में 204 वषों और 68 कुलों की कुल 313 प्रजातियां पाई गई। बिलासपुर वन मण्डल में 237 प्रजातियां पाई गई। *ऱ्यूमैक्स* की संख्या का विस्तारण हिमालय क्षेत्र के उच्च तुंगता एवं निचले क्षेत्रों में दर्ज किया गया।

जिनोमिक्स एवं प्रोटियोमिक्स

शुष्क एवं उच्च ताप दबाव के लिए थर्मोस्टेबल इन्जाइम की आवश्यकता होती है। विस्तारित थर्मोस्टेबिलिटी के लिए सुपरोक्साइड डिसम्यूटेज का निर्माण किया गया जो किसी भी तापमान पर कार्य कर सकता है।

पोडोफिलम एवं *पिक्रोराइजा* में मेटाबोलाइट उत्पादन के आण्विक आधार जानने के लिए एक परियोजना शुरु की गई है। गस रिपोर्टर जीन द्वारा ट्रांसजैनिक पौधे बनाने के लिए पेरामीटर का इष्टतमीकरण किया गया। फ्लेवोनोल सिन्थेज के जीन PTGS द्वारा बीजरहित या बहुत कम बीज वाले फलों को तैयार करने के लिए एक उपाय तैयार किया गया।

उच्च तुंगता जीवविज्ञान के कार्य में एरोबिडोप्सिस पर पेप कार्बोक्सिलेज (PEPCase) एसपरटेट एमिनोट्रांसपिरेज़ (AAT), तथा ग्लुटामिन सिन्थेटेज (GS) एन्जाइम ओवरएक्सप्रेस्ड किए गए। इससे निर्मित ट्रांसजेनिक पौधे ने बेहतर कार्बन फिक्सेसन क्षमता विभिन्न प्रकाश तथा CO_2 स्तर पर प्रदर्शित की।

सुपर ऑक्साइड डिस्म्यूटेज (SOD), केटालेज़ (AAT) तथा एस्कोरवेट परऑक्साइडेज़ (APX) इन्जाइमों का प्रयोग करके खाद्य पदार्थों को ज्यादा समय तक संरक्षित रखने के लिए कार्य शुरु किया गया है। टमाटर और पालक पर किए गए शोध में अच्छे परिणाम प्राप्त हुए हैं।

एकीकृत नेटवर्क जीवविज्ञान

अस्थमा तथा सेकेन्डरी बोन कैन्सर रोगों के प्रबल लक्ष्य की पहचान और प्रोटीन इन्टरेक्टोमस के लिए काम्प्लैक्स सिस्टम एनालिसिस और ग्राफ थ्योरी का उपयोग किया गया।

पौध प्रणाली में microRNA के लक्ष्य की खोज के लिए p-TAREF सॉफ्टवेयर तैयार किया।

नेनोबायोलाजी

लोनीसिरा *Lonicera japonica* एवं *Bauhinia variegata* *बाहुनिया वेरीगेटा* को Ag Au नेनोकणों के सिथेंसिस के लिए उपयोग किया गया। संश्लेषित धातु–नैनोकणों के आकार एवं रचना तथा पादप–सार की सांद्रता, मूल ध ातु–यौगिक की मोलरिटी, इन्क्यूबेशन का समय तथा तापक्रम के बीच सह–संबन्ध स्थापित किए गए।

प्राकृतिक पादप रासायनिकी

शतावर (*ऐस्पेरेगस रेसिमोसस*): आयुर्वेद में शतावर को वायुविकास, अल्सर, स्नायु संबन्धी विकास, प्रदाहक, यकृत रोग, अपच, दुग्धस्रावी के उपचार के रूप में किया जाता है। शतावर से दो स्टीरायडल सपोनिनस का शुद्धिकरण किया गया जिन्हें सटावरोसाइड–ए व बी नाम दिया गया। इन यौगिकों में प्रतिरक्षा क्षमता में वृद्धि करने के गुण पाए गए।

देवदार (*सेड्रस देवदारा*) : देवदार से दो नवीन सेसक्युटरपिन यौगिकों का शुद्धिकरण किया गया। दो ज्ञात यौगिकों, अटलाटोन व अटलान्टोलोन तथा मन्हेक्सन व क्लोरोफार्म रसो में फफूंदरोधी गुण पाए गए।

गुडुचि (*टिनोस्पोरा कॉर्डिफोलिया*) : गुडुचि के गर्म जल, इथामल एसीटेट व जल रसो में प्रतिरक्षा क्षमता को बढ़ाने के गुण पाए गए। इन रसों से प्रतिरक्षा क्षमता में वृद्धि करने वाले विभिन्न यौगिकों का शुद्धिकरण किया गया।

चाइनीज अलबीजिया : चाइनीज अलबीजिया के फिनोलिक यौगिकों के अभिलक्षणन हेतु यू.पी.एल.सी.–एम.एस. तकनीक का प्रयोग किया गया। इस प्रकार 15 यौगिको की पहचान की गई।

तिरमिरा (*जेन्थोजायलम अर्मेटम*) : तिरमिरे की छाल से तीन सीनामायॅल एमाइड्स, एक लिगनान व सीनामायॅल एस्टर; पत्तियों से पाँच लेवानायॅड्स; तथा बीजों से दो आइसोब्युटाइल एमाइड्स का शुद्धिकरण किया गया।

हावथॉर्न (*क्रैटेगस ऑक्सियाकंन्था*) : हावथॉर्न के पत्तियों के रस/सारसत्व में वाइटेक्सीन, हाइपरोसाइड् वाइटेक्सीन रहमनोसाइड, क्वेरसेटीन तथा एपीजेनीन के निर्धारण हेतु एच.पी.टी.एल.सी. आधारित विधि विकसित की गई।

दमस्क गुलाब : दमस्क गुलाब के ताजे फूलों (7355 कि. ग्रा.) का वृहद स्तर पर आसवन कर 2.576 ली. रोज तेल तथा 2000 ली. गुलाबजल का उत्पादन किया गया।

हिपोफी : हिपोफी की पत्तियों व फूलों में 6 फिलोलिक्स (रूटीन क्वेरसेटीन क्लेक्टोसाइड, क्वेरसेटीन, माइरीसेटीन, केम्फौराल तथा आइसोरहमोटीन) के परिवर्तन के निर्धारण हेतु एच.पी.एल.सी. विधि विकसित की गई। पत्तियों में रूटीन व क्वेटसेटीन ग्लेक्रोसाइड की मात्रा फूलों से अधिक पाई गई।

वनखोड़ (इंडियन हॉर्स चेस्टनट, *एस्कुलस इंडिका*) : वनखोड़ के बीजों से एसिन के शुद्धिकरण के लिए वृहद स्तर पर (130 कि0 ग्रा.) पर विधि विकसित की गई।

संश्लिष्ट रसायन विज्ञान : पी.डी. (ओ) के सोलिड–सपोर्टड नैनो व माइक्रो कणों (एस.एस.–पी.डी.) का विजातीय उत्प्रेरक की तरह प्रयोग कर बेन्जाइल एल्कोहल का वायुवीय ऑक्सीकरण किया गया जिससे प्राथमिक व द्वितीयक कार्बोनिल अच्छी मात्रा में प्राप्त हुए।

अनुक्रमित माइकल क्लेजन अभिक्रया के जरिए अक्रियाशील एसीटोन से साइक्लोहेक्स–1, 3–डाईओन बनाए गए।

समावयवीय हिमाचलीनस के मिश्रण से दो पदों की अनुक्रमित अभिक्रिया का प्रयोग कर नए बेन्जोसाइकलो हेप्टीन एमीनो विनायल ब्रोमाइड व्युत्पन्न बनाए गए।

एक टंडेम एलायलीक–आक्सीकरण–संक्षेपन/एस्टरीकरण अनुक्रम विकसित किया गया। जिससे प्रचुर मात्रा में पाए जाने वाले मीथोक्सीलेटेड फिनरयल प्रोपीन्स से डाइनोन्स तथा इनोन्स का संश्लेषण किया गया जिन में मलेरिया विरोधी प्रक्रिया पाई गई।

कुछ नवीन टंडेम अभिक्रियाओं का प्रयोग कर हाइड्रोक्सी प्रतिस्थापित स्टीलवीन–सी नोमायल संकरण तथा असममित डाईस्टायरील बेंजीन का संश्लेषण किया गया जिनमें मधुमेहरोधी गुण पाए गए।

एक अनुक्रमिक क्लेजन–स्मीड–नोवेन्जंल–हेक अभिक्रया का प्रयोग कर स्टीलवीन चालकोन संकरणो का संशलेषण किया गया। इन संकरणो के मलेरीया विरोधी गुण पाए गए।

आयनिक द्रवो में द्वितीयक एराइल अल्कोहल के निर्जलीकरणी हेक ऑलीफीकेषन से स्टीलबीनॉयडस का संश्लेषण किया गया। इस अनोखी विधि में द्वितीयक अल्कोहल का एराइल हैलाइड्स के साथ सयोग किया गया।

कोबाटर थेलोसायनीन का उत्प्रेरक की तरह प्रयोग कर कार्बोनिल यौगिकों का रिडक्टीव अमाइनेसन्स किया गया। इस विधि से एन–प्रतिस्थापित आइसोइण्डो लीनोन व्युत्पनन भी बनाए गए। इसी प्रकार निकल थेलोसायनिन की सहायता से कार्बोनिल यौगिकों का रिडक्षन किया गया।

बागानी फसलें

चाय में शुष्क प्रतिरोधकता आण्विक आधार : चाय के उत्पादन में एबायोटिक दबाब का अध्ययन किया। 1892 क्लोनों को अनुक्रमित एवं विश्लेषित किया गया। इसमें थोमाटिन जैसे प्रोटीन, चिटिनेज और लेटएम्ब्रियोजेनेसिस एबेडेट प्रोटीन को चाय में 'शुष्क दबाव अवरोध' तैयार करने के लिए उपयोगी लक्ष्य पाया गया। प्रक्रमित चाय में उपयोग किए गए उतकों से sRNA लाइब्रेरी तैयार की जिससे चाय मेटाबोलिजम के नियामकों को समझा जा सके। 6 नवीन sRNA विलगित किए गए और जिससे 67 जीन्स परिलक्षित किए गए जो विभिन्न पादप कार्यों के लिए उत्तरदायी हैं।

श्रेष्ट रोपण सामग्री का क्लोन के आधार पर चयन किया गया।

मनचाहे आकार की चाय पत्ती की तुड़ाई के लिए स्किफिंग मशीन की तीसरे वर्ष कार्य निष्पादकता जांची गई तथा वांछित परिणाम पाया गया।

स्पेक्ट्रोरेडियोमीटर से अध्ययन में पाया कि चाय बागान प्रबन्धन में कर्षण–प्रक्रिया चाय पौध के उच्चवर्णक्रमीय व्यवहार को प्रभावित करती है।

पुष्पण के विभिन्न अवस्थाओं में जैवरासायनिकी गुण : अनखिली कली से लेकर पूर्ण खिले फूल के पांच विकास स्तरों पर कायिकी और जैवरासायनिकी अध्ययन किया गया। एक व दो स्तरों पर प्रोटीन अधिक पाई गई जबकि अन्य स्तरों पर यह मात्रा कम होती गई।

बाँस : *डेन्ड्रोकैलामस एस्पर* के ताजे बीजों से नए पौधे तैयार किए गए। जम्मू व कश्मीर सहित देश के 15 राज्यों में खाद्य बाँस के 12 किस्मों के लगभग 5 लाख पौधों की आपूर्ति की गई। बाँस के जीवनकाल को बढ़ाने के कार्य में भी सफलता मिली।

बैम्बूसा न्यूटेंस की गांठो से अप्रत्यक्ष कायिक भ्रूणोत्पति के लिए एक प्रोटोकॉल की मानकित किया। परिणामों में कोई ज्यादा आनुवांशिक भिन्नता नहीं पाई गई।

डेन्ड्रोकैलामस हेमिल्टनाई से मंद गति परिस्थितियों में बहुत त्वरित बहुतगुणित कायिक भ्रूणोत्पति के मध्यम प्रकार के भण्डारण के लिए एलपीओ उपाय का प्रयोग किया गया।

जिन्कगो बाइलोबा : पालमपुर की कृषि जलवायु परिस्थितियों में *जिन्कगो बाइलोबा* में पौध विरलता और जैविक खाद के प्रयोग के प्रभाव का अध्ययन किया गया। इसके द्वारा पौधे की ऊंचाई और टहनियों की संख्या में कोई प्रभाव नहीं पड़ा लेकिन जैविक खाद के उपयोग से पत्तों की संख्या में महत्वपूर्ण वृद्धि पाई गई।

खाद्य एवं मसाला फसलें

स्टीविया : स्टीविया के सूखे पत्तों की जैवमात्रा में पौध विरलता और जैविक मल्च का प्रभाव देखने के लिए अध्ययन में पाया गया कि चीड़ की पत्तियों की अपेक्षा पापुलर के पत्तों की मल्चिंग करने पर स्टीविया के सूखे पत्तों की जैवमात्रा अधिक पाई गई, जबकि सिलवर ओक के मल्च का प्रभाव चीड़ के मल्च के समान ही रहा। नई परिवर्तिता के लिए चयनित जीनोटाइप से संकरण का कार्य आंरभ किया गया है।

सेब पोमेस : सेब पोमेस से बीजों को अलग करने के लिए एक प्रोटोटाइप को विकसित किया गया तथा इसका एक पेटेंट भी फाइल किया गया है। एक स्वतन्त्र एजेन्सी के द्वारा विकासित आहारीय रेसों का सुरक्षा मूल्यांकन पुनः निध ारित किया गया। निष्कषर्ण तकनीक से आहारीय रेसों से बहुत से उत्पादों को भी विकसित किया गया है।

केसर : केसर एक बहुमूल्य फसल है जिसको खाद्य पदार्थों में रंग व सुगंध एवं औषधीय उपयोग के लिए प्रयोग में लाया जाता है। शेरे कश्मीर कृषि विज्ञान एवं प्रौद्योगिकी विश्वविद्यालय, श्रीनगर के केसर अनुसंधान केन्द्र में सितम्बर 2009 को प्रदर्शन खण्ड विकसित किए गए जिसमें मादा घनकंद से अधिकतम 4 घनकंद तथा 5–7 ग्राम भार वाले 5 कोर्मलेट पाए गए।

पुष्प फसलें

शोभाकारी गुलाब : नई पुष्प किस्मों को बनाने के लिए शोभाकारी गुलाबों का प्रजनन किया गया। तेल की गुणवत्ता, फूलों के आकार और पुष्प विविधता के लिए गुलाब के 6 विभिन्न प्रजातियों (*रोजा बौर्बेनियाना, रो. बैंकेसी, रो. ब्रुनोनी, रो. सेंटीफोलिया, रो. रुगोसा* और *रो. चायनेंसिस मिनिमा*) में अंतरजातीय संकरण किया गया जिसके अच्छे परिणाम सामने आने लगे हैं।

जरबेरा : *जरबेरा जेमसोनाई* की दो किस्मों में अंतरजातीय संकरण द्वारा फूलों के रंग, आकार आदि में अच्छे परिणाम पाए गए।

***इन–विट्रो* कल्चर** : नारंगी रंग की जरबेरा की एक प्रजाति के कली, पत्तों आदि विभिन्न भागों को एमएस माध्यम में पुनर्जनन के लिए मूल्यांकित किया गया। इसमें 50 से 62.5 % सफलता दर्ज की गई तथा 8 पीस की पुश्प कली से सबसे अधिक पुनर्जनन देखा गया।

ग्लेडियोलस : भारतीय कृषि अनुसंधान संस्थान, पूसा, नई दिल्ली से लाई गई 10 कृषोपजातियों की कार्यनिष्पादन क्षमता को पालपमुर की जलवायु परिस्थितियों में जांचने हेतु 2009 से 2011 तक अध्ययन किये गये। परिणामों से पता चला की शबनम प्रजाति में सबसे अधिक लम्बी (127.88 सेमी.) स्पाइक प्राप्त हुई। धनवंतरि प्रजाति में सबसे अधिक फ्लोरेट रहे जो सबसे अधिक (17.27) दिनों तक ताजे रहे।

गुलादाउदी (क्राइसेन्थिमम प्रजाति) : गुलादाउदी को पूरे विश्व में कर्तित पुष्प के रूप में व्यापक रूप से उगाया जाता है जिसकी ताजगी बहुत लम्बे समय तक रहती है। सी.एस.आई.आर. के संस्थान राष्ट्रीय वनस्पति अनुसंधान संस्थान, लखनऊ से 33 छोटे आकार बाली किस्मों को पालमपुर की जलवायु में पालीहाउस परिस्थितियों में जांचने का अध्ययन 2010 से किया गया। रेटून फसल डेटा से वाइ2के प्रजाति में सबसे अधिक संख्या (430.66) में पौधे प्रतिवर्ष प्राप्त किए गए। सिजुका में सबसे अधिक पुष्प कलियां (33.73) प्रतिवर्ष प्राप्त की गई।

लिलियम : लिलियम के पुष्प की सुन्दरता, आकर्षण, चमकदार व विभिन्न रंगों में उपलब्धता, तुड़ाई के उपरान्त ज्यादा दिनों तक तरोताजा बने रहने की क्षमता, सरलता से उगाए जाने तथा कुछ किस्मों में मनमोहक सुगंध पाए जाने के कारण यह विश्व के सर्वोच्च 10 कर्तित पुष्पों की श्रेणी में आता है। व्यावसायिक रूप से एशियाटिक संकर लिलि प्रजाति के कंदो के आकार के मानकीकरण में पाराटो प्रजाति में अधिकतम कंद (14.37 से.मी.) पाया गया।

कार्नेशन : कार्नेशन एक बहुत ही महत्वपूर्ण कर्तित पुष्प फसल है जिसकी मोहकता और तरोताजगी के लिए अधिक मांग है। अध्ययन में पाया गया है कि इसकी खेती अधिक लाभ देने वाली है।

सूक्ष्मजैविकी एवं पाद रक्षण

भारत की समृद्ध सूक्ष्मजैविक विविधता का पता लगाना : भारतीय ट्रांस हिमालय के शीत पर्यावासों से जीवाणु, एक्टिनोमाइसिटी और कवकनाशी के 1080 ताजे संवर्धों को वियोजित तथा प्रतिपादित किया गया। सूक्ष्मजीव प्रतिरोधी गतिविधि जानने के लिए 205 जीवाणुओं, 120 एक्टिनोमाइसिटी तथा 25 कवकों के संवर्ध निष्कर्षणों का परीक्षण किया गया। 75 वियोजितों में एक या अधिक में जीव परीक्षणों में सक्रियता पाई गई, जिनमें से 22 जीवाणु, 7 एक्टिनोमाइसिटी और 4 कवक संवर्धों में *बेसिलस सब्टीलिस, कैंडिडा एल्बिकेल, ई. कोलाई, क्लेवसिला प्लेंटिकोला, माइक्रोकोकस ल्यूटस, पी. एरूगिनोसा, स्टैफिलोकोकस आयरिस* MLS 16 और *एस. आयरिस* के विरुद्ध वृहद गतिविधि पाई गई।

नैदानिक प्रभेदों के विरुद्ध सूक्ष्मजीन प्रतिरोधी गतिविधि के लिए 21 सक्रिय जीवाणु, एक्टिनोममाइसिटीज और कवक संवर्धों को अनुवीक्षित किया गया। सूक्ष्मजीव संवर्धों को अन्य जैविक गतिविधियों के अनुवीक्षण के लिए एक अध्ययन में 1600 संवर्ध निष्कर्षण तैयार किए गए जिनमें से 29, 19 और 16 निष्कर्षणों में क्रमशः β-lactamase (NIIST), AChE तथा α-glucosidase (CFTRI) निरुद्ध पाई गई।

पौधों पर आधारित जैवकीटनाशक बनाने की दिशा में 296 पादप सारसत्वों को कीटों ओर माइट के विरुद्ध जांचा गया। इनमें से 4 सारसत्वों में अच्छी गतिविधि पाई गई।

सेबों की माइट को नियंत्रित करने के लिए कुछ नए अकैरिसाइड को प्रयोगशाला में जांचा गया। कुछ प्रयोग ग्रीनहाउस में गुलदाउदी की माइट को नियंत्रित करने के लिए लगाए गए। सबसे अच्छे परिणाम एवामैक्टिन ने दिए। डैल्टामैथ्रिन को गुलाब के एफिड को नियंत्रित करने के लिए सबसे अच्छा पाया गया।

उच्च तुंगता वाले क्षेत्र में पाए जाने विभिन्न कीटों की जानकारी के लिए सर्वेक्षण किए गए। साथ ही *साल्विया सकलेरिया* को *हैलिकोवरपा आर्मिजेरा* को नया परपोषी पौधा पाया गया।

सेबों में दस कीटनाशकों को एक साथ पता लगाने के लिए एक बहुआयामी कीटनाशक अवशेष उपाय खोजा गया है। साथ ही कुछ नए कीटनाशकों (क्लैंटिजीन, टैब्यूफीनापाइरेड और फैनपाइरौग्जिमेट) को सेबों बागानों में प्रयोग के लिए प्रोटोकाल बनाए गए हैं। विभिन्न नमूनों को उच्च धातु के लिए भी जांचा गया है।

ग्रामीण विकास

चाय, बांस पौधारोपण, व्यावसायिक पुष्पविज्ञान, बागवानी और औषधीय एवं सगंध पौधों के उत्पादन और मूल्यवर्धन के लिए सामाजिक विकास गतिविधियों को शुरु किया गया। गुणवत्तायुक्त रोपण सामग्री, पौधशाला एवं पौध तैयारी, स्थल पर जाकर ही व्यावहारिक प्रशिक्षण, प्रक्रमण प्रदर्शन, जागरुकता भ्रमण, तकनीकी बुलेटिन तैयार एवं वितरित

करना, टेलीविजन एवं रेडियो कार्यक्रम प्रस्तुति, वेबसाइट में सामग्री और संस्थान द्वारा विकसित प्रौद्योगिकी पर ज्ञान का आदान–प्रदान जैसी कई गतिविधियां ग्रामीण विकास कार्यक्रम का हिस्सा हैं।

किसान, ग्रामीण समुदाय, सगंध तेल एवं पादप रसायन उद्योग, आयुर्वेद क्षेत्र, जैवसंपदा संरक्षण में लगे लोग और ग्राहक आदि इस परियोजना से सीधे तौर पर लाभान्वित हो रहे हैं। जैवप्रौद्योगिकी, बागवानी, वन विभाग और जिला ग्रामीण विकास अभिकरणों को ज्ञान, तकनीक के साथ–साथ रोपण सामग्री भी प्रदान की जाती है। हिमाचल प्रदेश, उत्तराखंड, जम्मू व कश्मीर जैसे पहाड़ी राज्यों के अतिरिक्त सिक्किम, मिजोरम और अरुणाचल प्रदेश जैसे उत्तर–पूर्व राज्यों के स्वयंसेवी संगठन भी इस योजना का लाभ उठा रहे हैं।

चाय : चाइना संकर चाय की मशीनी तुड़ाई एवं सख्त पत्तियों की छंगाई के लिए हिमाचल प्रदेश के कांगड़ा जिले के चाय उत्पादकों के चाय बागानों में प्रदर्शन कार्यक्रमों का आयोजन किया गया। 14 चाय उत्पादकों को इस मशीन के सुरक्षा उपायों तथा कार्य के बारे में प्रशिक्षण दिया गया। इसके द्वारा बीड़ व धर्मशाला के दो स्वयं सहायता समूहों ने अपने 3 हे. बागानों में इसका उपयोग किया। इससे श्रम की समस्या का भी कुछ हद तक छुटकारा संभव हुआ।

सभी चाय क्षेत्रों में चाय बागान प्रबन्धन के विभिन्न पक्षों पर चाय परामर्श सेवाएं आयोजित की गईं। धर्मशाला व पालमपुर क्षेत्र में 52 तथा बैजनाथ व जोगिन्द्रनगर क्षेत्रों में वर्ष के दौरान 47 परामर्श यात्राएं की गईं।

प्रशिक्षण एवं प्रदर्शन कार्यक्रमों का आयोजनः चाय बागानों के प्रबन्धन से संबन्धित विभिन्न पहलुओं पर वर्ष भर के दौरान संस्थान एवं विभिन्न चाय बागानों में जाकर 20 कार्यक्रमों का आयोजन किया गया जिसमें 477 लोगों ने प्रशिक्षण प्राप्त किया, जिनमें प्रदेश एवं उत्तराखंड के बागवान एवं चाय एवं कृषि विभाग के अधिकारी भी शामिल हैं।

पुष्पविज्ञान : अनखिली कली का प्रयोग करते हुए नारंगी रंग के इन–विट्रो जरबेरा तैयार किए गए। इन–विट्रो से तैयार जरबेरा के 10000, गुलदाउदी के 2500 और लिलियम के 6400 पौधों को प्रक्षेत्र परिस्थितियों में दृढ़ीकरण के लिए लगाया गया। इनकी सफलता दर 50 से 85% तक पाई गई।

व्यावसायिक पुष्पखेती को बढ़ावा देने के लिए किसानों के खेतों में प्रदर्षन प्रखंड स्थापित किए गए। जिसके परिणामस्वरुप पुष्पखेती के अधीन क्षेत्र का विस्तार हुआ है।

फसल	क्षेत्र हे.	जिला
लिलियम	2.00	कांगड़ा, लाहौल –स्पीति, मण्डी, कुल्लू एवं सोलन
गुलदाउदी	0.40	कांगड़ा, मण्डी एवं सोलन
गेंदा	6.00	कांगड़ा, मण्डी, चम्बा एवं ऊना
एलस्ट्रोमेरिया	0.10	कांगड़ा, चम्बा एवं शिमला
एगापेंथस	0.10	कांगड़ा
बर्ड आफॅ पेराडाइज	0.10	कांगड़ा, कुल्लू एवं शिमला
ग्लेडियोलस	2.50	कांगड़ा, मण्डी, कुल्ल एवं ऊना
कारनेशन	1.50	बिलासपुर, कांगड़ा कुल्लू एवं सोलन

रोपण सामग्री का बहुगूणन एवं वितरण : लिलियम, गुलदाउदी, गेंदा, एलस्ट्रोमेरिया, एगापेंथस, बर्ड आफॅ पेराडाइज, ग्लेडियोलस जैसे व्यावसायिक दृष्टि से महत्वपूर्ण कर्तित पुष्पों की रोपण सामग्री को बहुगुणित करके विभिन्न जिलों में वितरित किया गया।

प्रदर्शन प्रखंड : लाहौल व स्पीति में लिलियम, चम्बा में गुलदाउदी और गेंदा तथा कांगड़ा में एलस्ट्रोमेरिया, बर्ड आफ पेराडाइज और गुलाब के प्रदर्शन प्रखण्डों को विकसित किया गया।

वर्ष के दौरान कुल 6 प्रशिक्षण कार्यक्रमों का आयोजन किया गया जिसमें से 2 कार्यक्रम लाहौल में आयोजित किए गए। वर्ष के दौरान 603 किसानों, छात्रों आदि ने संस्थान के पुष्पविज्ञान प्रक्षेत्र का भ्रमण करके जानकारी प्राप्त की।

जिला ग्रामीण विकास अभिकरण, जिला कांगड़ा द्वारा दरंग में फ्लावर फेडरेशन द्वारा कांगड़ा में पुष्पोत्पादन का पुनरोत्थान विषय पर एक कार्यशाला में संस्थान ने अपनी विशेषज्ञता सेवाएं प्रदान की।

ग्रामीण विकास कार्यक्रम के अन्तर्गत ''कार्नेशन की व्यावसायिक खेती की तकनीक'' तथा ''सेब, आलूबुखारा एवं चेरी के फलों के विषाणु और वायरायड रोगों का प्रबन्धन'' विषयों पर दो तकनीकी ब्रोशर प्रकाशित किए गए।

औषधीय एवं सगंध पौधे : ग्रामीण विकास के अन्तर्गत औषधीय, सगंध एवं उच्च मूल्यवान फसलों की उच्च पैमाने में खेती को प्रोत्साहित किया गया है। संस्थान बीज से लेकर उत्पाद की संम्पूर्ण उत्पादन तकनीक उपलब्ध कराता है। कांगड़ा और उत्तराखंड के 10 हे. से भी अधिक क्षेत्र में दमस्क गुलाब की नई पौध को लगाया गया है। रोजमेरी, केमोमाइल, मुस्कबाला और जंगली गेंदे को हि.प्र. और उत्तराखंड में फैलाया गया है।

विशिष्ट प्रशिक्षण : जिला जलागम विकास एजेंसी, शिमला के सहयोग से षिमला जिले के किसानों के लिए तीन दिवसीय 10 प्रशिक्षण कार्यक्रमों का आयोजन किया गया जिसमें कुल 220 लोगों ने प्रतिभागिता की। इसी प्रकार का तीन दिवसीय कार्यक्रम उत्तराखंड के लोगों के लिए भी आयोजित किया गया। एक सात दिवसीय कार्यक्रम भारतीय वानिकी अनुसंधान एवं शिक्षा परिषद्, देहरादून के लिए आयोजित किया गया। इसके अतिरिक्त 8 अन्य प्रशिक्षण कार्यक्रमों का भी आयोजन किया गया जिसमें तीन कार्यक्रम भारतीय चिकित्सा पद्धति जोगेन्द्रनगर जिला मंडी के लिए किए गए जिसमें 94 किसानों को प्रशिक्षण प्रदान किया गया। इसी प्रकार तीन कार्यक्रम राष्ट्रीय बागवानी मिशन के अन्तर्गत जम्मू–कश्मीर के बारामूला के किसानों के लिए आयोजित किए गए।

औषधीय एवं सगध पौधों की रोपण सामग्री का वितरण : संस्थान ने दमस्क गुलाब, स्टीविया, अश्वगधा, लेवेन्डर, जंगली गेंदे, रोजमेरी, सुगंधित जिरेनियम, एलोवेरा, जिंकगो, मुश्कबाला, सफेदा, *बकोपा मोनिरी*, बनफ्सा, टैक्सस, क्रेटेगस जैसे औषधीय एवं सगंध पौधों के हजारों पौधे, कलमें तथा बीज हिमाचल प्रदेश, पंजाब, उत्तराखंड, जम्मू व कश्मीर, दिल्ली कर्नाटक, मिजोरम, प. बंगाल, आंध्र प्रदेश, उत्तर प्रदेश, ओडीसा आदि राज्यों को वितरित किए।

प्रदर्शनी में प्रतिभागिता : संस्थान ने कृषि विश्वविद्यालय, पालमपुर, धर्मशाला तथा ऊना में संस्थान के पुष्पविज्ञान की गतिविधियों को प्रदर्शित किया।

उत्तक संवर्धन इकाइयों को सहायता : इन विट्रो सेब विषाणु परीक्षित रूटस्टॉक रजत बायोटेक, घुमारवीं; नेवा प्लांटेशन, कांगड़ा तथा कुनाल बायोटेक, मनाली को प्रदान किए गए। यह उद्यमी इनसे तैयार पौधों को किसानों और पौधाशाला उत्पादकों को प्रदान कर रही है।

इन विट्रो सेब में से विषाणुओं की पहचान करने के लिए एक उपाय को विकसित कर लिया गया है।

बाँस का उपयोग : बाँसों के अनेक उपयोगों के विषय में उपयुक्त जानकारी तथा बाँसों से बनी वस्तुएं दर्शित करने के लिए हमारे निदेशक महोदय ने भरपूर रुचि ली। परिणामस्वरूप पूर्णतया बाँसों से निर्मित लगभग 3600 वर्ग फीट में फैला एक बाँस का संग्रहालय आज बन कर तैयार है। उत्तराखंड बैम्बू एवं फाइबर बोर्ड, देहरादून को निर्माण कार्य की जिम्मेदारी दी गई। यह एक स्वप्न था जो सभी के सहयोग से पूरा हो सका तथा सी.एस.आई.आर. ने इसके निर्माण हेतु वित्तीय सहायता प्रदान की। आज यह हिमाचल प्रदेश में एक विशिष्ट दर्शनीय भवन का दर्जा लेने जा रहा है और लोगों में बाँस के प्रति बढ़ती रुचि का भी परिचायक है। यहां इस बात का उल्लेख करना अनिवार्य होगा कि इसके निर्माण में स्थानीय रूप से उपलब्ध बाँस की प्रजाति का ही उपयोग किया गया तथा बाँसों को कीटरोधक रासायनिक प्रक्रिया से गुजारा गया ताकि इस भवन की वैभवता, दृढ़ता एवं स्थायीत्व को कोई हानि न पहुंचे।

निर्माण के लिए स्थानीय बाँस (*डैन्ड्रोकैलेमस हेमिलटीनाई* यानि मग्गर बाँस) का प्रयोग किया गया। अब जब यह सुन्दर भवन बनकर तैयार है तो हमें विश्वास है कि यह हमारे संस्थान तथा प्रदेश में आनेवाले सभी अतिथियों के लिए एक दर्शनीय स्थान के रूप में उभरेगा तथा उन्हे सोचने के लिए मजबूर कर देगा कि बाँस से इतने सुन्दर एवं टिकाऊ भवनों का निर्माण कर हम न केवल अपने वनों की सुरक्षा सुनिश्चित कर पाएंगे अपितु बाँस से जुड़े अनेक उद्योगों तथा कर्मियों की आजीविका का साधन भी बन पाएंगे। इसमें बाँस से बने अन्य उत्पादों को भी प्रदर्शित किया गया है।

ग्रामीण विकास परियोजनाओं का वार्षिक पर्यवेक्षण : हिमालय जैवसंपदा प्रौद्योगिकी संस्थान एवं 17 अन्य प्रयोगशालाओं द्वारा वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद् (सी.एस.आई.आर.) संस्थानों के माध्यम से ग्रामीणों, अनुसूचित जाति/अनुसूचित जनजाति, महिलाओं, उत्तर पूर्व और आदिवासियों के लिए ग्रामीण विकास कार्यक्रम की चौथी वार्षिक बैठक भारतीय रासायनिक प्रौद्योगिकी संस्थान, हैदराबाद में दिनांक 30–31 मई 2011 को डा. पी.एस. आहूजा, निदेशक, आई.एच.बी.टी. पालपमुर की अध्यक्षता में संपन्न हुई। इसमें 36 परियोजना अन्वेक्षकों के अतिरिक्त क्लस्टर निदेशक डा. पी.जी. राव एवं परिषद् मुख्यालय से श्री ए.के. कुंडलिया ने प्रतिभागिता की।

योजना, परियोजना, अन्वेक्षण और मूल्यांकन इकाई : 12वीं पंचवर्षीय योजना को तैयार किया। सी.एस.आई. आर. तथा आई.एच.बी.टी. के वार्षिक प्रतिवेदन के लिए सूचना को एकत्रित किया। इन्टरनेट तथा इन्ट्रानेट पर सामग्री को अद्यतन किया। एनएबीएल के लिए वेब आधारित सिस्टम को विकसित किया। 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। विभिन्न संस्थानों से 250 से ज्यादा छात्रों के लिए प्रशिक्षण सुविधा प्रदान की। संस्थान की अनुसंधान परिषद् की 47वीं बैठक का आयोजन किया। संस्थान में चल रही परियोजनाओं का मूल्यांकन किया। प्रकाशन, पेटेंट आदि से संबन्धित जानकारियों को संग्रहित किया।

कम्प्यूटर इकाई : 280 से अधिक कम्प्यूटरों को फाइबर बैकबोन एवं वाई–फाई नेटवर्क, वीडियोकान्फ्रेंसिंग 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। नेटवर्क सिक्योरिटी के लिए यूनिफाइड थ्रेट मैनेजमेंट सिस्टम, आईडीएस, आइपीएस, सेंट्रलाइज नेटवर्क सिक्योरिटी सिस्टम, एन्टीवायरस आन क्लाइंट सरवर मोडम तथा एसएमटीपी स्पेम/वायरस प्रोटेक्शन सॉफ्टवेयर को संस्थान के इ रिसोर्सस को संरक्षित करने के लिए लगाया गया। डोमेन नेम सरवर, डीएनएस, वेब, इमेल प्रोक्सी आफलिनेक्स को प्रबन्धित किया गया।

इंजीनियरिंग सुविधा : इस वर्ष इंजीनियरिंग प्रभाग ने 3600 वर्ग फीट में फैला एक बाँस का संग्रहालय बनाया है। इसके निर्माण में स्थानीय रूप से उपलब्ध मग्गर बाँस की प्रजाति का ही उपयोग किया गया तथा बाँसों को कीटरोधक रासायनिक प्रक्रिया से गुजारा गया ताकि इस भवन की वैभवता, दृढ़ता एवं स्थायीत्व को कोई हानि न पहुंचे। भवन की दिवारें भी बाँस द्वारा बनाई गई हैं तथा उनको सुन्दरता प्रदान करने के लिए बाँस की तीलियों से निर्मित 'चिक' (blinds) का समुचित प्रयोग किया गया है। फर्ष के लिए बाँस की बनी सुन्दर टाइलों को बैंगलौर से मंगवा कर एक विशिष्ट दिव्यता तथा गरिमा प्रदान की गई। छत की पैनलिगं के लिए बाँस से बुनी हुई चादरें प्रयोग की हैं जिससे भवन की वैभवता और भी बढ़ गई।

आई.एच.बी.टी. ज्ञान संसाधन केन्द्र : आई.एच.बी.टी. का ज्ञान संसाधन केन्द्र संस्थान के वैज्ञानिकों तथा तकनीकी कर्मियों तथा पालमपुर के आस–पास के शैक्षणिक केन्द्रों को लगातार सेवाएं प्रदान कर रहा है। वैज्ञानिकों तथा तकनीकी स्टाफ के लिए साइटेशन रिपोर्ट को एकत्रित किया गया तथा विषय विशेष पर बिविलियोग्राफी उपलब्ध कराई गई। दिनांक 1–2 मार्च 2012 को दिल्ली में विश्व पुस्तक मेले से संस्थान ने संबन्धित विषयों की 253 पुस्तकों की खरीद की। प्रत्येक सप्ताह केन्द्र में आने वाले नवीततम पुस्तकों, पत्रिकाओं आदि की जानकारी सभी को उपलब्ध कराई जाती है। 4500 से अधिक इ–जर्नल और डेटाबेस को देखा जा सकता है। इसके साथ ही 155 प्रकाशित जर्नल भी उपलब्ध हैं। 6990 उपयोगकर्ताओं ने केन्द्र की सेवाओं का लाभ उठाया। 1564 पुस्तकें इस वर्ष पाठकों को जारी की गई। तीन लाख से अधिक पृष्ठों की फोटोकापी प्रदान की गई। ऑनलाइन जर्नल को देखने के लिए पाठकों को प्रशिक्षण भी प्रदान किया गया।

पेटेंट : वर्ष के दौरान संस्थान ने भारत में 7 तथा विदेशों में 4 पेटेंट फाइल किए तथा 1–1 पेटेंट भारत तथा विदेश में प्राप्त/पंजीकृत हुए।

प्रकाशन : वर्ष के दौरान संस्थान ने स्तरीय जर्नल में 143 शोध पत्र प्रकाषित कराए। चार लोकप्रिय विज्ञान लेख विज्ञान प्रगति में प्रकाशित हुए। पुस्तकों में 6 लेख/पाठ प्रकाशित हुए।

संगोष्ठी/सेमिनार में प्रतिभागिता : संस्थान के वैज्ञानिकों ने 28 संगोष्ठियों तथा 23 बैठकों में प्रतिभागिता की।

संस्थान ने 4 प्रदर्शनियों में अपने उत्पादों तथा प्रौद्योगिकी को प्रदर्शित किया।

व्याख्यान : संस्थान के वैज्ञानिकों ने 25 स्थानों में व्याख्यान दिए।

संस्थान में 14 आंमत्रित व्याख्यान आयोजित किए गए।

दूरदर्शन कार्यक्रम : संस्थान के वैज्ञानिकों ने वर्ष के दौरान 10 दूरदर्शन कार्यक्रम दिए।

विदेश यात्रा : वर्ष के दौरान संस्थान के तीन वैज्ञानिकों तथा दो शोध छात्रों ने विदेश दौरा किया

छात्रों को प्रशिक्षण : संस्थान ने 14 विश्वविद्यालयों/ संस्थानों के 38 छात्रों को प्रशिक्षण प्रदान किया।

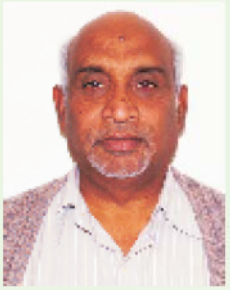
संस्थान के वैज्ञानिकों को इस वर्ष कई महत्वपूर्ण पुरस्कार/सम्मान प्राप्त हुए।

इस वर्ष संस्थान के 12 शोध छात्रों ने पी. एचडी., 34 छात्रों ने स्नातकोत्तर तथा 6 ने बी.टेक. डिग्री के लिए शोध–प्रबन्ध विभिन्न विश्वविद्यालयों में जमा किए।

अनुबन्ध : संस्थान ने अपनी प्रौद्योगिकी के ज्ञान के प्रसार के लिए 11 संस्थानों से अनुबन्ध किए।

विशिष्ट अतिथि :इस वर्ष 23 विशिष्ट अतिथियों ने संस्थान में यात्रा की।

OBITUARY



Dr. Syed Aijaz Asghar Zaidi, Sr. Principal Scientist
(16.09.1954-16.03.2012)

Dr. Syed Aijaz Asghar Zaidi was born on September 16, 1954 in Azamgarh (Uttar Pradesh). Dr. Zaidi joined CSIR-IHBT (formerly known as CSIR Complex, Palampur) on September 3, 1986 as Research Associate and on July 14, 1988 as Scientist B. In 2001 he took over as Head, Floriculture Division. During 25 years of service at this Institute, his main focus was on plant viral diagnostics and genome characterization of viruses infecting ornamentals, apple and cherry. His contribution to the field of Plant Virology in India is immense and will always be quoted. He has several patents, book chapters and more than 100 peer reviewed research publications to his credit. He guided 10 students for Ph.D. degree. He also visited several countries viz. Germany, Czech Republic and Taiwan.

He departed for his heavenly abode on March 16, 2012. He is survived by his wife Mrs. Naheed Fatima Zaidi, two daughters Ms. Sabika Zaidi & Ms. Falak Fatima Zaidi and son Mr. Saheed Asghar Zaidi.

CSIR-IHBT family prays for eternal peace to the departed soul and extends heartfelt condolences to the bereaved family.

OBITUARY

Sh. Jagdish Chand, Lab Attendant
(05.09.1957- 09.03.2012)

Sh. Jagdish Chand was born on September 05, 1957 in Maulichak, Palampur (H.P.). He joined the CSIR-IHBT (formerly known as CSIR Complex, Palampur) on July 05, 2004 as a Laboratory Attendant. He contributed significantly in Engineering Service Unit of the Institute. He was an expert painter and catered to routine maintenance activity of the Institute. He will be remembered for his devotation, dedication and diligence. He departed for his heavenly abode on March 19, 2012. He is survived by his wife Mrs. Lakshmi Devi and daughter Mrs. Rekha Devi.

CSIR-IHBT family prays for eternal peace to the departed soul and extends heartfelt condolences to the bereaved family.

CSIR-IHBT experimental farm

Crataegus oxyacantha in flowering