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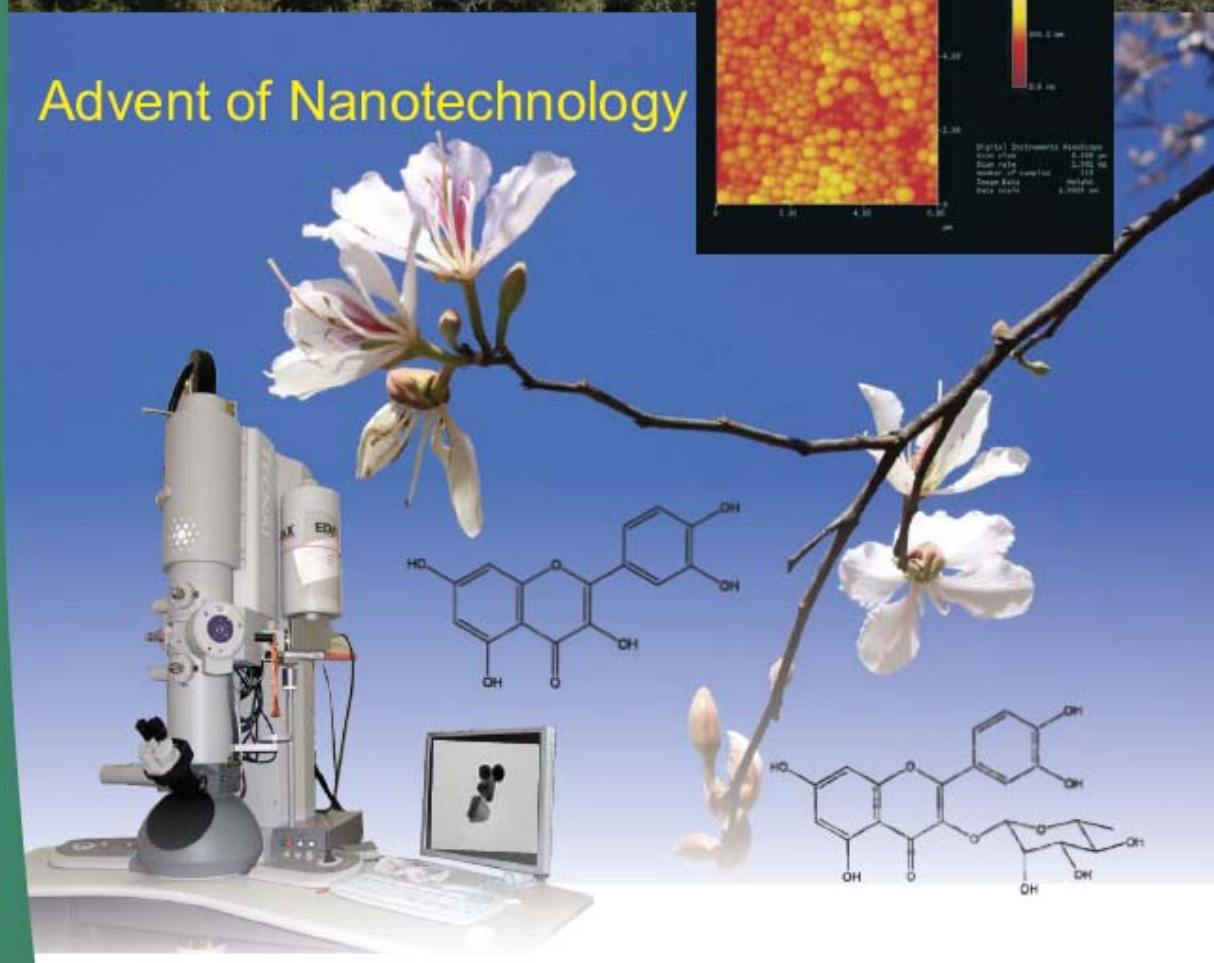
वार्षिक प्रतिवेदन 2010-11 Annual Report



CSIR-INSTITUTE OF HIMALAYAN BIORESOURCE TECHNOLOGY
Palampur (H.P.), India

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Annual Report 2010-11

With Best Compliments from

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Director

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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

CONTENTS

FROM THE DIRECTOR'S DESK

The relevance of IHBT's research mandate is underlined by the fact that '2010 was the year of biodiversity' and '2011 is the year of Chemistry'. Today, ecological integrity in the face of anthropogenic pressures and climate change is of utmost importance. Furthermore, the economics of ecologies and their sustainability in natural and agrarian systems is significant. Green technologies are central to drive growth and improve the quality of the environment as well as standard of life. Value addition to products per unit of our bioresources is the key for future development of a harmonious society. It is towards this global goal that our mandate focuses.

The gap of on-site data, which has been the major lacunae in forecasting the imprints of climate change has been filled up to an extent through our initiatives in demarcating long term experimental plots for periodic monitoring in different ecosystems in the Himalayan region. This was possible with the support of the H.P. State Forest Department. Simulation studies under Free Air CO_2 Enrichment and controlled environments were also initiated to strengthen the validation of our forecasting at the level of ecosystems, communities, organisms, metabolomes, proteomes and genomes. In this context, genome wide expression studies with *Picrorhiza kurrooa* reflect the changes in the production of the active principles that could occur under varying temperature regimes.

The reclaiming of the dumping sites of National Hydro Power Corporation in difficult Himalayan terrain was a daunting challenge undertaken by the Biodiversity division.

Activities were intensified on the demonstrations, trainings and distribution of quality planting materials in the areas of medicinal and aromatic plants, tea, flower crops, spices, stevia and bamboos to meet the increasing demands for these crops. Our experiments on saffron in association with SKUAST in J&K proved successful in raising disease free bulbs. This model needs up-scaling for field applications. Virus free rootstocks and budwood of apple, plum and cherry were developed for distribution to farmers via commercial Tissue Culture Units in H.P., namely, Neva Plantations, Kangra Monal Biotech, Una and Rajat Biotech, Ghumarwin.

Bamboos supplied to the Delhi Parks and Garden Society adorned the sites of the Commonwealth Games. Locally, trainings were imparted on charcoal making from bamboos in the small-drum-based-kilns designed for domestic use in homesteads. The mobile essential oil extraction unit was deployed for field demonstrations in remote rural areas. This was a major attraction at the CSIR Technofest -2010 pavilion at Pragati Maidan, New Delhi. Many agencies and State governments are interested in deploying this unit. A pilot scale process was standardized for the extraction of β-ascein from seeds of *Aesculus indica*, which otherwise goes waste in the mid-Himalayan zone. Apple and rose seed oil processes are other possibilities for waste biomass utilization. Process for obtaining

dietary fiber from apple pomace is also being worked upon in association with Himachal Pradesh Horticultural Produce Marketing & Processing Corporation Ltd. (HPMC).

For the synthesis of natural products and pharmaceuticals, eco-friendly chemo- and regio-selective reduction of nitro compounds is very important, and significant strides have been made by our scientists in this direction. Furthermore, an economic and green process was developed for the synthesis of hydroxylated DSB's (distyrylbenzenes) and OPVs (oligophenylenevinylenes). These have a wide spectrum of bioactivities for drug development.

A significant development during the year was the inauguration of our Regulatory Research Centre by the Hon'ble Chief Minister of H.P., Prof. Prem Kumar Dhumal. This centre would hasten the testing of new products developed at the institute as well as by other agencies. New initiatives in the areas of Nanobiology and Bioinformatics yielded good results and strengthened the mandate of the institute.

The other infrastructural facilities that were added include the extension of floor space for nutraceutical processing and Transmission Electron Microscope.

The quality of our publications witnessed a steady improvement in all areas of research. IHBT made concerted efforts to portray its know-how through circulation of bulletins, TV/radio broadcasts and popular articles in relevant magazines.

The year witnessed the commencement of the AcCSIR giving an academic orientation to the institutional system so as to provide quality HR to the nation in S&T.

With the challenges posed by the members of the Research Council, and the dynamic leadership of our Director General, **Team IHBT** marched ahead contributing towards environmental, societal and scientific goals for economic benefits.

(**Paramvir Singh Ahuja**)

CHARACTERIZATION AND MANAGEMENT OF HIMALAYAN BIORESOURCES

SURVEY AND MAPPING

Field survey generates primary information on the occurrence, distribution, density and ecological attributes of the floral wealth of a geographical entity for efficient planning and management of plant resources. Since 1994, the important components of this activity have been survey, collection and enumeration of plant specimens, and digitization of data. A total of 33 localities in Bilaspur, Hamirpur, Kangra, Kullu, Mandi, Solan and Una districts of H.P. were covered in 19 surveys for floristic, ethnobotanical and ecological studies during the year (**Fig. 1a**). Out of these, 6 surveys were conducted for ecological studies, 3 for marking permanent plots regarding climate change, 3 for recording spectral signatures of flora, 5 for pteridophytic collections and 2 for collection of flora. A total of 400 specimens including 100 angiospermic and pteridophytic species each were collected for enrichment of IHBT herbarium (PLP). Consolidated and compiled information on the specimens in PLP was published in the form of a catalogue.

Fig. 1a A survey team in the high altitudes of Himalaya

Plant sampling in interior areas of Dhauladhar revealed heavy anthropogenic pressure on medicinal plants, primarily *Picrorhiza kurrooa*. People camp in alpine regions for almost 5 months for collection of these plants. Similarly, in a part of Chamba, almost 11% of the *Taxus baccata* population was observed to be under pressure because of debarking. No regeneration in this species was observed with complete absence of seedlings and saplings. On the other hand, *Sapium sebiferum*, a highly invasive species was observed gaining dominance in nature. Its extent of occurrence was recorded to be 4091.44km^2 with major distribution and concentration in Kangra followed by Mandi districts (**Fig. 1b**). Profuse flowering and recruits indicated good regeneration of this species. At majority of places, the plant was found associated with *Ageratum*, *Eupatorium*, *Lantana* and other weedy species.

Fig. 1b Extent of occurrence of *Sapium sebiferum*

Spectral library of Himalayan flora (Funded by Space Applications Centre, ISRO, Ahmedabad)

In continuation to previous activity, field reflectance spectra from naturally occurring and ornamental species were recorded using handheld spectroradiometer (325 to 1075nm) at 1.4nm sampling interval. The narrow band spectral indices like structural, chlorophyll related, red edge and the derivative based were computed from reflectance spectra (**Table 1**).

Table 1 Vegetation indices of plant species

Structural indices	Natural vegetation		Ornamental vegetation	
	Minimum	Maximum	Minimum	Maximum
Normalized Difference Vegetation Index (NDVI)	0.5139	0.8828	0.5475	0.8951
Simple Ratio (SR)	3.1146	16.0689	3.4198	18.0576
Soil Adjusted Vegetation Index (SAVI)	0.3709	0.7712	0.4791	0.7804
Modified SAVI (MSAVI)	0.3376	0.8293	0.4774	0.8451
Optimized SAVI (OSAVI)	0.4580	0.8319	0.5170	0.8438
Modified SR (MSR)	-0.5486	-0.2081	0.4215	0.2065
Renormalized Difference Vegetation Index (RDVI)	0.3573	0.7375	0.4891	0.7457
Chlorophyll/Pigment related Indices				
Modified Chlorophyll Absorption Index (MCARI)	-0.0647	1.1208	0.4249	0.8556
Transformed CARI (TCARI)	0.0658	0.3876	0.1146	0.3054
Structural Insensitive Pigment Index (SIPI)	0.6808	0.8936	0.7312	0.8925
Normalized Pigment Chlorophyll Index (NPCI)	-0.0300	0.4083	0.0821	0.7218
Photochemical Reflectance Index (PRI)	-0.0011	9.7784	-0.1751	-0.0115
Red Edge Indices				
REDEDGE (740 nm)	0.2237	0.0523	0.0883	0.2081
REDEDGE (750 nm)	0.1324	0.4822	0.2238	0.4951
Zarco Tejada and Miller (ZTM)	1.5122	3.4393	1.4108	2.7761
Derivative Analysis Indices				
dG - Minimum of 1st derivative reflectance in the green (~570 nm)	-0.0039	-0.0005	-0.0009	0.0001
dg - Maximum of 1st derivative reflectance of the green (~525 nm)	0.0008	0.0049	0.0011	0.0046

Normalized Difference dG and dg (GGFN)	2.5000	15.0000	0.8571	4.6000
DRE - Maximum of 1st derivative of the reflectance in the red edge (~700-710 nm)	0.0038	0.0142	0.0074	0.0137
Normalized difference of dRE and dG (EGFN)	0.4140	0.8240	0.2813	0.8514
DDRE - Maximum of 2nd derivative reflectance in the red edge (~690 nm)	0.0004	0.0011	0.0005	0.0012

Plant diversity and soil attributes

The inter-correlation between Indian Remote Sensing Satellite (IRS) P6 LISS III multispectral image, plant species diversity and physico-chemical characteristics of soil were evaluated in the Kinnaur region of H.P. The study aimed at modeling of spectral variability of vegetation communities. It was inferred that the plant species diversity and soil physico-chemical characteristics affecting vegetation communities can be assessed using low cost multispectral satellite data.

Above ground biomass estimation

Extensive surveys were conducted during March-April, 2010 in Bilaspur forest division. In a rapid assessment strategy, total 60 plots of 0.5ha representing 8 forest types were selected (**Fig. 2**). In addition, the four corners of the plots were recorded using GPS receiver for spatio-temporal monitoring. Five sub-plots of 10 x 10m^2 were laid in the four corners as well as in the centre for estimating shrub population and biomass. In all these sub-plots, four corners of 1 x 1m^2 plots were laid to assess the herbaceous populations.

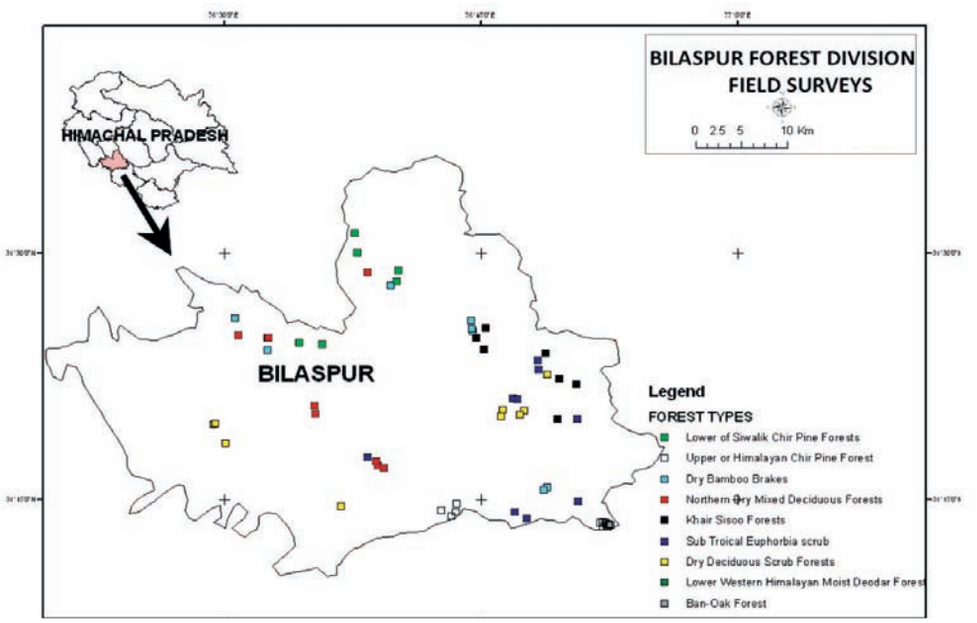


Fig. 2 Forest types sampled for biodiversity and carbon stock estimations

For ecological analyses of the landscape, latest high resolution satellite data (IRS LISS III and LISS IV satellite sensors) and 1:15000 topographic maps were used. The forest management maps were also scanned and digitized for Range and Beat boundaries.

At present, there are one Reserve Forest (RF), 13 Demarcated Protected Forests (DPF) and 417 newly notified DPFs in the entire forest division. The new DPFs form 80-85% of the forest area. The boundaries for these new DPFs were identified from the forest topo-sheets and digitized for their actual area estimation.

A total of 200 species of plants were encountered in the whole district. Of which, population data of ca.150 species was recorded. The voucher specimens were deposited in the herbarium of the institute.

Ecological characterization

A study was undertaken to describe the vegetation of Kinnaur on a multiple scale in three contrasting landscapes and to assess the extent of fragmentation using satellite images. Kinnaur (30°22'40"N to 33°12'40"N and 75°47'55"E to 79°04'20"E), a north-eastern frontier district in H.P., spans over an area of about 6400km^2 and has a heterogeneous landscape. It has three subdivisions, Pooh, Kalpa and Nichar. The species diversity of vegetation communities and their soil physico-chemical characteristics were also compared. The total landscape area (TLA) covered by natural vegetation is 285415.80ha with Nichar (**Fig. 3**), Kalpa (**Fig. 4**), and Pooh covering 65142.16, 52901.93 and 167371.71ha area, respectively. Pooh, the largest block lying in the east was poor in terms of landscape composition as compared to Nichar. Though rich in LSE, the extent of fragmentation was highest in Nichar. It has higher mean values of species diversity than other blocks. This was in contrast to the Pooh landscape, where the patch as well as the species diversity were the lowest. The mean values of soil physico-chemical characteristics in the three blocks showed that the available N and P significantly differentiate the landscapes. The mean values for soil bulk density, pH, EC and available P were significantly higher, but the values for soil porosity, saturation percentage, moisture percentage, organic C, available N and K, total N and K, and C/N ratio were low in Pooh as compared to Kalpa and Nichar.

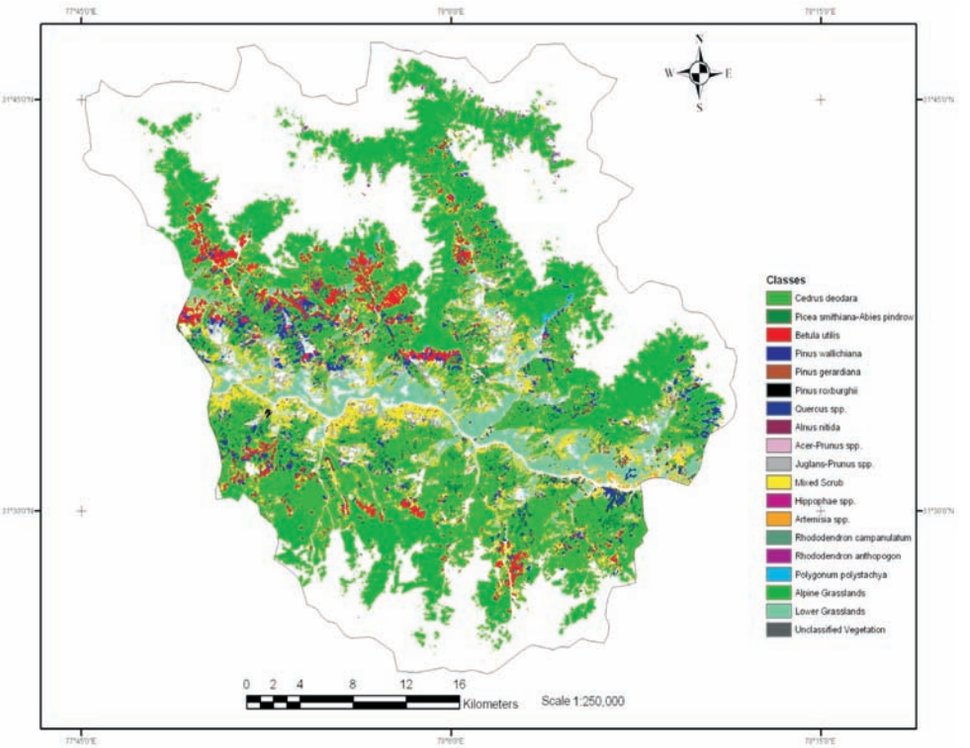


Fig. 3 Vegetation map of Nichar landscape

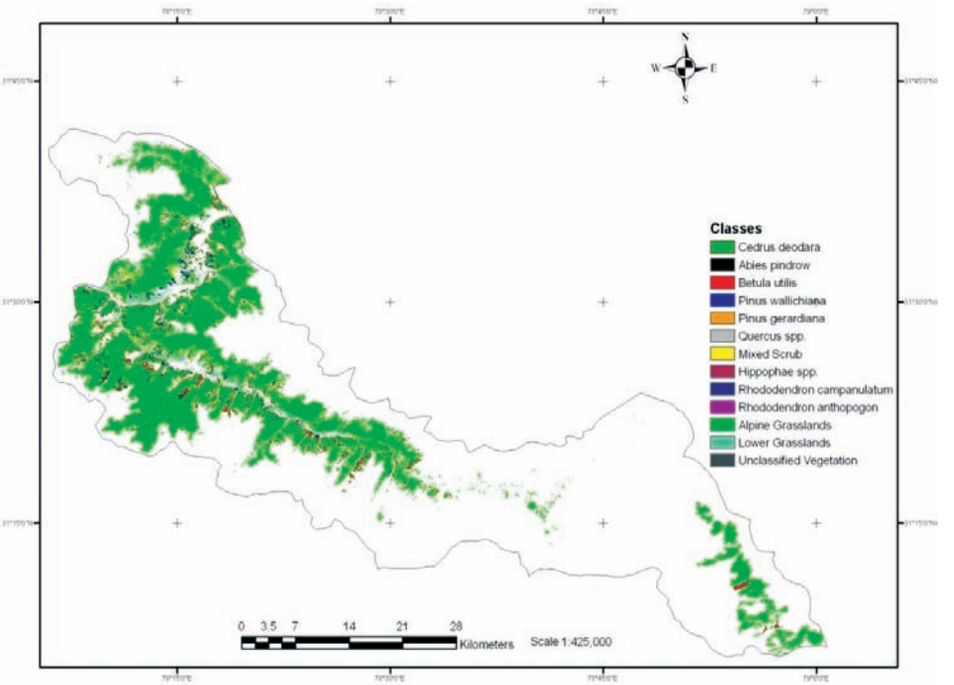


Fig. 4 Vegetation map of Kalpa landscape

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

The physical, soil and geological maps of the study areas (Dhauladhar Wildlife Sanctuary, Great Himalayan National Park, Rupi-Bhabha Wildlife Sanctuary and Pin Valley National Park) were prepared in Geographic Information System (GIS) environment. These maps 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, respectively. The physical map depicts information on major locations, transport network, contours, glaciers and rivers in the study area. The soil and geological maps provide information on soil taxonomy and lithological units of the region, respectively.

In seed biology studies, seeds of *Rumex nepalensis* collected from different altitudes differed in their germination response such that the percent germination in high altitude ecotypes showed greater decline with rise in temperature. However, the optimum seed germination in *Trifolium repens* occurred at 20°C.

The transcriptome of *P. kurrooa* was analysed at high (HPSC) and low picrosides synthesizing (LPSC) conditions using next generation sequencing platform. HPSC and LPSC represented different temperature regimes expected during climate change scenario. For HPSC, a total of 31338 assembled transcripts were obtained with 100bp as the minimum length, 403.87bp as average length at 64.68 average coverage. A total of 2029 assembled transcripts (6.48%) were longer than 1000bp, while the longest assembled transcript was 5326bp. For LPSC, 63718 assembled transcript sequences were obtained with minimum 100bp length, 434.39bp average length and an average coverage of 71.26. Sequences longer than 1000bp were 4988 with a maximum sequence length of 5210bp. Data showed up-regulation of the pathway genes at HPSC.

Initiatives on pteridophytes

In order to initiate studies on ferns and fern allies (pteridophytes) at IHBT, preliminary surveys were conducted in Palampur, Kangra, Dharamshala, Kandi, Bundla, Banuri, Bir and Billing areas of Kangra district, and Ghatasni, Jhitingri and Barot areas of Mandi district during July to October 2010. Around 300 specimens belonging to 100 species, 35 genera and 18 families were collected. The genera, *Adiantum, Chielanthes, Conoigramma, Polypodium, Polystichum, Pteris* and *Thelypteris* dominated the surveyed areas. The collected specimens were processed, identified and deposited in the herbarium of the institute.

Three pteridophytes viz., *Microlepia setosa* (Sm.) Alston (**Fig. 5a**), *Dryopteris zayuensis* Ching and S.K. Wu (**Fig. 5b**) and *Pteris biaurita* L. subsp. fornicata Fraser-Jenk (**Fig. 5c**). hitherto unknown in the flora of H.P. were discovered. Herbarium specimens of these species were deposited in the IHBT herbarium as PLP-11001, 11002 and 11003, respectively, and also introduced in the Fernery.

Ecological attributes of habitats of pteridophytes

Survey to interior areas of Dhauladhar and population quantification revealed high species richness mainly in wetlands and dense forest canopy along water bodies. Wide range of ecological attributes like soil, topography and climate endowed the landscape with rich fern diversity including several epiphytic ferns viz., *Athyrium*, *Polypodium*, *Phymatopteris* and *Lepisorus*. At majority of the places, ferns were found associated with *Ageratum*, *Eupatorium*, *Urtica* and *Lantana*.

Characterization of fern spores

Characterization of spores with respect to morphology, surface ornamentation and types play a key role in fern taxonomy. SEM studies were, therefore, initiated and spores of *Pteris vittata*, *P. cretica* and *Phymatopteris* species were characterized.

Fig. 5 Pteridophytes a) ***Microlepia setosa*****, b)** ***Dryopteris zayuensis*** **and c)** ***Pteris biaurita*** **L. subsp.** ***fornicata***

Establishment of fernery

A fern house (500m^2) was established (**Fig. 6**) at the botanical garden of the institute for the conservation of pteridophytes. Around 100 species including some rare and economically important taxa collected from different locations of H.P. were introduced in the fernery. Species of *Adiantum, Asplenium, Athyrium, Chielanthes*, *Coniogramma, Cyathea, Cyrtomium, Diplazium, Equisetum, Microsorum, Onychium, Osmunda, Polystichum, Pteris* and *Thelypteris* were introduced.

Fig. 6 Fernery at IHBT

Heavy metal tolerance

In continuation to earlier studies, ferns growing on fly ash were analyzed for heavy metal accumulation and subsequent metabolic adaptation to metal stress. Five fern species viz., *Adiantum capillus-veneris*, *Ampelopteris prolifera*, *Diplazium esculentum*, *Pteris vittata* and *Thelypteris dentata* were collected from the vicinity of fly ash. *P. vittata,* a hyper-accumulator of arsenic was the most tolerant plant among the three tested species. *P. cretica* was more suitable than *Diplazium maximum* and *Polystichum squarrosum* in bioaccumulation and tolerance to Cr.

In a separate activity on phytoremediation, three fern species viz., *Pteris cretica*, *Polystichum squarrosum* and *Diplazium esculentum* were found to be tolerant to Cr in a hydroponic experiment.

Botanical garden

A botanical garden spreading over 3 acres was established for recreation and generation of awareness among people on the importance of plants in human life and environment. A number

of trees, climbers, shrubs and herbs of medicinal and ornamental value were planted. The garden has 110 tree species, 40 shrubs, lianas and climbers each, and 10 palms besides a collection of 100 pteridophytic species and 40 species of bamboos. The important genera planted in the garden include *Oroxylum*, *Cassia*, *Michelia*, *Tabebuia*, *Mangifera*, *Platanus*, *Nyctanthes*, *Duboisia*, *Eucalyptus*, *Pinus*, *Bauhinia*, *Crpytolepis*, *Bignonia*, *Salix*, *Ginkgo*, *Crataegus*, *Juniperus*, *Cryptomeria* and *Sophora*. While a fernery was established, work on establishment of bambusetum is in progress.

himFlorIS

himFlorIS is an information system developed on the basis of floristic survey of H.P. during 2003-2009. Presently, it provides information on 1141 plant species distributed across 49 landscape elements (LSEs). LSEs, physiographic factors, abundance of the species at a particular location, geographical locations of a plant on the map, and taxonomic classification of the species along with its photographs and ethno-botanical uses are also included in the system.

REVEGETATION OF DUMPING SITES OF NATIONAL HYDROELECTRIC POWER CORPORATION, NHPC (Funded by NHPC, Faridabad, Haryana, India)

An MoU was signed on June 16, 2010 between IHBT and NHPC, Nagwain, district Mandi, H.P. (Head Quarter at Faridabad, Haryana) for plantation/revegetation of dumping sites of Parbati Hydro Electric Project Stage-II through integrated biotechnological approaches. Ten closed muck-dumping sites located in Sainj, Garsa, and Manikaran valleys of Kullu covering 8.78ha area were taken for revegetation. Plantation was completed at 5 dumping sites, DS-1 in Manikaran valley (Barshaini), and DS-12, DS-13, DS-14 and DS-16 in Sainj valley. Saplings of *Alnus*, *Picea*, *Aesculus*, *Ailanthus*, *Pinus*, *Cedrus*, *Populus*, *Robinia*, *Salix*, *Punica*, *Quercus* and bamboo were planted in gunny bags filled with soil, organic manure, peat moss and biofertilizer (plant growth promoting rhizobacteria) and placed in pits dug at the sites (**Fig. 7**). Pelleted seeds of *Rumex*, *Plantago* and *Tagetes minuta* were also spread on the surface of the dumping sites for providing a canopy of shrubs and herbs..

Fig. 7 Revegetation a) closed dumping site, b) muck-dumping site, c) diging of pits, and d) planting of saplings

GENOMICS AND PROTEOMICS

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

In a new study, transcriptome sequencing of may apple (*Sinopodophyllum hexandrum*) was carried out using genome analyzer and bioinformatics. A total of 87786 *de novo* transcripts were assembled. Of these, 56422 transcripts had significance in known biological processes. Similarly, in transcriptome analysis of picrorhiza, a total of 74336 transcripts were assembled.

Assembling performance was also analyzed in response to k-mer size, wherein k-mer size of 23mer was the best choice, as it had a balance between over- and under-represented transcript numbers, coverage, maximum length obtained and average transcript length.

Molecular basis of winter dormancy

In studies on understanding molecular mechanism of winter dormancy (WD) of tea, down-regulation of genes related to cell cycle, cell division and DNA processing was observed. However, stress-responsive genes, and genes encoding chaperons were up-regulated.

In another study, the gene expressions were modulated in similar ways by high temperature (HT; 25°C) during WD and PAG (period of active growth) (**Fig. 8**).

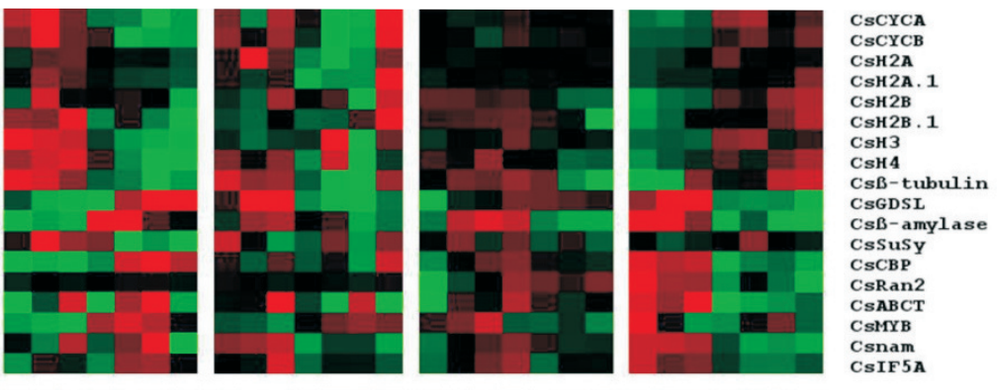


Fig. 8 Expression of 27 genes in 'two leaves and a bud' harvested at different periods of growth. Green and red color indicates down and up-regulated genes, respectively

Silencing of caffeine synthase

Agrobacterium tumefaciens carrying RNAi construct (pFGC1008-CS) of caffeine synthase (CS) cDNA was used to produce transgenic tea from roots of one month-old seedlings. The results showed suppressed expression of *CS* gene and a marked reduction in caffeine and theobromine contents in young shoots (**Figs. 9** & **10**). The transformation system can be used for functional analysis of genes in woody and perennial plants.

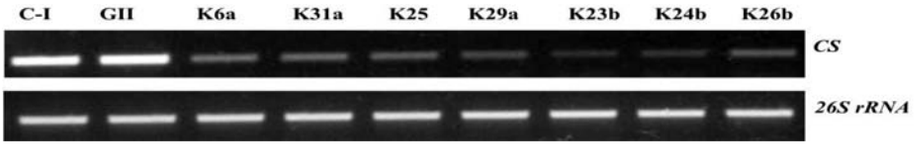


Fig. 9 Semi-quantitative PCR for caffeine synthase expression analyses

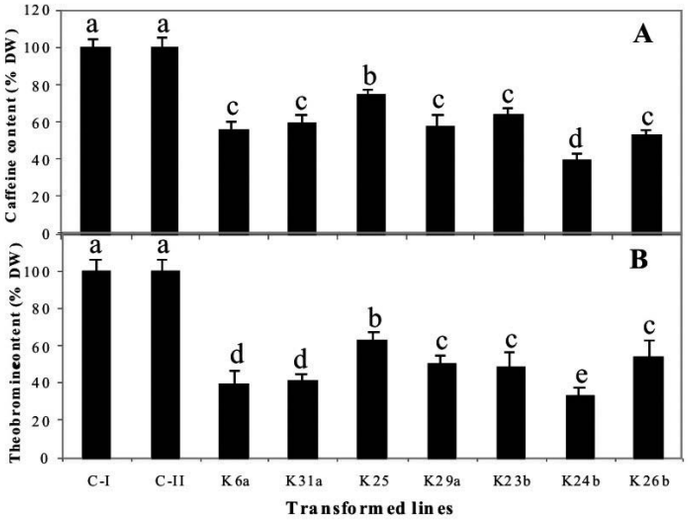


Fig. 10 (a) Caffeine and (b) theobromine contents in transformed (K) and control (C-I and C-II) lines

Development of cold inducible synthetic promoter for specific expression of transgenes in plants during cold stress (Funded by Department of Biotechnology, Govt. of India)

In continuation to previous studies on developing constructs for cold tolerance, 11 constructs viz., *GFP, CaMV 35S::CBF3CDS::GFP, Spacer::AtRD29A::GFP, Spacer::3xDRE::AtRD29A::GFP, Spacer::AtRD29A::CBF3CDS::GFP*

Spacer::3xDRE::AtRD29A::CBF3CDS::GFP, Spacer::CaMV35S::CBF3CDS::GFP, Spacer::AtCBF3::GFP, Spacer::3XDRE::AtCBF3::GFP, Spacer::AtCBF3::CBF3CDS::GFP, Spacer::3XDRE::AtCBF3::CBF3CDS::GFP were prepared for raising transgenics. Analyses of transgenic plants showed the effectiveness of enhanced DRE elements in gene expression.

Bioprospecting Himalayan bioresource through transgenic and nutraceutical technologies (Funded by Department of Biotechnology, Govt. of India)

In large scale expression analyses, several stress related genes in *Rheum australe* and *Caragana jubata* were identified. Genes encoding *WRKY* transcription factor and succinyl CoA ligase were used for functional evaluation. Transgenic arabidopsis plants over-expressing these genes under the control of CaMV35S promoter were generated. A higher survival rate of transgenic plants (~40%) after re-watering was observed in comparison to wild type (~ 25%). Hence, the genes have the potential for utilization in agriculturally important crops for abiotic stress tolerance.

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

Gene construct for phosphoenol pyruvate carboxylase (PEPCase) was developed in addition to ribulose 1,5-bisphosphate (RuBP) carboxylase-oxygenase (Rubisco) and used for raising transgenic arabidopsis. T3 generation plants over-expressing all the genes exhibited significantly enhanced level of carbon and nitrogen.

Protein dynamics during seed germination under copper stress in arabidopsis over-expressing potentilla superoxide dismutase

2D electrophoresis of germinating arabidopsis wild type (WT) and transgenic seeds harboring *Potentilla atrosanguinea* Cu-Zn SOD revealed 39 differentially expressed protein spots under Cu stress (**Fig. 11**). MALDI-ToF and subsequent peptide mass fingerprinting analysis of these spots revealed that the down-regulated proteins in transgenics were related to oxidative stress, detoxification, germination, intermediary metabolism and regulatory proteins. Changes in key proteins, vis-a`-vis alleviation of oxidative stress resulted in higher germination rate and percentage.

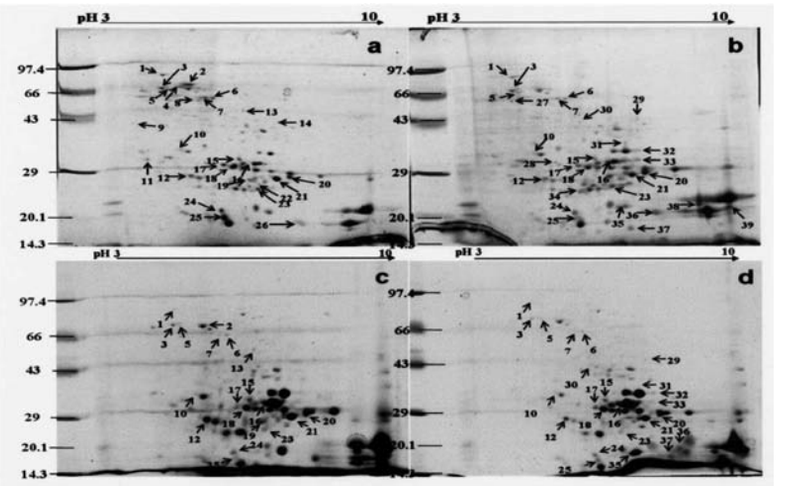


Fig. 11 2D profiles of germinating seeds of arabidopsis (a, c) WT and (b, d) transgenic line in response to 1 mM $CuSO_4$. Arrows indicate regulated proteins

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 scavengers viz., superoxide dismutase (SOD), catalase (CAT) and ascorbate peroxidase (APX) were developed into formulations to increase the shelf-life of food products. Application of the SOD based formulation reduced the spoilage/scalding of ripe tomato fruits. The formulation was found to be effective in maintaining the lycopene content in tomato, and beta-carotene and chlorophyll content in spinach under low as well as high humidity storage conditions. In case of tomato, application of SOD along with CAT was found to be more effective in maintaining the nutritional quality.

BIOINFORMATICS

Computational biology and bioinformatics

In a new activity, a centre was established to develop bioinformatic tools for miRNAs and non-coding elements, epigenomics, regulomics, systems biology and Next Generation Sequencing.

Regulatory system analysis with respect to miRNA and development of related tools and servers (Funded by Department of Biotechnology, Govt. of India)

A machine learning tool was developed to predict miRNA targets in animal and plant transcriptomes. The algorithm attained very high accuracy and performance benchmarking. A novel algorithm capable of distinguishing plant miRNAs from animal miRNAs with very high accuracy even at precursor level and origin was also developed.

Graph-theoretical analysis of protein structures for identifying topological features specifying stability and function

In a new activity on structural bioinformatics, graph-theoretical models of protein structures (Protein Contact Networks, PCN) were constructed. PCN models were used for probing the topological loci of thermostable proteins. Features derived from proteins of functionally disparate classes such as allosteric and membrane proteins were used to probe structural differences and their implications in information transfer mechanisms within protein structures. A PCN model is illustrated (**Fig. 12**).

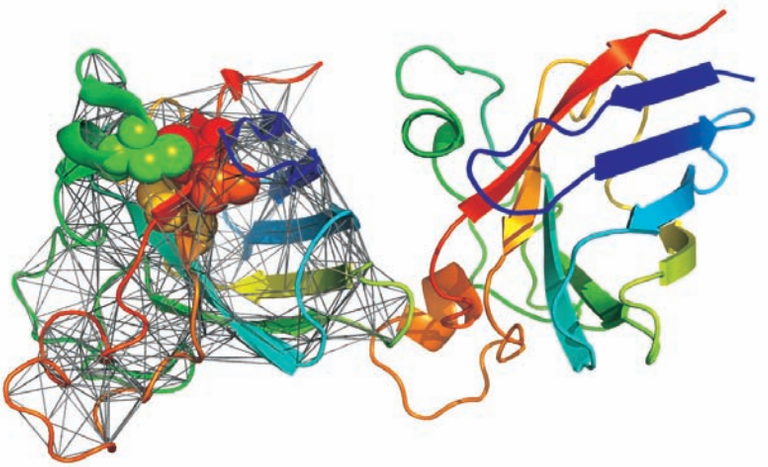


Fig. 12 Contact network of a dimeric protein depicting critical residues identified through a computational procedure

Metabolic engineering of vinca alkaloid pathway

A cDNA library was constructed from young leaves of *Catharanthus roseus* and sequenced. Analyses of sequence data revealed various genes of the secologanin and vindoline pathways (**Table 2**).

Table 2 Various genes of the secologanin (S) and vindoline (V) pathways

Gene family	Genes identified
Cyclase	(S)
Glycosyltransferases	(S)
Cytochrome p450/Monooxygenase	*10-hydroxygeraniol oxidoreductase* (S)
Hydroxylase	*tabersonine 16-hydroxylase* (V), *geraniol 10-hydroxylase* (S), *desacetoxyvindoline 4-hydroxylase* (V)
Hydratase	(V) (18 sequences)
N-methyltransferase	*2,3-dihydro-3-hydroxytaberosonine-N-methyltransferase* (V)
Methyltransferase	*loganic acid methyltransferase* (S), *16-hydroxytabersonine-O-methyltransferase* (V)
Synthase	*secologanin synthase* (S)
Others	*tryptophan decarboxylase*, *strictosidine synthase*, *strictosidine beta-glucosidase*
Total number of transcripts in the library: 35,341; E-value cut off=$1e^{-05}$	

In another study, the possibility of conversion of 16-methoxytabersonine into 16-methoxy-2, 3-dihydro-3-hydroxytabersonine was analysed using 18 hydratases obtained from the cDNA library (**Table 3**).

Table 3 Transcriptome analyses of identified hydratases

Hydratase scaffold	BlastX results
scaffold1524; scaffold6664; scaffold14267; C174768; C182064; C220804	Aconitase protein (3-isopropylmalate dehydratase)
scaffold4881; scaffold7018; scaffold12057; C158946; C168920; C192928; C186618; C196402; C197736	Enoyl-CoA hydratase (Crotonase)
scaffold14527	Cyanate hydratase
C218090	Naphthoate synthase
C177082	Carbamoylputrescine amidase (Nitrilase)

Putative microRNAs and their targets from horsegram

In a new activity, an EST based approach was used to identify novel miRNAs in horsegram. A total of 989 ESTs were subjected to CAP3 assembly to remove the redundancy. This resulted in an output of 72 contigs and 606 singletons as non-redundant datasets. The miRNAs were then predicted by using miRNA-finder. A total of eight potential miRNAs were predicted and named as hor-miR1 to hor-miR8. The target mRNAs for these miRNAs belong to zinc finger, chromosome condensation, protein kinase, abscisic acid-responsive, calcineurin-like phosphoesterase, disease resistance and transcriptional factor family proteins. These targets appeared to be involved in plant growth and development, and environmental stress responses.

Syzygium cumini and *Bauhinia variegata* were explored for the synthesis of various types of Ag and Au nanoparticles. 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. 13**).

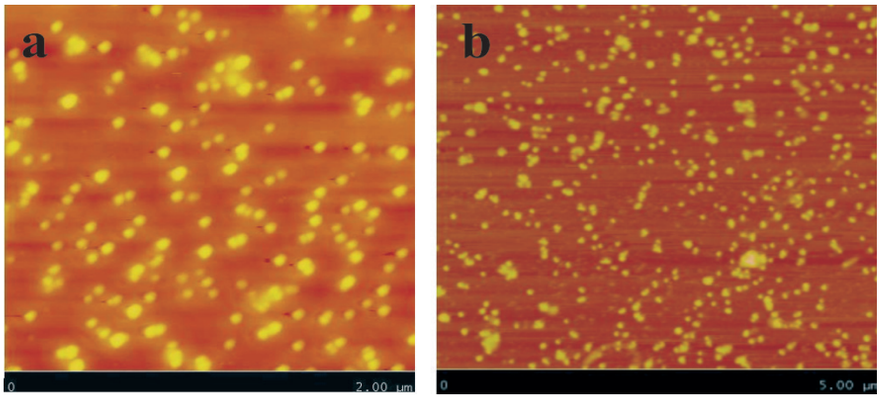


Fig. 13 NPs synthesized from leaf extract of a) *S. cumini* and b) *B. variegata*

The solubility, stability and bioavailability of quercitrin and quercetin were improved by nanoencapsulation on biodegradable PLA (poly lactic acid) nanoparticles with efficiency of 96.7 and 19.4% actual drug loading. The mean diameter of PLA and quercetin loaded PLA nanoparticles was ~170±25 and ~130±30nm, respectively. The activity of quercetin was retained after nanoencapsulation as evident from DPPH assay. The biphasic release profile includes initial burst effect followed by sustained slow release. High encapsulation efficiency, small size and slow release make quercetin loaded PLA nanoparticles a suitable candidate for development of nanomedicines. Similarly, quercitrin was encapsulated on PLA nanoparticles with 40% efficiency. The mean diameter of quercitrin loaded PLA nanoparticles was 250±68nm. The *in vitro* kinetics of quercitrin revealed initial burst followed by sustained release (**Fig. 14**).

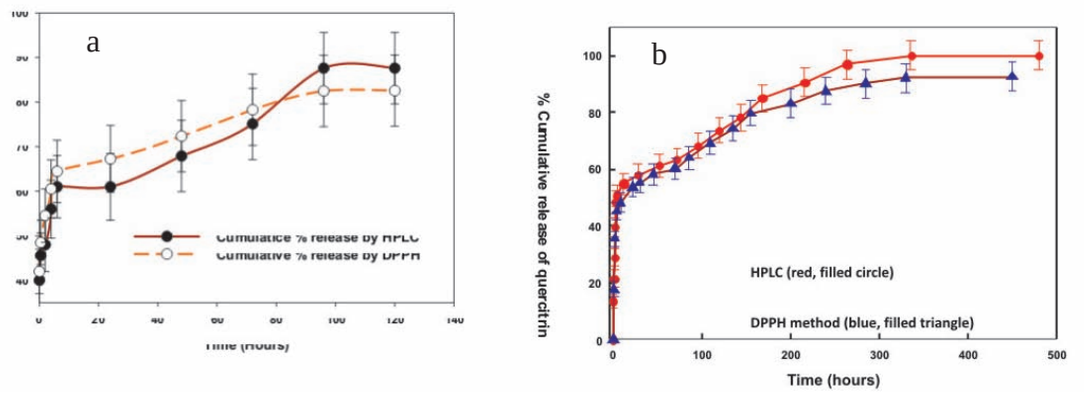


Fig. 14 Release profiles of a) quercetin and b) quercitrin loaded PLA nanoparticles

Further, steviol glycosides were nanoencapsulated on core-shell PEG-PLA nanoparticles of size 150-170nm as characterized by SEM, AFM and TEM (**Fig. 15**). The formulation has the potential for intravenous/oral injection in experimental *in vivo* system. The encapsulation efficiency was 41%. The *in vitro* profile showed an initial burst followed by slow control release.

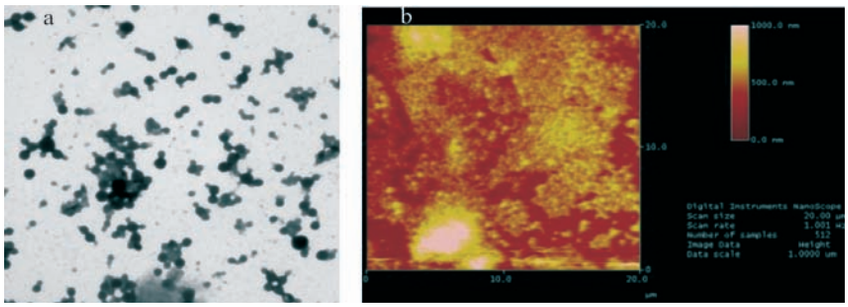


Fig. 15 Biodegradable nanoparticles from steviol glycosides a) TEM and b) AFM image

NATURAL COLOURS AND DYES

ARNEBIA (*Arnebia euchroma*)

Shikonin derivatives, the active ingredients of several pharmaceuticals and are used as dye for fabrics, food products and hairs. The roots yield 1.58-1.94% shikonin derivatives.

In a study to identify the regulatory genes involved in biosynthesis of GPP (geranyl pyrophosphate), PHB (*p*-hydroxy benzoate) and GHB (geranyl hydroxyl benzoate), cell suspension cultures for low and high shikonin production systems were developed. Studies with the inhibitors of ***MVA*** (mevalonic) and ***MEP*** (methylerythritol phosphate) pathways suggested MVA to be the preferred route for GPP supply. Genetic analyses of MVA (eight genes), PP (three genes), and GHB biosynthetic pathways showed down-regulation of all the genes in response to mevinolin treatment, whereas, gene expression was not influenced by fosmidomycin (**Fig. 16**).

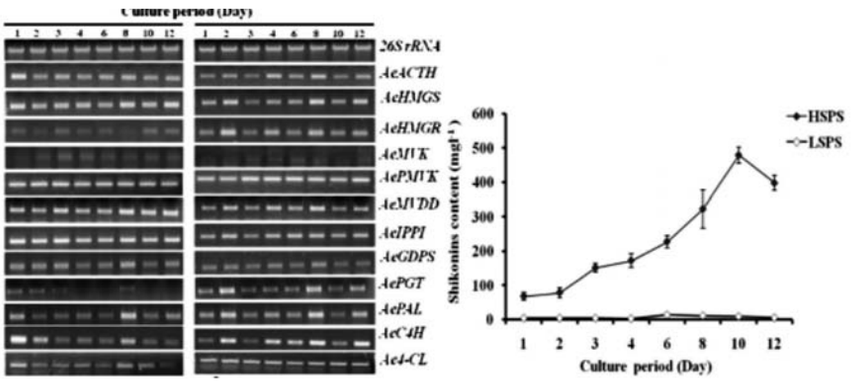


Fig. 16 Shikonin production in low (LSPS) and high (HSPS) producing systems

The effect of light, temperature, sucrose and pH on production of shikonin derivatives in cell suspension cultures was studied. Light completely inhibited their production (**Fig. 17**). Among the temperature regimes, the highest yield (586.17 mg/g FW) was recorded at 25°C. Maximum production (656.14 mg/g FW) was observed in medium having 6% sucrose. Alkaline pH (7.25–9.50) favoured their production.

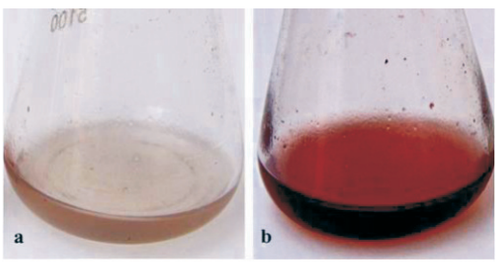


Fig. 17 Cell suspension cultures of *A. euchroma* under a) light and b) dark after 8 days of cultivation

BLACK CARROT (*Daucus carota* ssp. *sativus*)

Four anthocyanins (**1-4**) were isolated and characterized (**Fig. 18**). Their amounts were determined as **2>4>3>1** in fresh plant materials by HPLC. In addition, *in vitro* DPPH radical-scavenging activity of the extract and isolated compounds were determined.

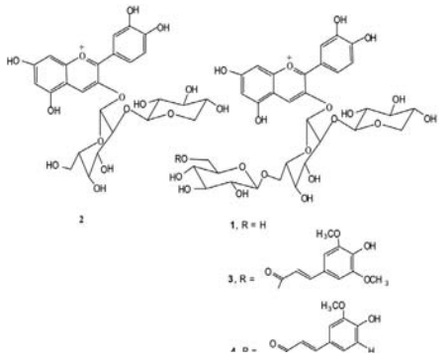


Fig. 18 Chemical structures of anthocyanins

RHODODENDRON (*Rhododendron* spp.)

A rapid and sensitive RP-HPTLC method was developed for the simultaneous determination of four bioactive phenolics *viz*., epicatechin, syringic acid, quercetin-3-*O*-galactoside and quercitrin in the leaves of *R. arboreum*, *R. campanulatum* and *R. anthopogon* (**Fig. 19**).

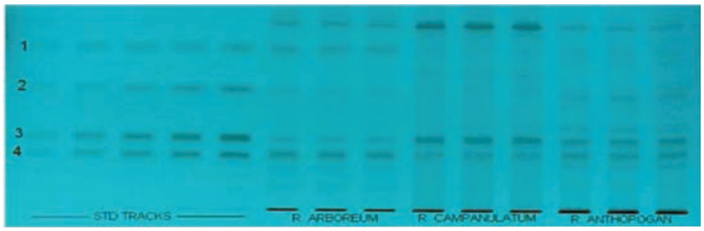


Fig. 19 RP-HPTLC analysis of rhododendron phenolics

Rhododendron anthopogon

Volatile constituents of the hydrodistilled (HD) and supercritical–CO_2 extracted (SC-CO_2) oil were compared with headspace analysis (HS). A total of 27, 31 and 17 constituents were identified in SC-CO_2, HD and HS, respectively. The key compounds identified were p-menthadiene-2,9,diol (7.28%), β-caryophyllene (5.96%) and α-humulene (4.06%) in SC-CO_2 whereas, β–caryophyllene (11.62%), limonene (11.26%), α-humulene (7.22%) and *E*-nerolidol (5.83%) dominated the HD oil. In HS analysis, γ-terpinene (40.73%), limonene (24.14%), β–ocimene (7.15%), α-terpinene (4.92%) and β–phellandrene (3.44%) were the major constituents.

WALNUT (*Juglans regia*)

Methanolic extract and its *n*-hexane, chloroform, ethyl acetate and *n*-butanol fractions from bark were investigated for total phenolic content and *in vitro* antioxidant activities. Highest activity was observed in ethyl acetate fraction which was comparable to synthetic antioxidant butylated hydroxy toluene (**Table 4**). In an another study, a simple, reliable and validated RP-HPTLC method was developed for the simultaneous quantification of gallic acid, caffeic acid, quercetin, rutin, myricetin and juglone in the extract/fractions (**Fig. 20**). These were also evaluated for the color properties in terms of brightness (L), hue (h) and chroma (C) (**Table 5**). The results indicated that the phenolic rich fractions, especially ethyl acetate, might find use as a natural antioxidant and/or colorant.

Table 4 Antioxidant activity of walnut bark extract/fractions

Sample	DPPH activity (% inhibition)	ABTS activity (mmol trolox/mg)	FRAP activity (mM AA/g)
Gallic acid	94.67 ± 1.13 a,b	15.69 ± 1.05 a	8.5 ± 0.1 a
Quercetin	78.82 ± 0.57 e	7.23 ± 0.25 b	4.5 ± 0.2 b,c
BHT	95.28 ±1.08 a	5.47 ± 0.15 c	4.7 ± 0.3 b
Juglone	64.12 ± 0.83 g	2.86 ± 0.14 d	0.45 ± 0.03 g
MeOH	77.62 ± 1.58 f	1.35 ± 0.03 f	3.8 ± 0.2 d
Hex	5.41 ± 1.03 i	0.09 ± 0.01 h	0.40 ± 0. 2 g
CHL	23.5 ± 1.05 h	0.25 ± 0.04 g,h	0.65 ± 0.05 g
Ethyl acetate	90.4 ± 0.28 c	1.95 ± 0.2 e	4.30 ± 0. 2 c
BU	83.03 ± 1.0 d	0.78 ± 0.04 f,g	1.75 ± 0.3 e
INS	42.6 ± 1.5 h	0.61 ± 0.02 g,h	1.25 ± 0.2 f

[a]Values are mean ± standard deviation of three different assays. BHT- butylated hydroxy toluene, MeOH- methanol extract, Hex- hexane fraction, CHL- chloroform fraction, BU- n-butanol fraction, INS- insoluble part

Table 5 Color characteristics of walnut extract/fractions

Samples	L	a	b	C	h^0
MeOH	86.24	4.27	35.50	35.76	83.09
Hex	95.76	-0.83	10.5	10.55	94.48
CHL	91.85	-0.50	10.09	10.10	92.87
EA	93.63	-0.81	23.33	23.35	92.01
BU	92.22	0.99	21.27	21.73	87.33
INS	77.03	9.27	51.52	52.35	79.76

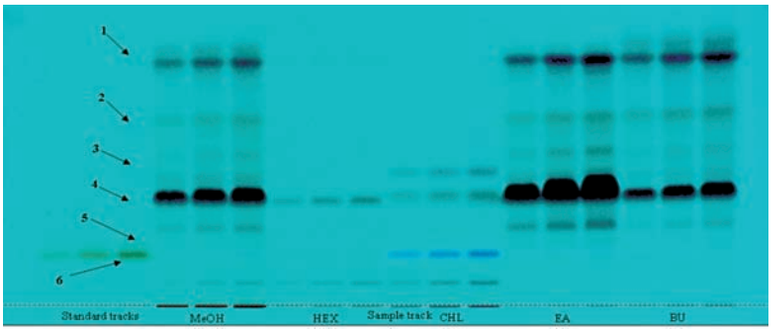
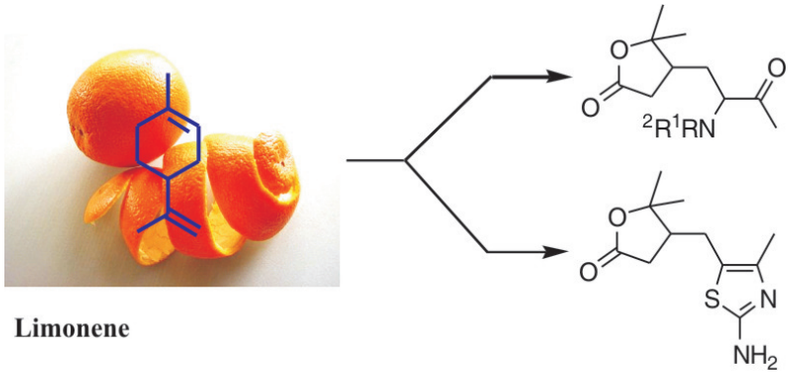


Fig. 20 RP-HPTLC analyses of phenolic compounds in walnut bark extract/fractions. 1: gallic acid, 2: caffeic acid, 3: rutin, 4: myricetin, 5: quercetin, 6: juglone

Synthetic chemistry

Amine and thiazole substituted gamma-butyrolactones from naturally occurring limonene

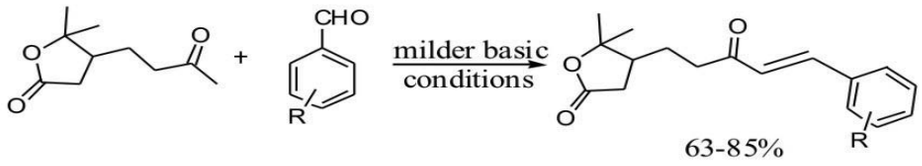
Substituted γ-butyrolactones are important structural motifs in several natural products and pharmaceuticals. A novel γ-butyrolactone amine and thiazole derivatives were synthesized from naturally occurring limonene. The regioselective bromination followed by nucleophillic substitution with different amines and thiourea gave desired products in moderate yield.



Synthesis of amine and thiazole derivatives

Synthesis of aldol derivatives of gamma-butyrolactones

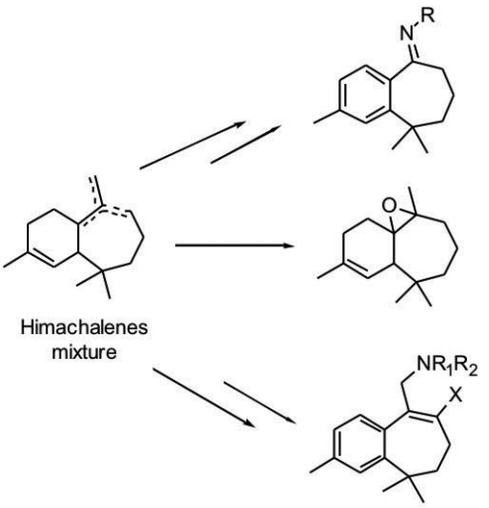
An aldol condensation was carried out under milder basic conditions for the synthesis of α, β-unsaturated ketone derivatives of γ-butyrolactone using different substituted benzaldehyde derivatives.



Aldol condensation of γ-butyrolactones

Value addition of himachalenes

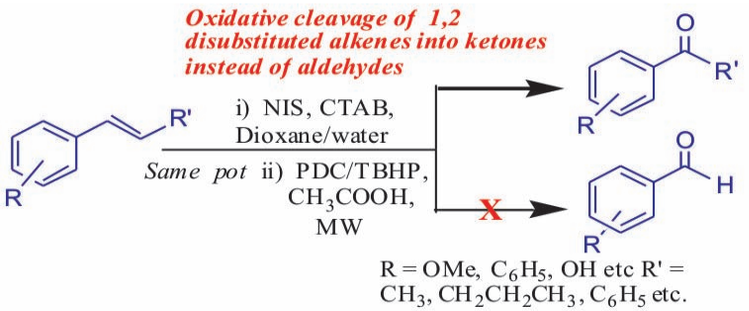
Benzocycloheptene compounds containing amine and imine moieties act as ORL-1 receptors or human β_3 adrenergic receptor agonists with good oral bioavailability and anti-arrhythmic, anti-inflammatory and anti-cancer activities. Novel skeletons of epoxide, imine and amino vinyl halides of benzocycloheptene were synthesized from himachalenes (α, β and γ).



Value addition of himachalenes

Oxidative cleavage of 1,2-arylalkenes to aryl ketones

A method was developed for a one-pot and selective oxidative cleavage of aryl- and 1,2 diarylalkenes leading to one-carbon shorter aryl ketones. This provided a complementary approach to classical ozonolysis. The methodology was applicable to diverse aromatic and polyaromatic arylalkenes bearing electron-donating or withdrawing groups on the aromatic ring. The protocol also provided an useful one-pot oxidative cleavage–condensation sequence which could have potential applications in natural product total synthesis.

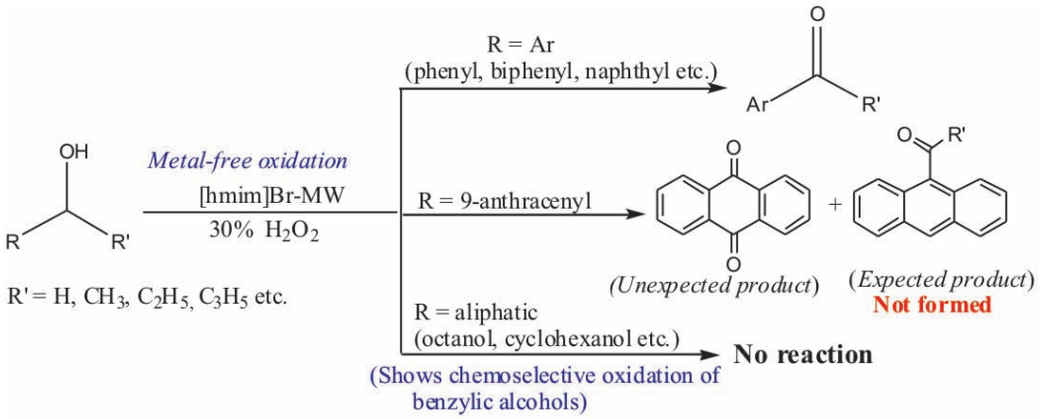


Oxidative cleavage of 1,2-disubstituted arylalkenes

Metal-free chemoselective oxidation of benzylic alcohols

Oxidation of alcohols in ionic liquid was revisited, wherein, ionic liquids under the influence of microwave irradiation facilitated activation of H_2O_2 without any metal catalyst. The method utilized a neutral ionic liquid [hmim]Br both as catalyst and solvent for efficient and chemoselective oxidation of benzyl alcohol derivatives on aromatic (β, γ) alcohols, cyclic and aliphatic analogues.

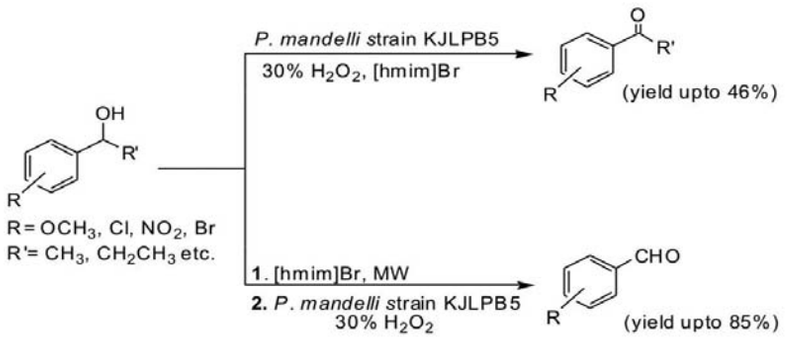
An unexpected oxidation of 9-anthracenyl propanol, a polyaromatic benzyl alcohol resulted in the formation of 9,10-anthraquinone by the loss of propyl side chain.



H_2O_2-assisted chemoselective oxidation of various benzyl alcohols

Chemoselective 2° aryl alcohol oxidation using *Pseudomonas mandelii* KJLPB5 and [hmim]Br in H_2O_2

Pseudomonas mandelli KJLPB5, a bacterial strain was reported for the oxidation of aryl alcohols in ionic liquid [hmim]Br (1-hexyl-3-methyl imidazolium bromide) with H_2O_2. With a slight alteration of reaction conditions, the developed protocol led to (i) chemoselective oxidation of 2° aryl alcohols over 1° and aliphatic counterparts or (ii) direct one pot-two step sequential conversion of 2° aryl alcohols into corresponding one or two carbons shorter aryl aldehydes through oxidative cleavage pathway. This provided a new facet to metal-free oxidations.

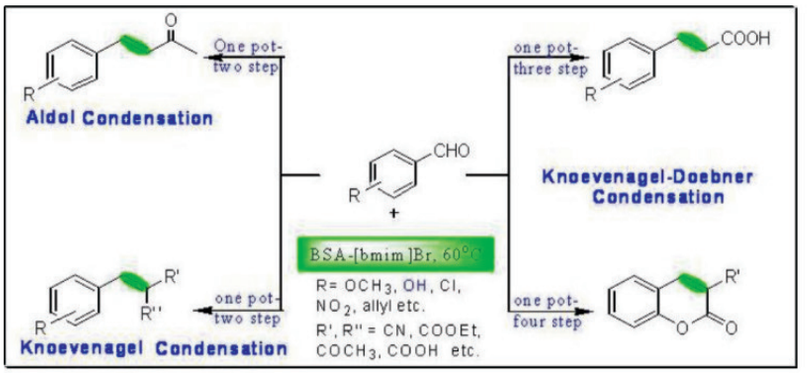


Chemoselective oxidation of 2° aryl alcohol

Bovine serum albumin promoted synthesis of enones, cinnamic acids and coumarins

In exploiting the catalytic promiscuity of crude porcine pancreas lipase (PPL) in ionic liquid for C=C bond formation, bovine serum albumin (BSA) was found competing for the reactions. These transformations are possible by unspecific protein catalysis rather than catalytic promiscuity of "PPL"- a first insight into the role of protein impurities in crude enzyme. A novel and highly efficient environment friendly approach involving synergistic catalysis by BSA-[bmim]Br was

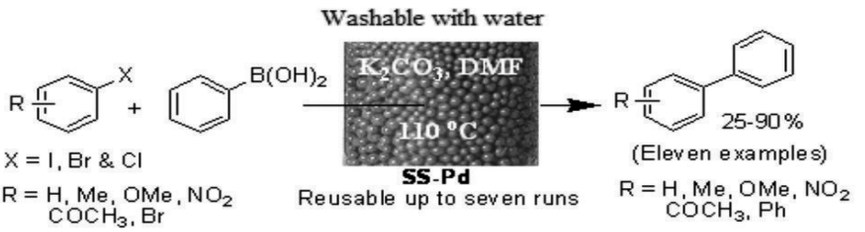
developed for the synthesis of (*E*)-α,β-unsaturated compounds including one-pot cascade synthesis of cinnamic acids and coumarins via aldol, Knoevenagel and Knoevenagel-Doebner condensation.



Synthesis of enones, cinnamic acids and coumarins

Development of solid supported bimetallic nano catalysts and their applications in coupling reactions (Funded by Department of Science and Technology, Nano Mission, Govt. of India)

Solid-supported nano- and microparticles of Pd(0) (SS-Pd) were prepared and used as heterogeneous catalysts for Suzuki–Miyaura cross coupling reactions of aryl halides (chloro, bromo and iodo) and phenyl boronic acid under mild and ligand-free conditions. Scanning electron microscope (SEM) and UV–Vis studies showed the distribution of nano- and microparticles of Pd over solid surface and their oxidation states (**Fig. 21a and b**). In addition, the catalyst was stable under moist conditions and could be reused up to 7 runs without significant loss of activity.



SuzukiMiyaura cross coupling reaction

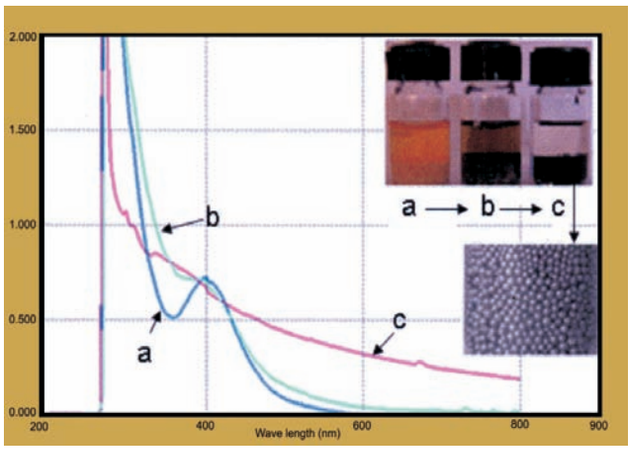


Fig. 21a UV-Vis absorption spectrophotometric study of in situ conversion of Pd(II) salts to Pd(0)

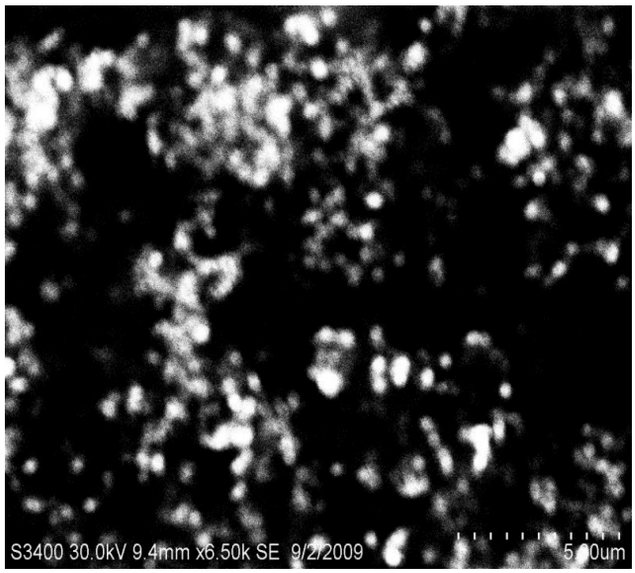
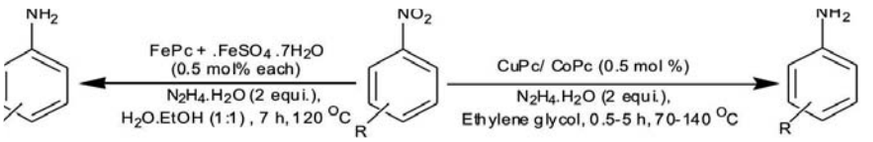


Fig. 21b Scanning electron micrograph of SS-Pd nano- and microparticles

Chemo- and regioselective reduction of aromatic nitro compounds

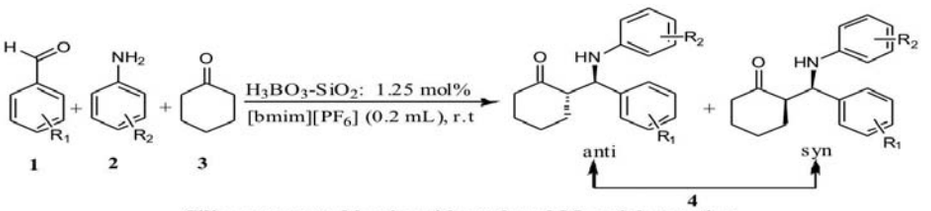
Copper/cobalt phthalocyanines and iron phthalocyanine with iron sulphate were established as catalysts for very efficient chemo- and regio-selective reduction of aromatic nitro compounds to generate corresponding amines. The selective reduction of nitro compounds was observed in presence of large range of functional groups such as aldehyde, keto, acid, amide, ester, halogen, lactone, nitrile and heterocyclic functional groups. Furthermore, the present method was found to be highly regioselective towards the reduction of dinitro aromatic compounds in shorter time with higher yields. In most of the cases, the conversion and selectivity was >99% as monitored by GC-MS. The reduction mechanism was elucidated by UV-Vis and electrospray ionization quadrupole time-of-flight tandem mass spectrometry.



R = -F, -Cl, -Br, -I, $-CH_3$, -OH, $-OCH_3$, -CHO, $-COCH_3$, -COOH, -CN, $-COOCH_3$, $-CONH_2$, $-CHCH_2$, $-NO_2$, $-OCH_2C_6H_5$, $-NHCH_2C_6H_5$, $-SO_2NH_2$

Green and efficient method for Mannich reactions

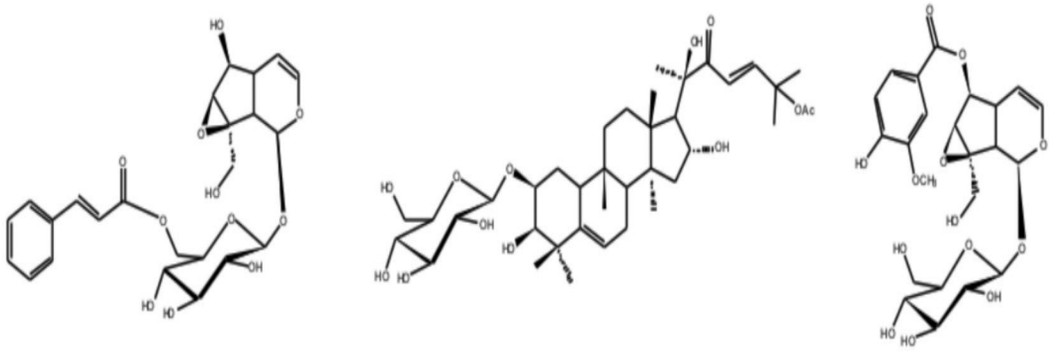
A rapid and efficient silica-supported boric acid/ionic liquid ([bmim][PF_6]), catalyzed, one-pot three-component Mannich reaction was carried out to synthesize β-amino carbonyl compounds at room temperature. The reaction afforded desired products in excellent yields with moderate to good diastereoselectivity. The preparation of H_3BO_3-SiO_2 catalyst and its use with [bmim][PF_6] to synthesize Mannich products is the first report. The catalyst can be reused at least 7 times.



Silica-supported boric acid catalyzed Mannich reaction

PICRORHIZA (*Picrorhiza kurrooa*)

P. kurrooa is an important alpine medicinal herb endemic to Himalayas and is used in traditional and modern medicines for liver disorders. Three molecules, picroside-I, II and cucurbitacin-C were isolated and characterized (**Fig. 22**).



Picroside I **Cucurbitacin-C** **Picroside II**

Fig. 22 Chemical structures of compounds isolated from *P. kurrooa*

Owing to extensive uprooting of underground parts for extraction of picrosides, the plant is now endangered. However, the work at IHBT has shown the presence of picrosides in leaf tissues too (**Fig. 23**). The plants have higher leaf biomass as compared to underground parts and can serve as a potential source of picrosides. This will prevent the uprooting of underground parts thereby allowing plant regeneration in subsequent growing season.

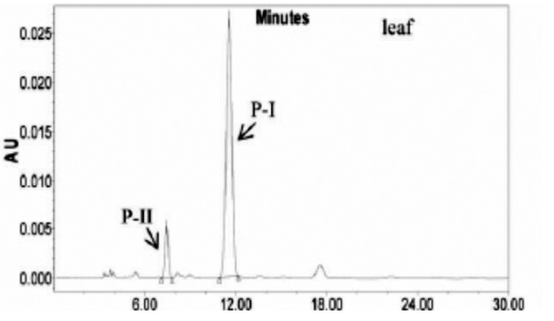


Fig. 23 HPLC profile of picroside –I (P-I) and picroside – II (P-II) in leaf tissues of *P. kurrooa*

In a study to understand the molecular basis of picroside biosynthesis, the promoters of regulatory genes p*khmgr* and p*kdxs* were analysed. These had TGAC *cis-acting* elements at multiple locations, the proposed binding sites of WRKY transcription factors. Electrophoretic mobility shift assays showed the functionality of TGAC elements. Two *WRKY* genes were cloned to full-length. Of these, the expression of *WRKY2* (**Fig. 24**) showed a positive correlation with picrosides content, suggesting it to be an important regulator of picroside biosynthesis.

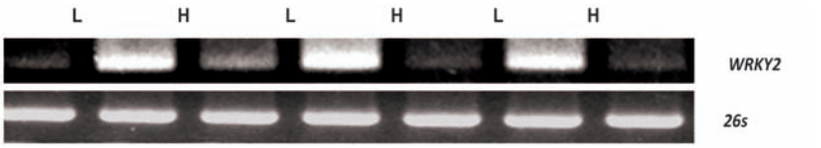


Fig. 24 Expression of *WRKY2* during low (L) and high (H) picrosides synthesizing conditions

Regeneration protocol of *P. kurrooa* was standardized using leaf segments and aseptic shoot cultures were raised. Transcription factor WRKY from *P. kurrooa* in pCAMBIA1302 and *gus* gene in *Agrobacterium* strain GV3101 was used for transformation of leaves. Shoot buds emerged from the transformed leaf segments after 24-28 days. These shoot buds grew further to form small shoots on selection medium containing kanamycin (**Fig. 25**).

The transcriptome of picrorhiza was assembled at two different temperatures and several isoforms were detected using next generation sequencing. In digital gene expression analyses and whole transcriptome annotations, upregulation of several secondary metabolic pathway genes at lower temperature were identified.

Fig. 25 Multiple shoots and shoot primordia developing from leaf explant

HAWTHORN (*Crataegus oxyacantha*)

The plant is a valuable remedy for cardiovascular system. Its leaves and fruits are rich sources of polyphenolic compounds which are responsible for hypolipidemic, antioxidant, anti-inflammatory, hypotensive and anti-ischemic activities. In characterization of the active principles, 10 molecules of flavonoids, triterpenoids, steroidal and phenolic skeletons were isolated from *n*-butanol and ethyl acetate fractions (**Fig. 26**). A method was also developed and validated to determine main phenolic compounds *viz.,* chlorogenic acid, epicatechin, vitexin, hyperoside, quercetin and apigenin in the plant extracts.

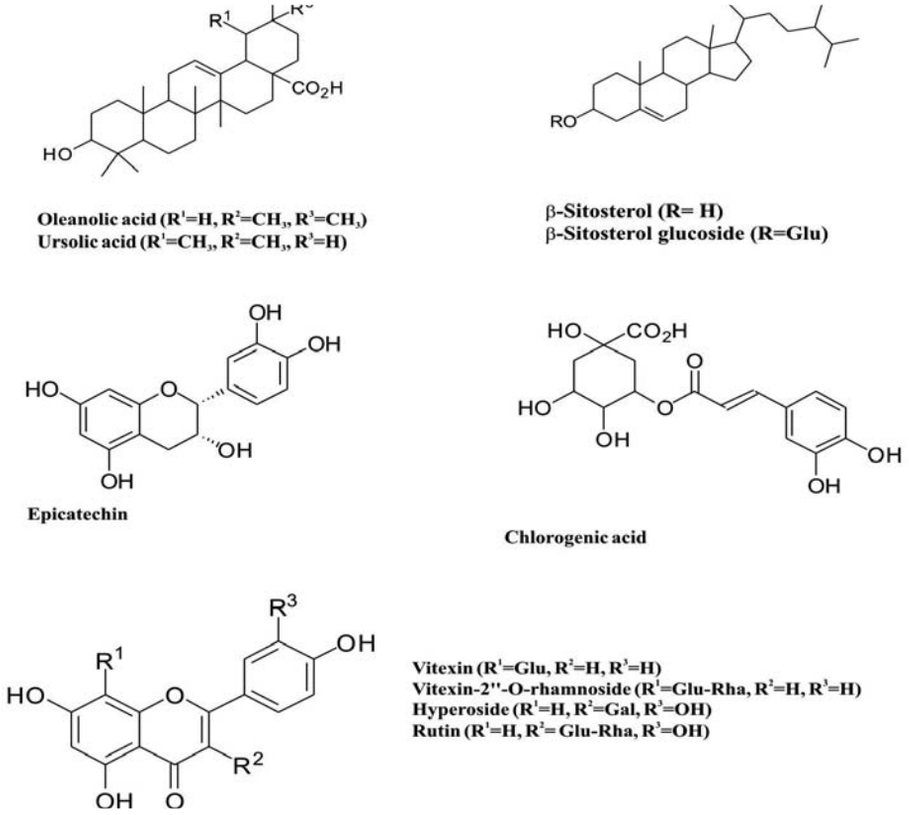


Fig. 26 Chemical structures of compounds isolated from *C. oxyacantha*

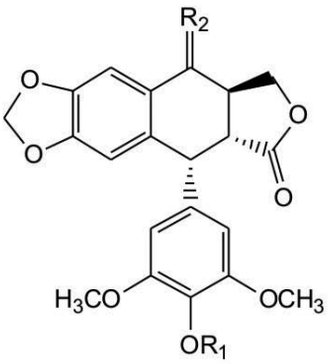
Two long term field experiments were initiated in July, 1999 to rationalize plant spacing and level of FYM application for its cultivation. Increase in fruit yield was observed with increased level of FYM and plant spacing upto 3x1m^2 in 2010 (**Table 6**).

Table 6 Effect of plant spacing and FYM levels on fruit yield of *C. oxyacantha*

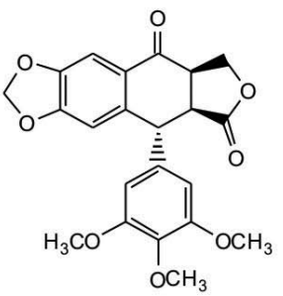
FYM (t/ha)	Fruit yield (kg/plot)	Plant spacing (m^2)	Fruit yield (kg/plot)
15.0	4.7	1 x 1	2.5
22.5	4.8	2 x 1	5.9
30.0	6.2	3 x 1	7.7
37.5	7.8	2 x 2	4.2

MAY APPLE (*Podophyllum hexandrum*)

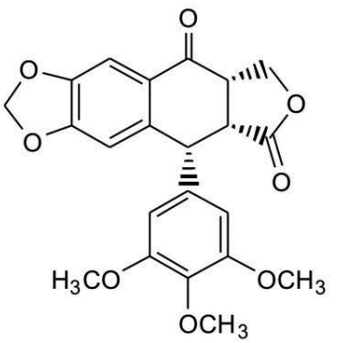
The plant is a perennial herb known to contain highest contents of podophyllotoxin which is used for the semi-synthesis of the anti-neoplastic drugs, etoposide and teniposide. Different chromatographic techniques led to isolation of four flavonoids and six lignans.The flavonoids were characterized as rutin, quercetin, kaempferol and quercetin-3-O-rhamnopyranoside and lignans as podophyllotoxin, 4'-demethylpodophyllotoxin, podophyllotoxone, isopicropodophyllone, picropodophyllone and deoxypodophyllotoxin (**Fig. 27**). New HPTLC method was also developed for quantitative analysis of lignans and flavonoids in different extracts (**Fig. 28**).



R_1=H, R_2 = OH **4'-Demethylpodophyllotoxin**
R_1=CH_3, R_2 =OH **Podophyllotoxin**
R_1=CH_3, R_2 =O **Podophyllotoxone**
R_1=CH_3, R_2=H, H **Deoxypodophyllotoxin**



Picropodophyllone



Isopicropodophyllone

Fig. 27 Chemical structures of lignans isolated from *P. hexandrum*

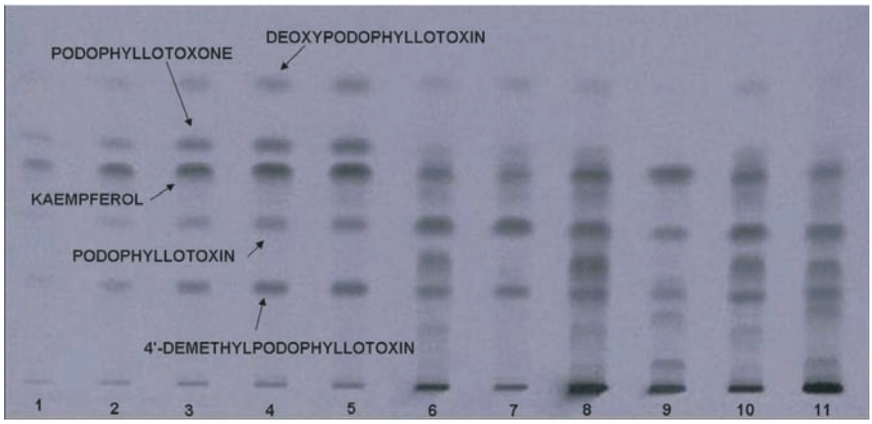


Fig. 28 HPTLC analyses of *P. hexandrum* samples

In a study on female gametophyte development in Berberidaceae, the ovule was found to be anatropous, crassinucellate and bitegmic with polygonum type embryo sac development. Archesporial cell developed directly into megaspore mother cell followed by meiotic divisions. In mature embryo sac, a small chamber is present above egg apparatus towards micropylar end. The synergid cells have filiform apparatus and endostomic condition which is considered as primitive.

In the genus *Podophyllum*, however, the ovule is pseudocrassinucellate with sub-hypodermal and single celled archesporium.The primordia for outer integument develops first and the contribution of outer integument (5 to 6 cell-layer thick) in the formation of micropyle is more than the inner integument (2 cell-layer thick).These distinct features of the plant indicate it to be more evolved than its counterparts.

WILD TURMERIC (*Curcuma aromatica*)

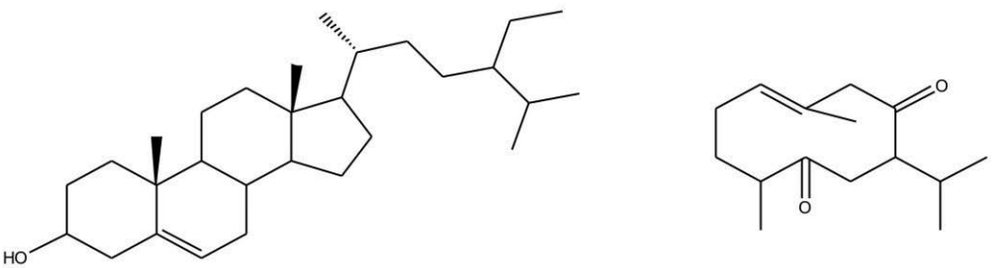
The essential oil of turmeric rhizomes is used in pharmaceutical applications. The plant is also reported to possess antifungal, antimicrobial, mosquito repelling and anti-inflammatory properties. Distillation of about 1246 (2-year old) and 300 kg (1-year old) fresh rhizomes produced 4280 and 980ml oil with a recovery of 0.343 and 0.327%, respectively.

In a program on evaluation of non-commercial crops for value addition, the essential oil fractions collected from rhizomes at different time intervals at lab and pilot scales were analysed using GC-MS and ^{13}C NMR. The last fraction (IV) showed marked reduction in camphor and increased level of high boiling compounds (**Table 7**). In another study, three molecules were isolated from the chloroform fraction of rhizomes, of which, two were characterized as β-sitosterol and curdione (**Fig. 29**). A new economic process was also developed for production of value added fragrances from the essential oil.

Table 7 Chemical composition of *C. aromatica* essential oil extracted at pilot plant scale

Compounds	F-1 (%)	F-II (%)	F-III (%)	F-IV (%)
Camphene	4.5	3.6	3.1	3.1
Eucalyptol	10.0	4.6	2.1	1.8
Linalool	3.3	1.9	1.1	1.0
Camphor	24.4	12.8	6.6	5.3
iso-Borneol	7.6	4.8	3.1	2.6
Curdione	3.3	7.8	8.0	7.8
Oil yield	0.13	0.08	0.02	0.01

(F-1 =1-3 hrs, F-II=4-10 hrs, F-III=11-13 hrs and F-IV=14-16 hrs of extraction)



I II

Fig. 29 Chemical structures of compounds (I-β-sitosterol and II-curdione) isolated from *C. aromatica*

INCARVILLEA (*Incarvillea emodi*)

The earlier domesticated plants were investigated for chemical constituents and two major iridoid glucosides, plantarenaloside and boschnaloside were isolated and characterized from the shoots (**Fig. 30**). These iridoids are known for neurotrophic and antibacterial activities.

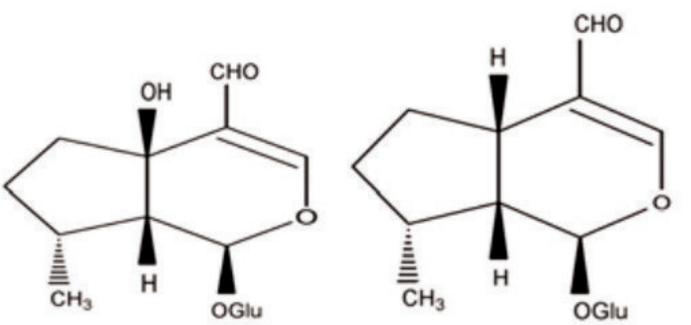


Fig. 30 Chemical structures of compounds isolated from *I. emodi*

CLARY SAGE (*Salvia sclarea*)

It is one of the most important aromatic plants cultivated worldwide as a source of essential oils. The effect of irradiance stress and plant geometry on oil content was studied. Oil yield was higher in the open as compared to 25-75% shade **(Fig. 31).** Flower yield was observed to be significantly higher at 30x30 cm^2 spacing but the oil content was not significantly affected.

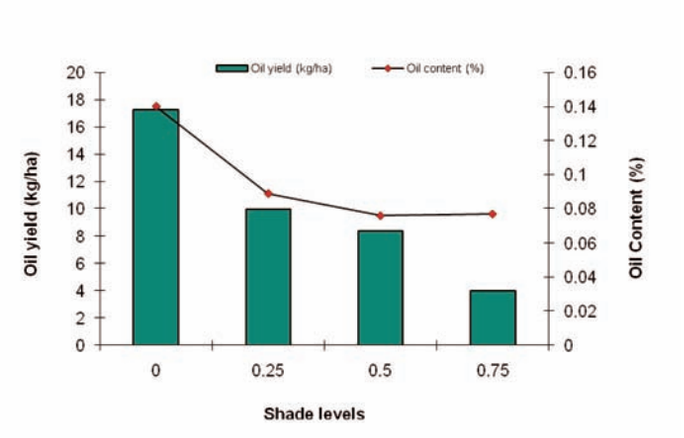


Fig. 31 Effect of shade on oil content (%) and yield of *S. sclarea*

In a separate study, a leaf area estimation allometric model was developed using linear measurements of leaf length (L) and maximum width (W). A linear model having LW as the independent variable (y=-3.4444+0.729LW) provided the most accurate estimation (R^2=0.9904, RMSE=7.05) of leaf area (**Fig. 32**). Further, validation of the regression model by using the data from another experiment showed that the correlation between measured and predicted values was very high (R^2 =0.9858, RMSE=10.38).

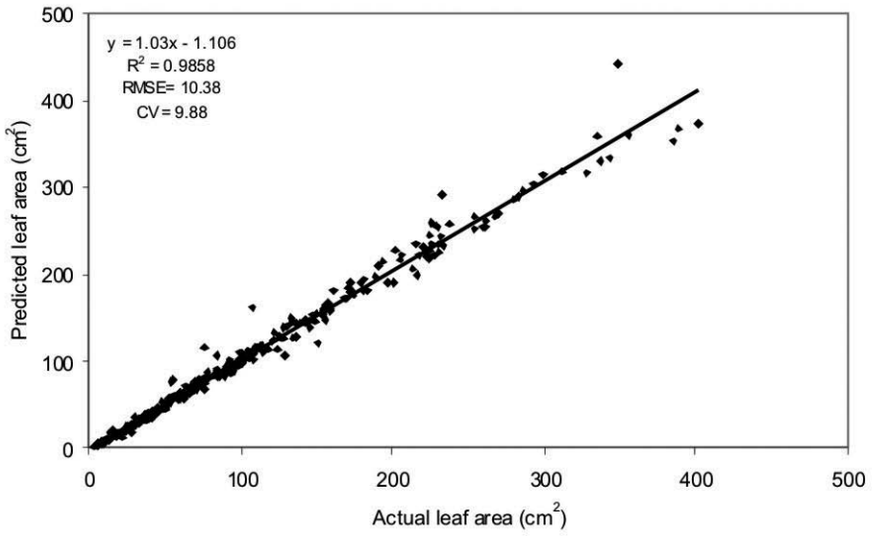


Fig. 32 Validation of the actual vs predicted values of single leaf area

CAPILLIPEDIUM (*Capillipedium parviflorum*)

Volatile constituents of the hydrodistilled (HD) and supercritical–CO_2 extracted (SC-CO_2) oil were compared with headspace analysis (HS). The non-terpene contents were 90.7, 84.0 and 92.5% in HD, SC-CO_2 oils and HS, respectively (**Table 8**). While monoterpenes were found in low concentration in HD oil, these were not detected in SC-CO_2 and HS. Sesquiterpene hydrocarbons ranged between 1.5 and 3.1% in SC-CO_2 oil and were higher in comparison to HD and HS techniques. 4-Nonanone, 4-nonanol, 4-undecanone and 4-undecanol dominated the volatile constituents (Table 13). In SC-CO_2 extraction, nine combinations of temperature and pressures were tested and three sets were selected to determine the effects on extraction yields. Maximum yields viz., 0.14, 0.18 and 0.18% were recorded at temperature (°C)/pressure (MPa) of 85/9, 35/17 and 85/25, respectively.

Table 8 HD and HS analysis of volatile constituents from *C. parviflorum*

Constituents	HDOil	HS analysis
Monoterpene hydrocarbons	0.2±0.1	-
Oxygenated monoterpenes	0.6±0.3	0.3±0.2
Sesquiterpene hydrocarbons	0.9±0.5	0.3±0.3
Oxygenated sesquiterpenes	2.4±0.4	0.4±0.4
Non terpenes	90.7±1.5	92.5±0.9
Total	**94.9±1.5**	**93.5±1.2**

MENTHA (*Mentha piperita*)

Distillation of about 276kg fresh leaf produced 640ml oil with 0.23% yield. GC-MS analysis of the oil revealed menthol (33.6%), menthone (19.4%), menthyl acetate (7%), menthofuran (5.3%) and 1,8 cineole (5.5%) as major constituents.

AKARKARA (*Spilanthes acmella*)

It is an annual herb of tropical and sub-tropical parts of India. It is used as a common spice having natural analgesic effect. The plant extracts are also used to cure toothache, throat and gum infections, stomatitis, tongue paralysis and psoriasis. Four compounds were isolated from *n*-hexane extract of the flower heads and three of them were characterized as taraxasteryl acetate, spilanthol and *n*-hexadecanoic acid (**Fig. 33**).

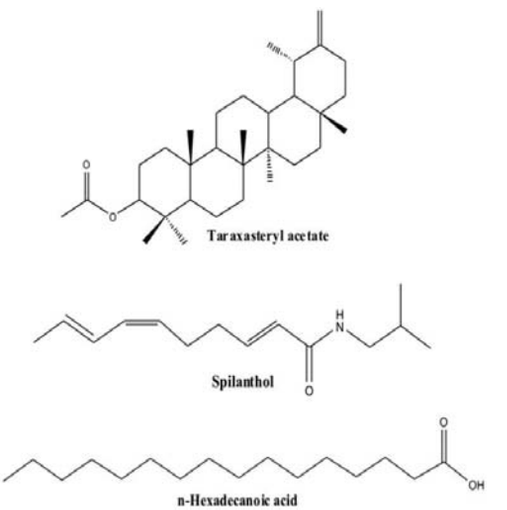


Fig. 33 Chemical structures of compounds isolated from *S. acmella*

ELSHOLTZIA (*Elsholtzia fruiticosa*)

Thirty-five constituents were identified in *Elsholtzia* oil extracted by SCE and HD methods, whereas, 14 volatile constituents were identified in head space (HS) analysis. The oil extracted by HS, HD and SCE were predominated by non-terpenes (59.8%), oxygenated monoterpenes (41.1%) and sesquiterpene hydrocarbons (21.8%). Monoterpene hydrocarbons were determined to the extent of 13.6, 19.4 and 4.3% in HS, HD and SCE extractions (**Table 9**).

Table 9 Variability of terpenes of *E. fruiticosa* essential oil with different extraction techniques

Terpenes	SFE (%)	HD (%)	HS (%)
Monoterpene hydrocarbons	4.3	19.4	13.6
Oxygenated-monoterpenes	37.1	41.1	22.4
Sesquiterpenes-hydrocarbons	21.8	6.6	1.1
Oxygenated- sesquiterpenes	3.0	0.8	-
Diterpenes	3.4	-	-
Non-terpenes	24.5	29.8	59.8
Total	**94.2**	**97.7**	**96.9**

EUCALYPTUS (*Eucalyptus cinerea*)

Eucalyptus oil was extracted by hydrodistillation (HD) and supercritical carbon dioxide extraction (SCE) techniques. HD yielded highest oil (free volatiles) content (3.1%) in comparison to SCE (1.1%). Both the free and bound volatiles contained 85.1 and 20.6% 1,8-cineole, respectively. Similarly, the oil produced by SCE was dominated by 1,8-cineole (70.4%) followed by oxygenated sesquiterpenes (6.4%) and sesquiterpene hydrocarbons (3.3%).

TIRMIRA (*Zanthoxylum armatum*)

The plant is mainly distributed in tropical and sub-tropical parts of India. It is extensively used in the Indian Systems of Medicine for preventing toothache as a carminative, stomachic and anti-anthelmintic. In exploring its active principles, 5 compounds were isolated from chloroform fraction of the leaves, of which, four were characterized as furofuran lignans and one as 2-hydroxy-4,6-dimethoxyacetophenone (**Fig. 34**).

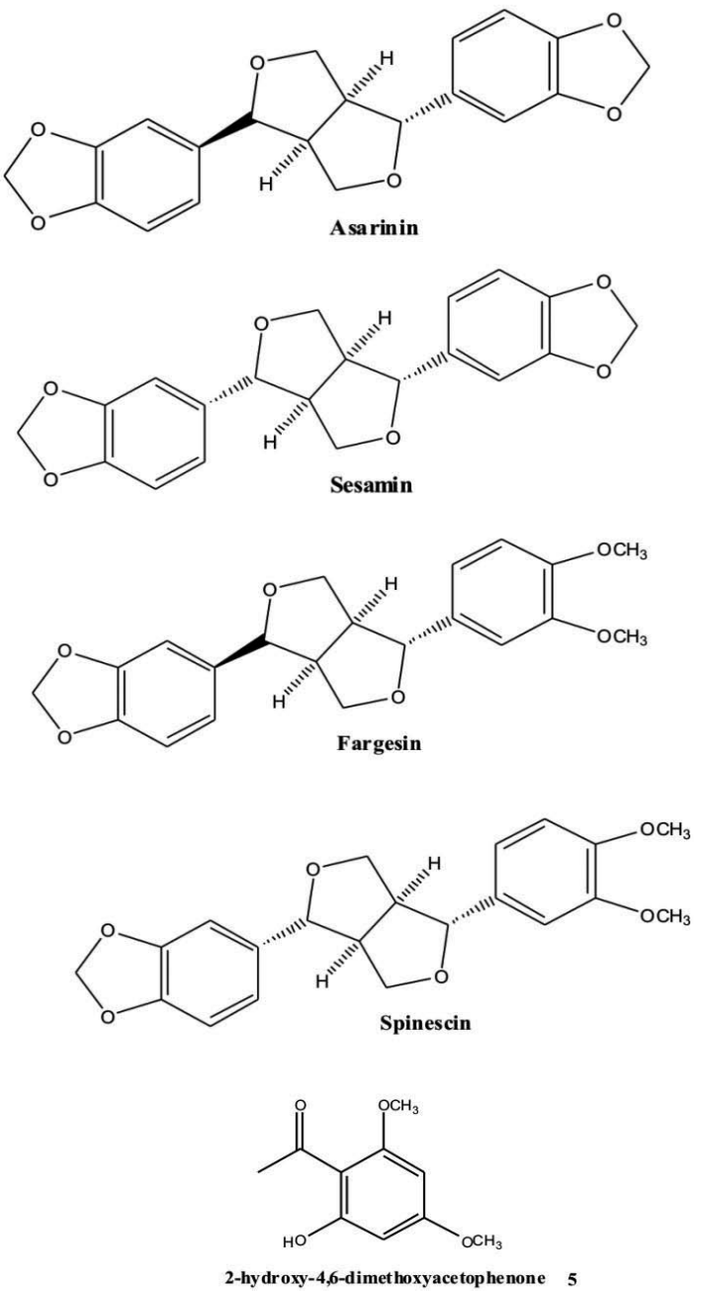


Fig. 34 Chemical structures of compounds isolated from *Z. armatum*

DEODAR (*Cedrus deodara*)

Deodar is native to the Himalayan region. The plant is the main source of cedar wood oil having varied industrial applications. Five sesquiterpenes, α-himachalene, β-himachalene, γ-himachalene, atlantolone, (*E*)-α-atlantone were isolated and characterized from *n*-hexane and chloroform fractions (**Fig. 35**).

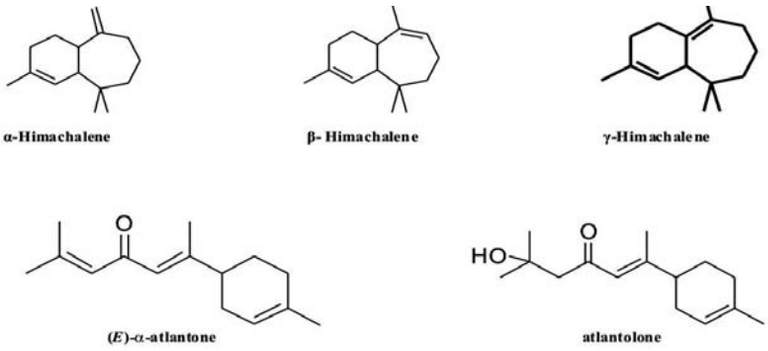


Fig. 35 Chemical structures of sesquiterpenes isolated from *C. deodara*

CHINESE ALBIZIA (*Albizia chinensis*)

It is a native of mixed deciduous forests of humid tropical and sub-tropical monsoon climates and reported to have antioxidant, antiseptic, anti-dysenteric, anti-tubercular, anti-tumor, spermicidal, molluscicidal and insecticidal properties. Thirteen marker compounds in the categories of flavonoids and phenolics were isolated and characterized (**Fig. 36**).

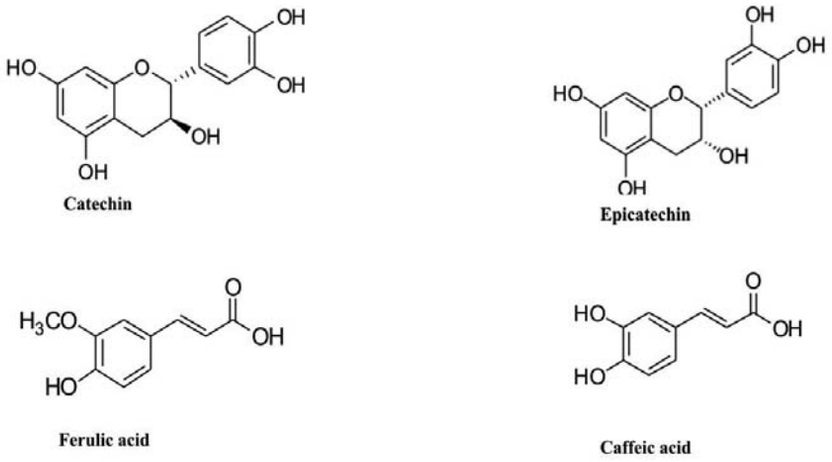


Fig. 36 Chemical structures of marker compounds isolated from *A. chinensis*

SCENTED ROSE (*Rosa* spp.)

Rosa damascena

A total of 7305.50 kg fresh rose flowers were distilled at pilot scale to produce rose oil and water. About 2220 ml of rose oil was recovered from 5797.9 kg of fresh rose flowers with an average oil yield of 0.038% (v/w). About 1500 l of rose water was produced from 1500 kg rose flowers (**Table 10**).

Table 10 Chemical composition of rose oil distilled at pilot plant

Compound	Content (%)
Linalool	8.39
cis-Rose oxide	0.16
Phenyl ethyl alcohol	1.87
α-Terpineol	2.78
Nerol	15.08
Citronellol	16.34
Geraniol	13.16
Geranial	1.76
Eugenol	1.95
Geranyl acetate	2.01
Methyl eugenol	1.12
β-Caryophyllene	1.06
Germacrene-D	1.02
n-Heptadecane	1.47
1-Nonadecene	2.34
n-Nonadecane	9.95
n-Eicosane	0.77
n-Heneicosane	3.01

Rosa bourboniana

In an ongoing study, transgenic *R. bourboniana* plants having *osmotin* gene were analysed for salt and drought stress tolerance. An increased tolerance to NaCl and PEG was evident from higher chlorophyll content in transgenic plants as compared to untransformed controls (**Fig. 37**). The relative water content of the transgenics was also higher (**Fig. 38**).

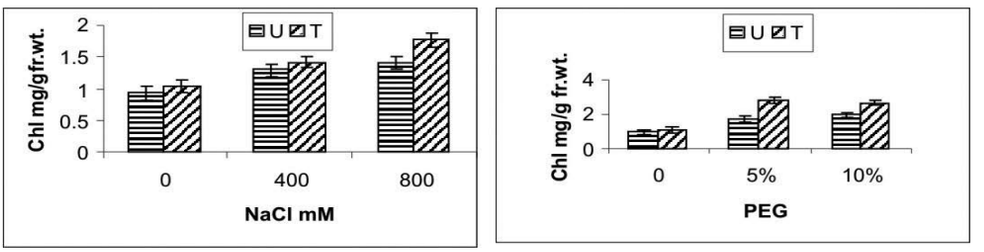


Fig. 37 Chlorophyll contents in response to a) NaCl and b) PEG

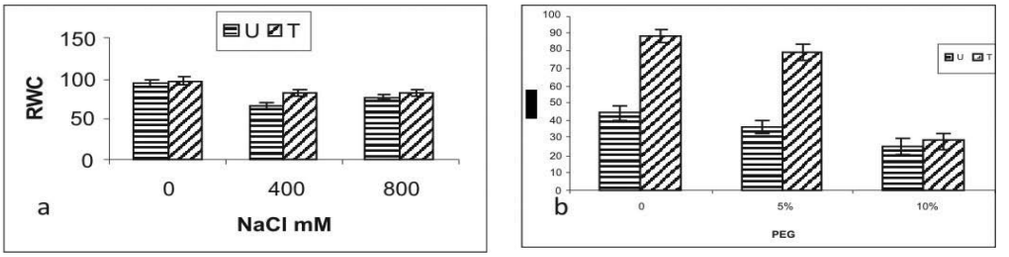


Fig. 38 Relative water content in response to a) NaCl and b) PEG

PLANTATION CROPS

TEA (*Camellia sinensis*)

Construction of integrated linkage framework map

In continuation to previous studies, the existing pseudo test cross progeny of SA-6 (R)xAsha (S) comprising of 212 individuals were selected for establishing the marker trait association for blister blight resistance (**Fig. 39**). A total of 572 primers were tested for identification of markers distinguishing the parental lines and respective bulks. Molecular analyses identified 1619 markers distinguishing the parental lines, whereas only 197 were able to identify the respective bulks. So far, 190 markers (AFLP, RAPD, SSR) were utilized for genotyping of 212 F_1 individuals. Complete genotyping identified 260 markers in 1:1 ratio segregation.

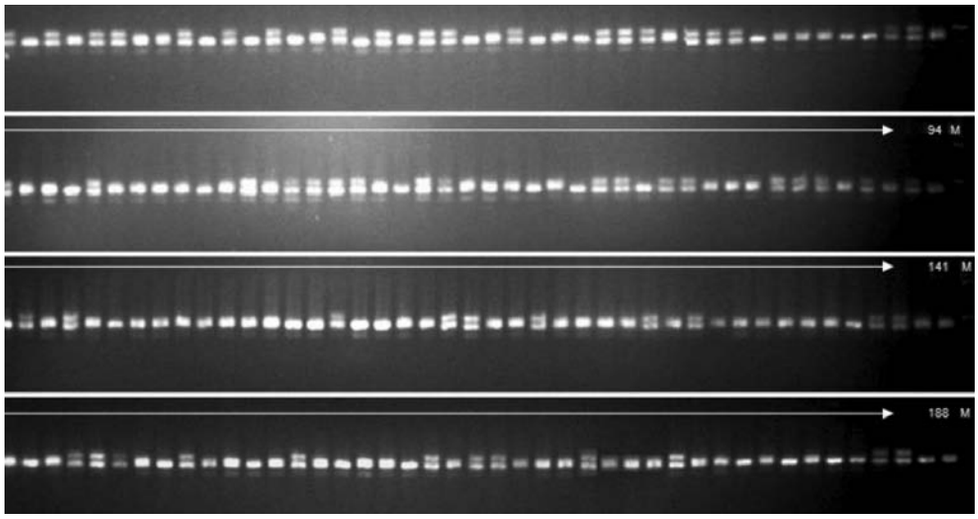


Fig. 39 Representative profile of F_1 individuals of pseudo-test cross progeny of selected parental groups SA-6 (R)xAsha (S) genotyped with primer combination TEGMS 65.

Selection of elite planting material

Clonal plants selected from mother bushes of Kangra Jat and biclonal seed stocks were evaluated. The leaf yield of the accession CEF-02 continued to be significantly higher than other accessions and was at par with the high yielding clone UPASI-9 (control) (**Table 11**) along with the seed-stock selection-3.

Table 11 Performance evaluation of elite planting material

Clone/Selection	Yield (kg of made tea/ha)
Kangra selection BS-070	672
Kangra selection BS-081	681
Kangra selection BS-102	885
Kangra selection CEF-02	1420
Seed-stock selection-1	895
Seed-stock selection-2	909
Seed-stock selection-3	1245
Seed-stock selection-4	50
Seed-stock selection-5	350
Seed-stock selection-6	529
Seed-stock selection-8	1120
SA-6	891

In another study, 61 accessions planted in two blocks i.e., F (25 accessions) and G (35 accessions) were evaluated for leaf yield under field conditions. Accession CEF-02 produced 15% higher yield than UPASI-9 (control) in the ensuing season. Likewise, SST-01 and CEF-01 also recorded higher yield (9-11%) than control (**Table 12**). Accession SST-09 of Assamica type produced more leaf yield than the control.

Table 12 Performance evaluation of accessions

Accession name	Number of bushes/plot	Yield (kg of made tea/ha)
Germplasm Block-F		
BGP-017	13	1572
BGP-063	30	1584
BGP-066	27	1558
BGP-072	30	1882
BGP-118	28	1531
BGP-119	30	1647

BGP-122	29	1635
BGP-123	30	1538
BGP-144	19	1870
BGP-146	19	1728
BGP-156	9	1653
CEF-02	22	2282
UPASI-9 (control)	25	1980
Germplasm Block-G		
BGP-146	22	1605
BGP-151	17	1605
CEF-01	12	1968
CEF-03	18	1604
SST-01	19	2010
SST-02	10	1736
SST-09	9	3924
UPASI-9 (control)	23	1803

Pesticide residue and heavy metal analyses

A multiresidue analysis method was developed and validated for the detection of 8 more organochlorine pesticide residues in tea, herbs and herbal products. NABL certificate was also obtained for detection of organochlorine pesticide residues.

In another activity on heavy metal analyses, the earlier validated detection method was used to investigate the metal load in herbal drugs of Himalayan region. The results revealed that the loads were well below the permissible limits specified by the Prevention of Food Adulteration Acts & Rules (PFA) in all but one sample. In analyses of leaf samples from Banuri tea garden, Mn followed by Fe, Zn and Cu were the most detected essential metals. The toxic heavy metals (Pb, Cd and Ni) were too low or undetected in tea leaves, made tea and infusions.

Farm mechanization

The performance of the skiffing machine STIHL 81 was evaluated for the second year. The benefit-cost ratio (BCR) was worked out to be 1.34, 1.53 and 1.63 for level-off skiff, light skiff and deep skiff, respectively. In another study, a pruning machine OTC 4300 weighing 7.3 kg with 250x100 mm P-tipped saw blade and a rotating action blade was evaluated. The BCR for collar pruning was worked out to be 1.96.

Molecular markers and descriptor development

In continuation to earlier studies, 113 microsatellite markers were identified from genic and enriched genomic libraries. Two hundred additional markers were identified while validating 482 markers in selective accessions and related species of *Camellia*. Analysis revealed an average 5.89 alleles and 0.411 PIC (Polymorphism Information Content) per marker. The observed and expected mean heterozygosities were 0.634 and 0.612, respectively. These markers recorded a high level of transferability (98-100 %) in the cultivated and related *Camellia* species.

Transgenics

In continuation to earlier studies, improved tolerance to PEG induced osmotic stress was observed in the transgenic plants expressing osmotin gene (**Fig. 40a**). The transgenics showed increased accumulation of osmolytes like raffinose and sorbitol and recovered from stress more rapidly as compared to control (**Fig. 40b**).

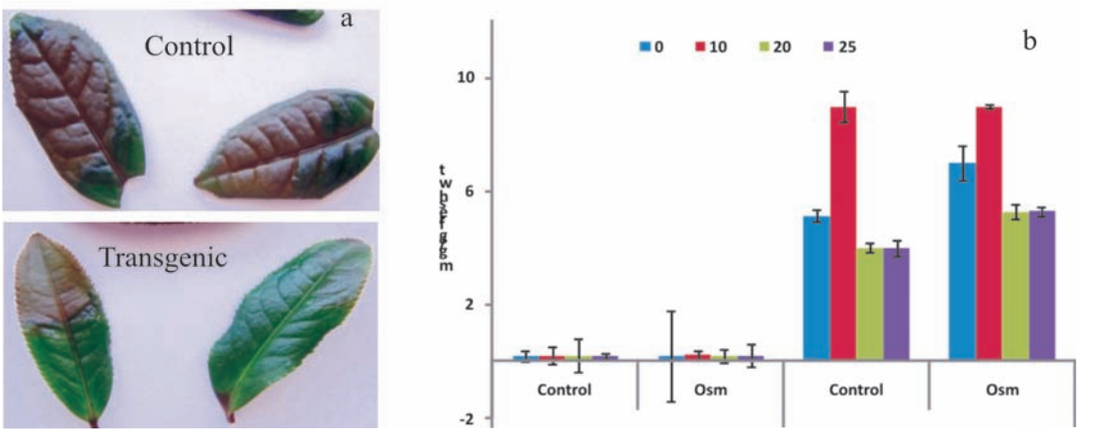


Fig. 40 Response of transgenic plants to osmotic stress a) leaf senescence, b) accumulation of osmolytes

Decaffeination of Kangra orthodox tea

Kangra orthodox tea was decaffeinated at different extraction temperatures (35, 60 and 85°C) and pressures (90 and 170 bar) using a Thar Supercritical Extraction System. Highest decaffeination was obtained at 35°C and 170 bar and least decaffeination was obtained at 35°C and 90 bar. Decaffeinated tea recorded highest loss in theaflavins, total colour and brightness of the infusion. In flavour components, decrease in aldehydes (2-hexenal), hydrocarbons (limonene oxide), pyrazines (2,5-dimethyl pyrazine) and esters (methyl salicylate and hexyl hexanoate) responsible for the typical Kangra note was observed.

Bioprospecting Himalayan bioresource through transgenic and nutraceurtical technologies (Funded by Department of Biotchnology, Govt of India)

In a separate study, purified mixtures of 5 flavanols from tea and 3 flavones from hippophae were mixed in different proportions to prepare nutraceuticals. Highest antioxidant activity was recorded when flavonoids from hippophae and tea were mixed in 40:60 ratio (**Table 13**).

Table 13 Antioxidant activity of nutraceutical preparations

Type of extraction	DPPH (%)	FRAP (µm/l)
Hippophae (H)	85.2	7788.0
Tea (T)	86.0	8631.0
(H+T) 80:20	82.6	14920.5
(H+T) 60:40	83.5	14918.0
(H+T) 50:50	83.7	15655.5
(H+T) 40:60	86.4	15865.5
(H+T) 20:80	84.2	14448.0

Extraction and purification of saponins from Kangra tea seeds

The tea is propagated vegetatively and its seeds are rarely used for replanting. In a new activity, work was initiated to isolate and purify saponins from seeds. Four saponins (S_1-S_4) were isolated and characterized **(Fig. 41)**. These saponins showed high activity against the dermatophytic fungus, *Trichophyton rubrum* that causes ringworm and athletes foot.

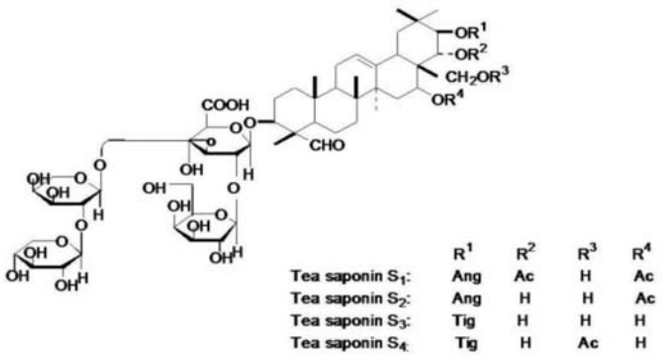


Fig. 41 Structure of saponins isolated from tea seeds

Headspace analysis of tea flowers

Tea flowers were analysed by headspace-GC/MS at different stages of development (unopened bud to full bloom; I, II and III). The important insect attractants, cis-hex-3-ene-1-ol, acetophenone and cis- furanoid linalool oxide were highest in stages I, II and III, respectively (**Table 14**).

Table 14 Headspace analysis of volatiles in tea flowers at different stages of development

Compound	RRI (HP-5)	RRI (BP-20)	Bud (stage I)	Petals start to split (stage II)	Full bloom (stage III)
2-Amyl furan	833	1241	nd	nd	0.97
3-Hexen-1-ol	863	1393	3.46	2.83	2.12
n-Hexyl formate	926	861	0.97	nd	nd
Benzaldehyde	966	1528	7.77	11.45	20.94
1-Octen-3-ol	973	1461	9.84	5.58	8.81
(*Z*)-Furanoid linalool oxide	1062	1449	1.81	1.18	1.12
Acetophenone	1064	1654	23.58	34.83	20.15
Linalool	1078	1559	42.53	nd	nd
(*E*)-Furanoid linalool oxide	1101	1477	3.75	30.42	35.14
1-Phenylethanol	1109	1822	1.1	nd	nd
Benzyl alcohol	1140	1849	1.21	nd	1.41
Methyl salicylate	1207	1775	1.57	1.18	1.9
Nerol	1225	1807	0.31	0.26	nd
Germacrene D	1490	1914	nd	0.51	0.52
Octadecane	1788	1548	0.41	nd	nd
Nonadecane	1903	1523	0.2	nd	nd
Eicosane	2000	1528	nd	0.46	nd

GINKGO (*Ginkgo biloba*)

It is a medicinal plant known for blockage of platelet activating factor, free radical scavenging, neuritogenic and vasoprotective properties. Fifteen bioactive molecules comprising of ginkgolides, flavonoids, biflavonoids and steroidal glucoside were isolated from *n*-butanol fractions using an improved extraction method. In DPPH and ABTS assays, the *n*-butanol and ethyl acetate fractions showed antioxidant activities (**Fig. 42**). In another study, a simple, sensitive, selective and precise RP-HPTLC method was developed and validated for the densitometric quantification of major flavonoids and biflavonoids (**Fig. 43**).

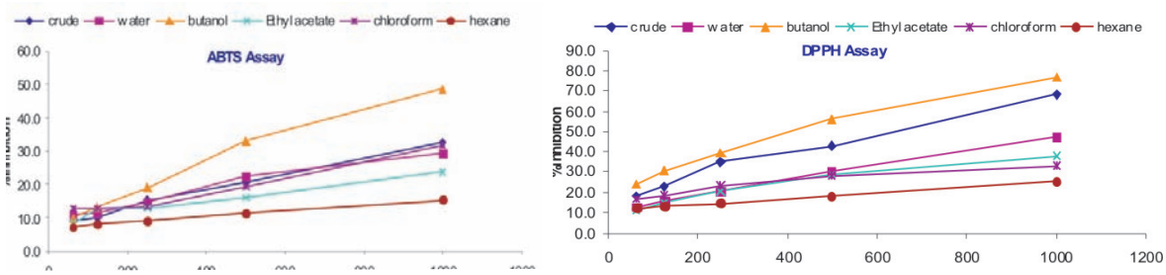


Fig. 42 Antioxidant activity of *n*-butanol and ethyl acetate fractions of *G. biloba*

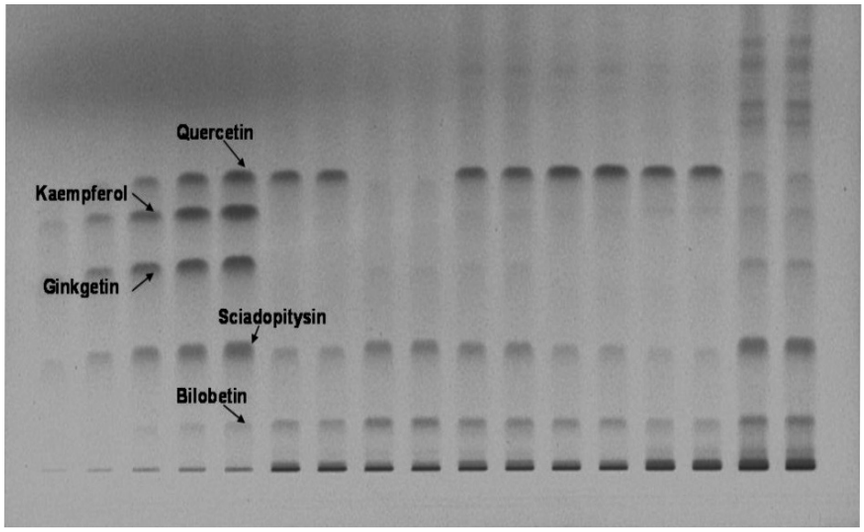


Fig. 43 RP-HPTLC analyses of flavonoids and biflavonoids of *G. biloba*

In agronomical studies, significant increase in leaf yield was recorded at all levels of FYM as compared to control (**Fig. 44**). Although the circumference and diameter of the plant at ground level was not affected (**Table 15**), the application of FYM 45 t/ha resulted in significantly taller plants.

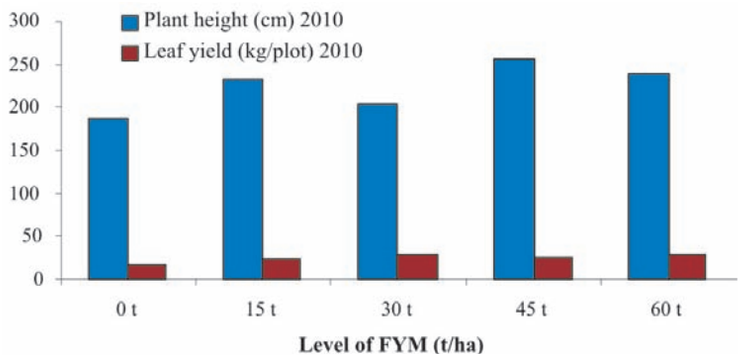


Fig. 44 Plant height and leaf yield of *G. biloba* plantation at different levels of FYM

Table 15 Effect of FYM application on circumference and diameter of *G. biloba* plant at ground level

FYM (t/ha)	Plant circumference (cm)	Plant diameter (cm)
0	14.8	7.4
15	18.8	9.4
30	16.7	8.4
45	18.4	9.2
60	18.2	9.1
LSD (P=0.05)	NS	NS

LAVENDER (*Lavandula angustifolia*)

The plant samples collected from district Chamba (H.P.) were steam distilled at Jassaurgargh and Pritmas villages during June, 2010 for extraction of oil. The chemical constituents were analysed by GC-MS (**Table 16**).

Table 16 Lavender oil composition

Constituent	Content (%)	
	Pritmas	Jassaurgarh
β-Phellandrene	3.76	2.04
Limonene + 1,8 Cineole	1.44	0.80
cis-*β*-Ocimene	1.67	1.15
trans-*β*-Ocimene	1.82	2.05
Linalool	19.37	25.21
1-Octen-3-yl acetate	1.14	0.97
Borneol	2.41	2.26
Terpine-4-ol	0.74	1.00
α-Terpineol	2.37	3.31
Linalyl acetate	36.86	36.83
Lavandulyl acetate	1.71	2.31
Neryl acetate	0.90	1.03
Geranyl acetate	1.56	1.82
β-Caryophyllene	9.61	6.28
cis-*β*-Farnesene	2.27	1.97
Germacrene D	1.10	0.57
Caryophyllene oxide	1.46	0.98

Extraction of volatile oil was carried out by different hydrodistillation techniques. Water distillation (WD) produced higher yield of oil (1.6%) than water-steam distillation (WSD) (1.1%) and steam distillation (SD) (0.9%). Comparative essential oil composition in GC and GC-MS analysis revealed higher content of monoterpene hydrocarbons (10%) and sesquiterpenes (10.3%)

in the oil produced by SD followed by WSD (6.3 and 7.7%) and WD (5.6 and 3.2%), respectively. However, higher ester content (50.4%) was observed in the oil produced by WSD followed by SD (41.3%) and WD (35.5%). Linalyl acetate, one of the quality determining constituents of lavender oil was higher in WSD (47.1%). The total alcohol content was higher in WD (52.3%) followed by SD (35.6%) and lowest in WSD method (31.9%). Hence, WSD technique was more effective for commercial scale lavender oil extraction.

BAMBOO

Genetic diversity and phylogenetic analyses using various molecular markers

A total of 224 accessions belonging to *Dendrocalamus hamiltonii* (111), *D. strictus* (40), *Bambusa nutans* (44), *B. bambos* (15) and *B. balcooa* (13) were assessed for genetic diversity using AFLP markers. Eight primer combinations showing high polymorphism rate in limited accessions detected 2095 polymorphic loci in total and 261.87 loci on an average. The mean PIC value was 0.186. Highest and lowest Marker Index (MI) of 63.08 and 34.87 were observed for the primer combinations E-AAC/M-CAC and E-AGG/M-CTA, respectively. Cluster and principal component analyses revealed the relationships within and between the species (**Fig. 45**).

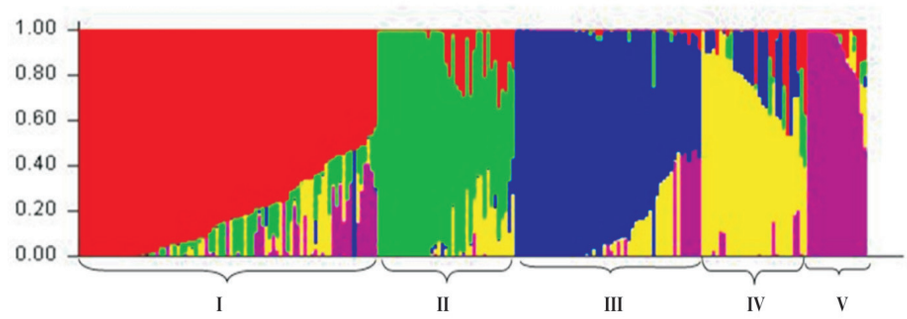


Fig. 45 Genetic clusters of bamboo inferred by STRUCTURE. Cluster I and V: *D. hamiltonii*, Cluster II: *D. strictus;* Cluster III: *B. nutans*, *B. bambos* and *B. balcooa;* Cluster IV: intermixed

EDIBLE AND SPICE CROPS

APPLE (*Malus domestica*)

Value added product development using apple pomace

Apple pomace, a solid residue obtained after juice extraction is an industrial waste that causes high degree of environmental pollution. Therefore, studies were intiated to utilize this waste for value added product development. The antioxidant activity of aextracts obtained from apple pomace was analyzed. Highest activity was obtained with acetone (36.5%) as a solvent as compared to ethanol or methanol (36.3 & 32.1%, respectively).

Apple chlorotic leaf spot virus (ACLSV)

A 6 kb region of the ACLSV genome (7.5 kb) containing the movement and coat proteins, and partial replicase gene was cloned and sequenced (**Fig. 46**).

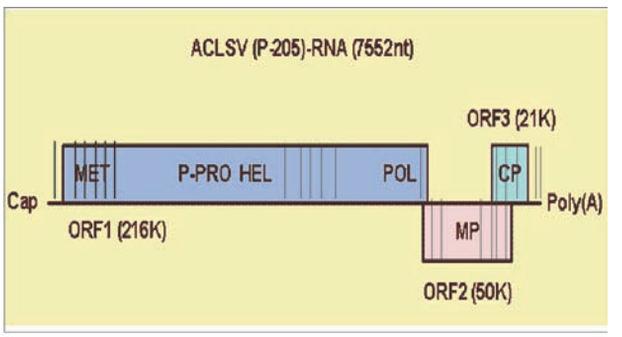


Fig. 46 The ACLSV genome

Twenty-seven isolates from different geographic locations were analyzed to understand the homology/divergence. In case of coat protein, all the isolates shared 91-100% and 70-98% sequence identity at amino acid and nucleotide level, respectively. Based on available classification, these were separated into P-205 and B-6 groups. The highest degree of variability was observed in middle of the protein with 9 amino acid substitutions (72nd-98th) in contrast to the N-terminal and C-terminals.

Molecular plant microbe interactions

In continuation to previous studies on molecular basis of *Alternaria mali* pathogenesis in apple, detached leaf assays were developed. *In silico* expression analyses was carried out on identified apple homologs of arabidopsis genes associated with hormonal (JA, SA and Ethylene) signalling in plant defence (**Fig. 47**). An apple ortholog of arabidopsis brassinosteroid insensitive1 (BRI1)-associated receptor kinase (*BAK1*), a master regulator of defence signalling in plants was also identified.

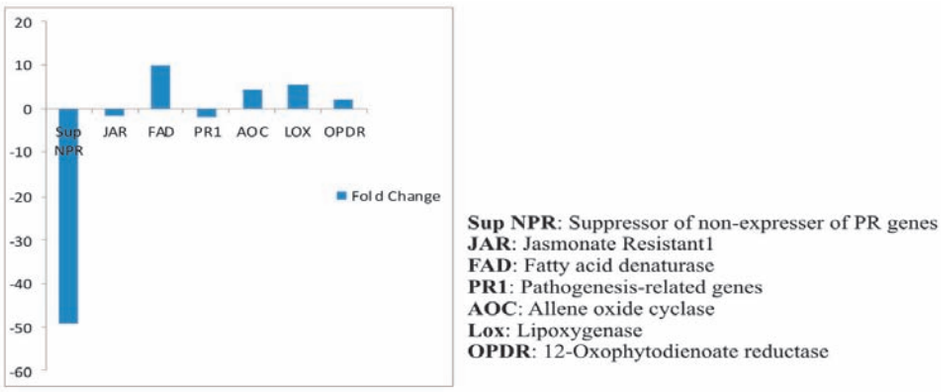


Fig. 47 Expression analyses of defence genes of apple following 12 hrs of SA treatment

Pest management and pestcide residue analysis

Pest infestation of apple germplasm in H.P. results in huge economic losses. Therefore, the apple growing regions were surveyed. Aphids, wooly aphids, caterpillars, shoot borer, termites, scale insects and mites were found to be the major pests. Analytical protocols were standardized using GC-ECD (standard curve, limit of detection and quantification (LOD/LOQ) for the detection of hexithiazox and spiromesifen pesticide residues in apple

STEVIA (*Stevia rebaudiana*)

Introduction and maintenance of germplasm

Stevia is a herbaceous, perennial plant widely grown for commercial production of diterpene glycosides (steviosides). Six accessions were introduced from national (Madhya Pradesh, Punjab and Pune) and international (Brazil, USA, Canada and Japan) germplasm centres. These are being maintained and exploited for improvement of steviol glycoside content and leaf yield.

Germplasm screening

Among 85 genotypes, significant variations were obtained for stevioside, rebaudioside-A and total glycoside contents, and ratio of rebaudioside-A/stevioside. The variations indicated the scope of exploiting these genotypes for crop improvement. Selections made for different traits are listed in **Table 17.**

Table 17 Selection of genotypes for different traits

Parameters	Quantity	Genotypes
High dry leaf weight per plant	>135g/plant	F-7-2-6; E-1-2-1
Total glycoside content	>11%	U-24-4-12; U-24-4-11
Stevioside content	>10%	U-16-5-15
High Rebaudioside-A / Stevioside ratio	>1	U-22-5-1

Development of polyploids

Polyploidy induction was standardized to improve the steviol glycoside content and leaf yield of the plants. Colchicine treatment of seeds (0.2% or more) reduced the survival rate to below 50%. In comparison to the diploid plants (control), the 2C value (nuclear DNA content) was found to be double in the putative polyploids. Further cytological analysis confirmed their tetraploidy (2n=44) in comparison to control (2n=22). The tetraploids produced increased leaf size and thickness, chlorophyll content and reduced internode length. SEM micrographs of abaxial leaf surface showed increased stomata size and trichomes (**Fig. 48**).

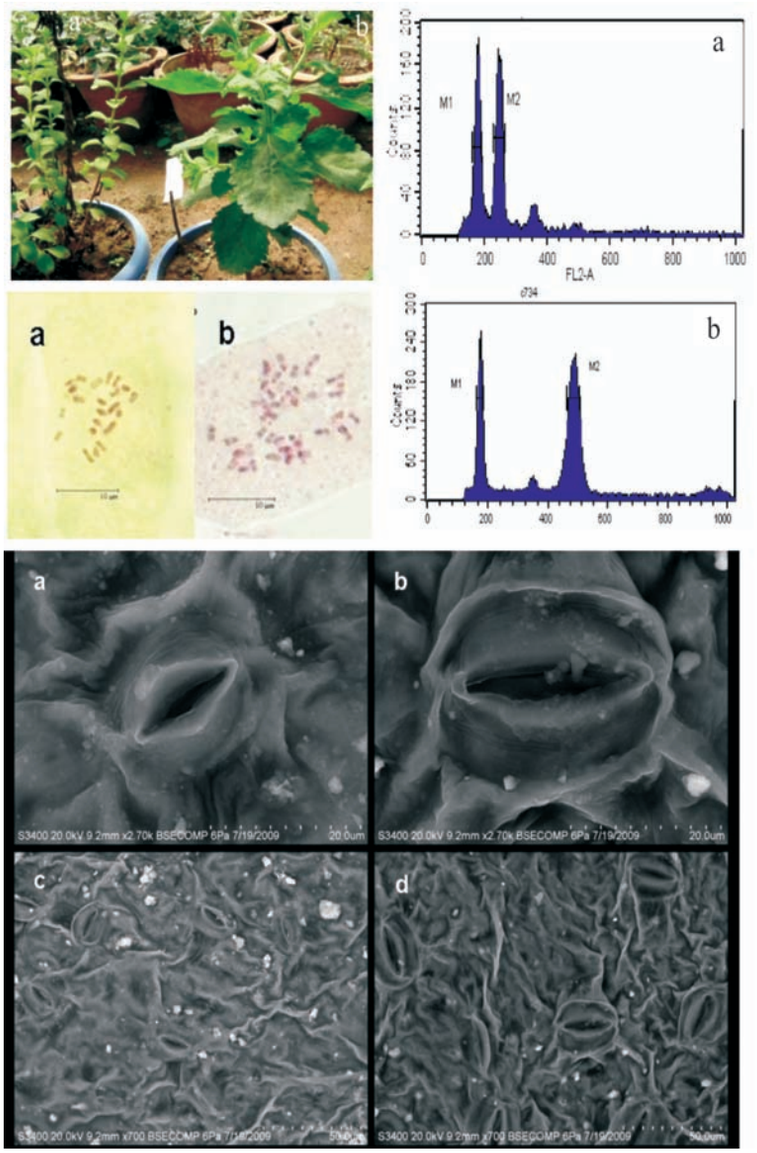


Fig. 48 Morphological variation a) diploid and b) tetraploid; Flow cytometry histograms using tomato as internal standard (M1) a) diploid (M2) and b) tetraploid (M2); Chromosome counts from root tips a) 2n=22 and b) 2n=44; Micrographs of stomata a) diploid and b) tetraploid; stomata frequency c) diploid and d) tetraploid

The essential oil composition of leaves and stems was determined for the first time. *trans*-Caryophyllene, humulene, nerolidol and spathulenol were identified as the major constituents.

A commercial plant of 300 kg/day capacity to process dry leaves was installed, commissioned and handed over to M/s Jallan Trinitea Processing Pvt. Ltd., Gurgaon. A total of 89 batches of 50 kg each were processed. Total steviol glycosides of 402.52 kg were produced from 4450 kg of dry leaves with an average yield of 9% (w/w).

SAFFRON (*Crocus sativus*)

Saffron is an expensive spice used for flavoring and coloring foods. Two marker compounds, Crocin-1 and 2 were isolated from aqueous extract of dried stigma and analysed by HPLC.

The growth performance of *in vitro* cormlets and *in vivo* corms produced at IHBT was evaluated at saffron research centre, Sher-e-Kashmir University of Agriculture Sciences and Technology, Kashmir (SKUAST-K) (**Fig. 49**). The *in vivo* produced cormlets (5-7g) performed better than the *in vitro* cormlets (**Table 18**).

Table 18 Performance evaluation of *in vitro* cormlets and *in vivo* corms

Weight (g)	Sprouting (%)	Mean days for leaf emergence	Fold increase in corm number	Mean days for flowering	Mean length of stigma (cm)
<5 (*in vitro*)	62.20	117	1.5	65	2.2
5-7 (*in vitro*)	66.12	91	2.5	63	2.2
5-7 (*in vivo*)	76.70	87	2.5	63	2.3

Fig. 49 Demonstration plot of saffron at Pampor, Srinagar (J&K)

In continuation to previous studies, two multilocation trials were conducted in forest nursery and farmer's field at Udaipur (Lahaul & Spiti). In farmer's field, corm sprouting was 97% in September 2009 but a mortality rate of 72% was recorded during May-June, 2010 (summer season). High mortality was due to the extended snowfall period in the region.

In another study on the effect of growth media at Palampur during 2009-2011, maximum increase (40%) in corm weight/plant was recorded in soil: sand: vermicompost (1:1:1) in comparison to control.

FLOWER CROPS

ORNAMENTAL ROSE (*Rosa* spp.)

Breeding

Inter-specific crosses were attempted among 14 different rose species to generate desirable variations for flower, fruit and essential oil characters. Back-crosses and three-way crosses were attempted by hybridizing F_1 hybrids with different species involved in the breeding program. Inter-varietal crosses involving reciprocals were attempted in *R. damascena* and *R. rugosa*, respectively (**Table 19**). Hybridization among ornamental roses was also undertaken to generate new floral variations (**Table 20**). Overall, 1127 seeds were obtained from 1057 pollinations in inter-specific crosses, 1062 seeds from 967 pollinations in back-cross and three way-crosses, 248 seeds from 218 pollinations in inter-varietal crosses and 107 seeds from 93 pollinations in crosses involving ornamental roses. Apart from these, 330 seeds were obtained from open pollinated hips of two *R. webbiana* accessions collected from Ribling area of Tandi Panchayat in Lahaul valley (H.P.). The harvested seeds were kept for scarification to allow germination.

Table 19 Seed set obtained under inter-varietal hybridization programme

Cross	No. of crosses	No. of seeds
R. rugosa (White x Pink)	60	150
R. rugosa (Pink x White)	25	68
R. damascena (Himroz x Jwala)	56	26
R. damascena (Jwala x Himroz)	77	4

Table 20 Seed set obtained under hybridization

Cross	No. of crosses	No. of seeds
Queen Elizabeth x *R. bourboniana*	15	21
Queen Elizabeth x Pink Panther	30	55
Pink Panther x First Prize	30	15
Queen Elizabeth x First Prize	18	16

Cytological studies

Four strains of wild roses belonging to *R. brunonii* (strain no. 16), *R. alba* (strain no. 21), *R. cathayensis* (strain no. 23) and *R. multiflora* (strain no. 24) were characterized cytologically to determine their ploidy level for appropriate utilization in breeding programme. All the indigenous strains were observed to be diploid with a chromosome count of 2n=14. These strains exhibited vigorous growth and winter activeness implying their potential in improvement through breeding program.

CHRYSANTHEMUM (*Chrysanthemum* spp.)

Performance evaluation and production of quality planting material

Chrysanthemum is extensively grown all over the world for cut flowers with excellent vase life. Recognizing the increasing demand for dwarf cultivars, 33 cultivars were collected and evaluated.

Maximum number of flowers (71.06/plant/year) was recorded in the cv Little Orange. It was also observed that the cv Hemant produced early flowers.

Virus tested plants of cvs Purnima, Yellow Star and White Star were mass multiplied on MS medium supplemented with BAP (1.0mg/l), NAA (0.025mg/l) and IBA (0.025mg/l). About 4000 *in vitro* rooted plantlets were hardened and maintained under greenhouse conditions (**Fig. 50**).

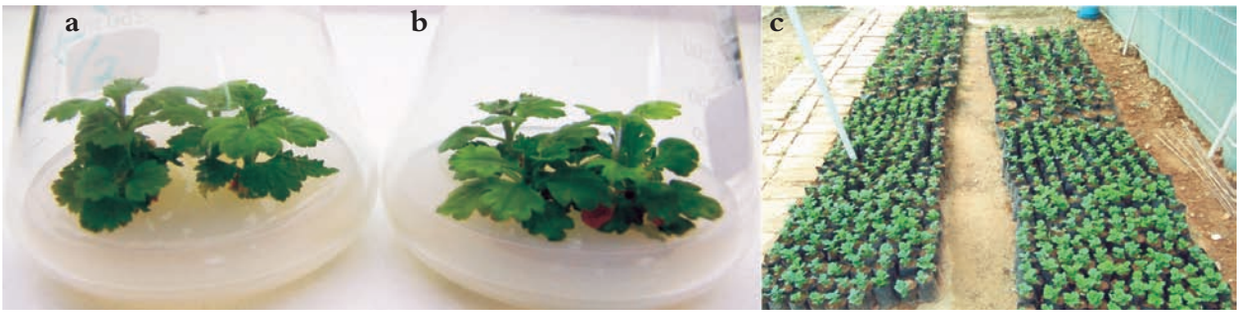


Fig. 50 Chrysanthemum a) *in vitro* culture of cv Yellow Star, b) Purnima, and c) hardened plants

Economic analysis

The economic viability of cut flower production in 500 m^2 polyhouse area was analyzed based on different cost components. In case of subsidy, the income for farm business, family labour, net and farm investment was calculated as Rs. 277732, 262907, 254907 and 269732, respectively. However, without subsidy, the income was Rs. 269332, 250542, 242542 and 261332 for farm business, family labour, net and farm investment, respectively. The analysis revealed that the chrysanthemum production is economically viable in H.P. in both the cases.

LILIUM (*Lilium* spp.)

Virus tested *in vitro* cultures of cvs Adelina, Pollyanna, Brunello, Prato and Nove Cento were multiplied on medium supplemented with BAP (2.0mg/l), NAA (0.01mg/l) and IBA (0.02mg/1). Tissue culture raised micro-bulblets (11275) were planted under protected conditions for hardening (**Fig. 51**).

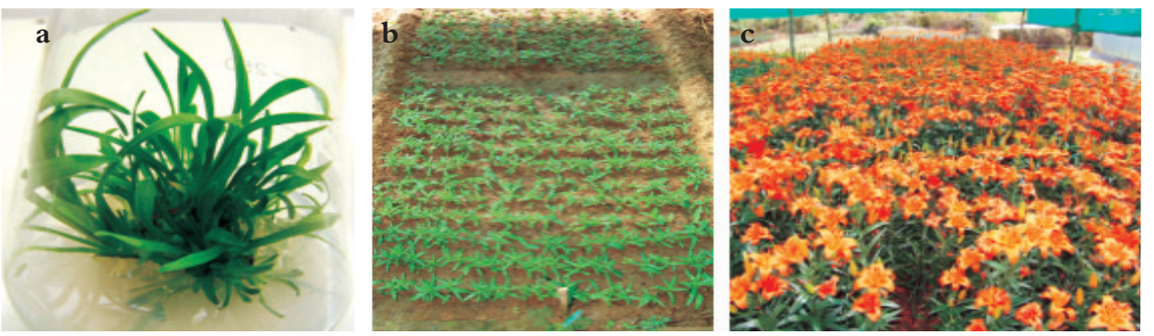


Fig. 51 Lilium a) *In vitro* culture, b) hardened plants and c) performance of virus tested bulbs

Comparative performance evaluation of Asiatic hybrid lily

Field experiments were conducted in Khinang village of Chandra valley (Lahaul & Spiti) and Palampur (Kangra) to investigate the scope of commercial cultivation of Asiatic hybrid lily cvs, Brindisi, Brunello and Coriour in summer season. At Chandra valley, Brunello showed maximum length of flowering shoot (98.20cm) and number of flower buds (5.66 per shoot) among the cultivars. The performance of the cvs was found to be better at Chandra valley in comparison to Palampur conditions.

GERBERA (*Gerbera jamesonii*)

Breeding

Variations were recorded for different floral features in the F_1 plants of gerbera genotypes (IHBT Gr 3-1-6, IHBT Gr 8-2-1, IHBT Gr 12-1-8) obtained through controlled crossing (**Table 21**).

Table 21 Details of floral features of promising gerbera F_1 plants

Descriptors	IHBT Gr 3-1-6	IHBT Gr 8-2-1	IHBT Gr 12-1-8
Cross	IHBT Gr-7 x IHBT Gr-4	IHBT Gr-4 x IHBT Gr-5	IHBT Gr-5 x IHBT Gr-4
Flower colour	Red	Pink	Yellow orange
Peduncle length (cm)	53	39	45
Flower diameter (cm)	10.5	9	10.5
Flower shape	Semi-double	Semi-double	Semi-double
Disc colour	Dark brown	Dark brown	Dark brown
Flower type	Standard	Mini dwarf	Standard
Leaf length (cm)	29.5	25.2	19.6

Expression of floral fasciation in gamma-ray induced mutants

In a new activity on floral fasciation, the seeds obtained from controlled crossings among white genotypes were irradiated. In M1 seed raised plants, ring- and linear-fasciation were observed to be recurrent leading to deformed and asymmetric flower heads, which were mostly male and female sterile. However, the wild type (normal) plants which were male and female fertile showed occasionally spontaneous floral fasciation. In the mutated plants, the increase in number and arrangement of vascular bundles in fasciated capitula stalks suggested alterations in shoot apical meristem. Further, the difference in phenotypes also indicated variable expressivity of the traits. Fasciated gerberas can thus be propagated vegetatively to perpetuate their unusual forms to designate as cultivars of the species (**Fig. 52**).

Fig. 52 Floral development in normal (a, b, c, d & e), spontaneous (f, g, h, i & j), ring (k, l, m, n & o) and linear fasciated (p, q, r, s & t) plants of *G. jamesonii*. Transverse sections of flower stalks stained with Delafield's haematoxylin

Production of CMV tested gerbera

Meristem tips of 0.3 and 0.4 mm were used to produce 63.33 and 53.33 % CMV free *in vitro* gerbera shoots, respectively. The hardened plantlets (14499) were virus tested and distributed to the State Horticulture Department and growers of H.P. (**Fig. 53**).

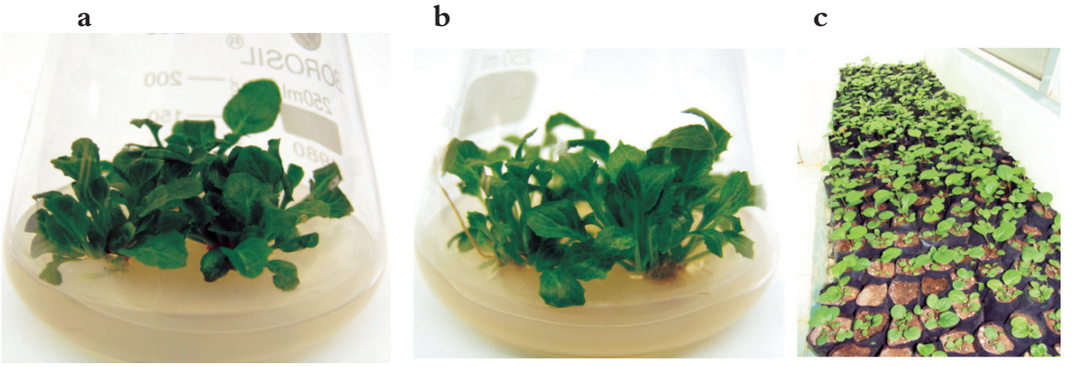


Fig. 53 *In-vitro* multiplication of gerbera *cv* a) Red, b) Pink and c) hardened plants

ALSTROEMERIA (*Alstroemeria hybrida*)

Economic analysis

Alstroemeria, also known as the lily of the Incas, Peruvian or Inca lily has the potential to become a cut flower crop. Hence, a study was initiated to evaluate the economic viability of its production. Based on data collected through selected farmers, cost components were calculated for cultivation of the crop in 500m^2 area under natural ventilated polyhouse conditions. The results showed that the production of alstroemeria is economically viable with respect to farm business income (Rs. 333800), family labour income (Rs. 313033), net income (Rs. 299345) and farm investment income (Rs. 301595).

Biocontrol of vascular wilt and corm rot of gladiolus

Plant growth promoting rhizobacterial strain S2BC-2 (*Bacillus atrophaeus*) and strain mixture, S2BC-2+TEPF-Sungal (*Burkholderia cepacia*) were inhibitory to the growth of *Fusarium oxysporum* f. sp. *gladioli* (FOG). Talc-based formulations of these were developed for corm dressing and soil application. The mixture of strains recorded maximum spike (100%) and corm (150%) production with concomitant reduction in vascular wilt (73.6%) and corm rot (54.8%). Induction of chitinase, β-1,3-glucanase (**Fig. 54**), peroxidase (PO) and polyphenol oxidase (PPO) imparted disease resistance under greenhouse conditions (**Fig. 55**).

In field experiments, the strain mixture recorded less incidences of vascular wilt and corm rot (48.6 and 46.1% mean reduction over the non-bacterised control). This was almost comparable with that of fungicide (51.5 and 47.1%, respectively). Average increase in spike and corm yield (58.3 and 27.4%, respectively) was also recorded as compared to the control.

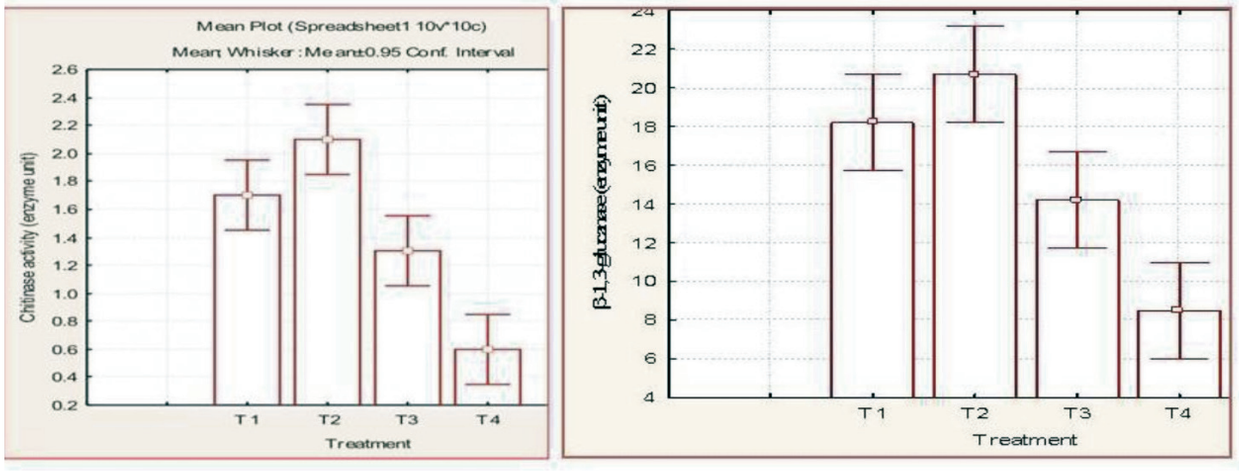


Fig. 54 Induction of a) chitinase and b) β-1,3-glucanase in gladiolus against vascular wilt and corm rot; plants treated with S2BC-2 (T1); S2BC-2+TEPF-Sungal (T2); pathogen control (T3); untreated control (T4)

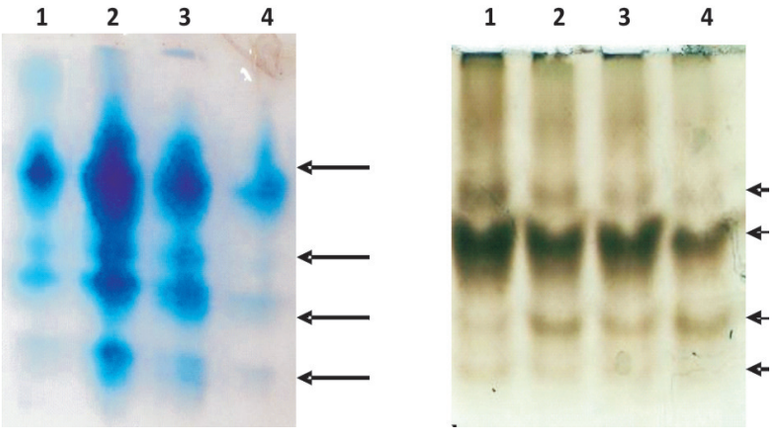


Fig. 55 Native-PAGE analysis for a) PO and b) PPO induced by the biocontrol agents in gladiolus challenged with FOG. Lane 1: S2BC-2 Lane 2: S2BC-2+TEPF-Sungal Lane 3. pathogen control 4: Untreated control; arrows indicate the isoforms

Infrastructure

A polyhouse of 240m^2 was constructed to generate planting materials of commercially important flower crops (**Fig. 56**). In addition, the existing cold storage capacity was increased for forcing treatment of bulbs.

Fig. 56 Infrastructure a) polyhouse and b) cold storage

MICROBIOLOGY

Exploitation of India's rich microbial diversity (NWP006)

In studies on diversity analysis of pea root-nodulating bacteria based on 16S rRNA, sequencing of *nodC* and *nifH* genes revealed a distinct pattern of *Rhizobium leguminosarum* bv. *viciae* distribution in Lahaul and Spiti valleys, H.P. The Lahaul and Spiti strains showed maximum similarity with the western and Chinese strains, respectively. Phylogenetic analysis of concatenated sequences of *atpD* and *recA* genes revealed a common *Rlv* sublineage in Spiti and three sequence types in Lahaul strains. Carbon-source utilization pattern (BIOLOG™) and whole-cell fatty acid profiling elucidated intraspecies polymorphism. Adaptation to specific ecological niches demonstrated by the principal component analysis of whole-cell fatty acids distinguished the genetically and phenotypically similar Spiti valley strains into two clusters.

In a separate study on developing microbial consortium for plant growth promotion, formulations based on *Pseudomonas* sp. BIHB 756, *P. putida* NBRI 03 and inorganic fertilizers on cauliflower were demonstrated in farmers' fields. Significant increase in yield with reduced application of inorganic fertilizers was observed.

In yet another study on discovery of new antimicrobial metabolites, a total of 503 culture extracts of 469 bacteria, 20 actinomycetes and 14 fungal cultures were tested for antimicrobial activity. Nineteen bacteria, 2 actinomycetes and 4 fungal cultures showed broad-spectrum activity against *Bacillus subtilis*, *Candida albicans*, *Escherichia coli*, *Klebsiella planticola*, *Micrococcus luteus*, *P. aeruginosa*, *Staphylococcus aureus* MLS16 and *S. aureus*. A total of fresh 256 cultures of bacteria, actinomycetes and fungi were isolated from the cold deserts and preserved.

Among 14 active cultures, 13, 11, 7 and 3 cultures showed antimicrobial activity against Methicillin-resistant *S. aureus* (MRSA), Vancomycin-resistant *Entrerococcus* (VRE), *C. albicans* (FCZr) and *Aspergillus fumigatus* at Indian Institute of Integrative Medicine, Jammu. The cultures showing broad-spectrum activity against drug resistant strains were identified as *Aspergillus flavipes, Bacillus amyloliquefaciens, B. thuringiensis, Brevibacillus laterosporus, Burkholderia stabilis, Janthinobacterium lividum, Lentinula edodes, Penicillium rolfsii, Streptomyces aureus, S. blastmyceticus, S. netropsis, S. sioyaensis, S. spiroverticillatus, S. subrutilis, S. xcanthophaeus* and *Ulocladium tuberculatum*.

In studies on screening of microbial cultures for other biological activities, 1400 culture extracts were prepared. Of these, 24, 19 and 12 extracts showed inhibition of β-lactamase (NIIST), AChE and α-glucosidase (CFTRI), respectively. Sixty eight and four extracts showed cytotoxicity against HuT-78 cells and anti-NIK1 activity (IMTECH), respectively.

Enzymes from microbes of low temperature environments (psychrotrophs and psychrophiles) have potential industrial applications. Among 340 isolated bacteria, those positive for protease (91), CMCase (62), amylase (49), lipase (216) and cyclodextrin glucanotransferase (3) activities at 28°C were selected. Thirty six fungal isolates among 41 were also found positive for cellulase production.

An extracellular protease of 35 kDa was partially purified (9.8-fold) from *Acinetobacter* sp. MN12. The enzyme showed optimum activity at pH 9.0 and 40°C. It was stable at pH 7.0-11.0 and retained >75% activity. The activity was inhibited in presence of Hg^{+2} and Cu^{+2} and was enhanced by Ca^{+2}, Na^{+}, Mn^{+2} and Zn^{+2}. The enzyme removed dried blood stains from cotton fabrics at low temperature and was compatible with commercial detergents. The Michaelis-Menten constant (*Km*) for casein and gelatin was 0.35 and 2.03 mg/ml, respectively.

In another study, a partially purified CMCase from a promising *Paenibacillus* IHB B 3084 isolate was found to be stable at 5-50°C and pH 5-9. The activity was enhanced by Na^{+}, Ca^{+2}, Zn^{+2}, Mg^{+2} and EDTA. Sixteen bacterial isolates showing either protease or CMCase were identified as *Acinetobacter* sp., *Bacillus* sp., *B. cereus, B. pumilus, Enterobacter* sp., *Exiguobacterium undae, Mycoplana bullata*, *Paenibacillus* sp., *Serratia marcescens* by 16S rRNA sequencing.

PLANT PROTECTION

Discovery and development of pest management agents from herbal sources (NWP037)

Plant based pesticides are potential alternative to chemical pesticides for sustainable management of insect pests. In evaluation of 331 plant extracts/fractions against *Aphis craccivora*, *Plutella xylostella*, *Spodoptera litura*, *Helicoverpa armigera* and *Tetranychus urticae*, CSM 2169 P02 A001 against diamondback moth and CSM 2153 P02 A001 & RJO 2681 P03 A001 against aphids were found to be effective. In the process of developing a commercial product, 8kg extract of RJO-2355 was prepared by NEIST, Jorhat. Based on toxicological data, the botanical dust formulation NCL49 was identified to be risk free.

Larvicidal potential of essential oil/fractions and structure-activity relationship studies

Essential oil and fractions of Himalayan cedar (*Cedrus deodara*) were evaluated for insecticidal activities against 2nd instar of diamondback moth (*P. xylostella*). Solvent extraction by pentane was identified to be the most toxic (LC_{50}=287µg/ml) fraction followed by himachalene enriched fraction (LC_{50}=362µg/ml).

In another study, a series of chalcones (A–CH=CH–CO–B) synthesized under microwave irradiation showed pesticidal activity against *P. xylostella*. The compound with para-Cl substitution on rings A and B showed maximum activity (LC_{50} =170.24µg/ml).

Ageratum enation virus (AEV) infecting common weed

In continuation to earlier studies, the commonly occurring weeds viz. *Crassocephalum crepidioides* and *Ageratum conyzoides* were found infected with begomoviruses in the Palampur region of H.P. Complete geminiviral components of approximately 2.8 and 1.3 kb from the weeds showed association of AEV and a nanovirus-like DNA1 with *C. crepidioides* and *A. conyzoides*. Their sequences were submitted to GenBank database under the accession numbers FN794201 and FN794202, respectively. In phylogenetic analyses, all Palampur isolates formed a separate clade while rest of the isolates grouped separately showing their geographical relatedness (**Fig. 57**).

Chilli leaf curl Palampur virus

Capsicum frutescens (chilli) were found associated with a begomovirus and a betasatellite like molecule. The begomoviral genome (FM877858) and the betasatellite (FM877803) consisted of 2775 and 1376 nucleotides (nt), respectively and appeared to be monopartite. In phylogenetic analysis, the sequence grouped with an isolate of *Papaya leaf curl virus*-[Pakistan:2010] (FM955601) reported from *Rhynchosia capitata* and *Tomato leaf curl New Delhi virus*-[India:2006] (DQ629102) reported from tomato. The betasatellite showed maximum identity (94%) with chilli leaf curl betasatellite (AM279671) from Pakistan (**Fig. 58**).

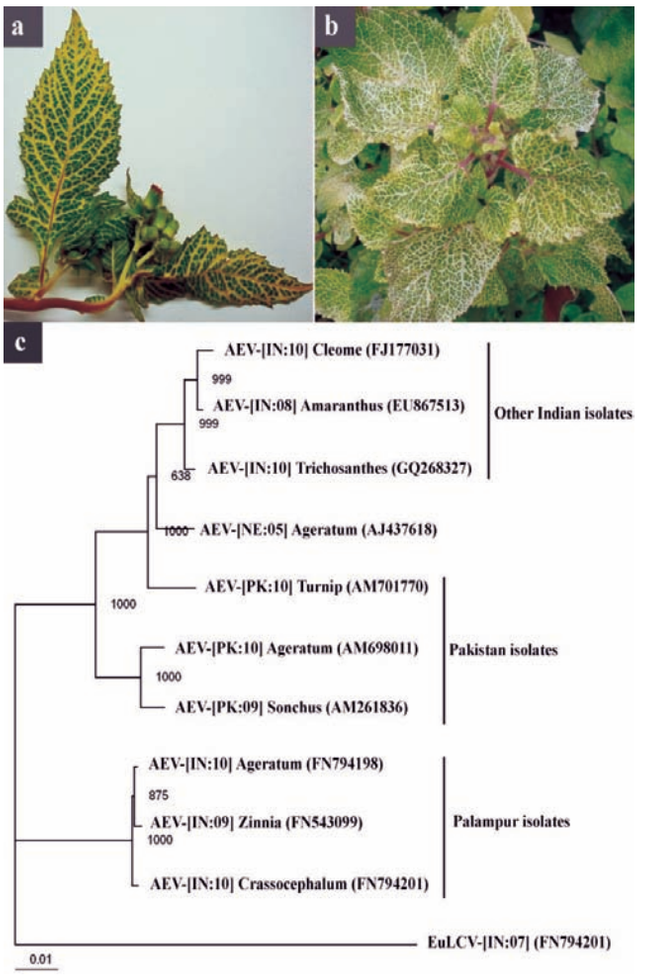


Fig. 57 Vein yellowing symptoms in a) *C. crepidioides*, b) *A. conyzoides* and c) Phylogenetic analysis of AEV from various weeds. IN: India; PK: Pakistan; NE: Nepal

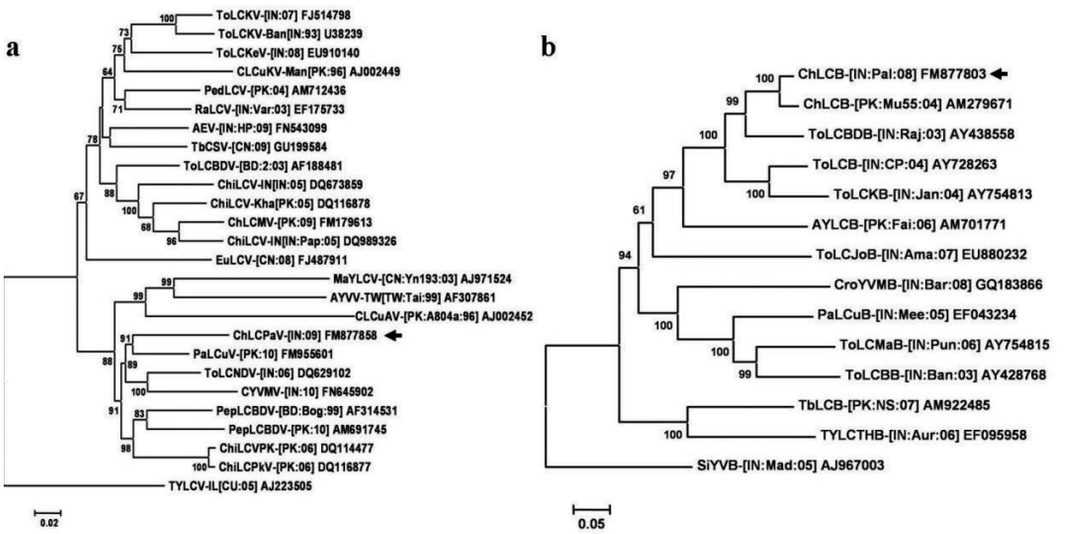


Fig. 58 Phylogenetic trees of a) genomic component and b) betasatellite of begomoviruses

Identification of plant proteins interacting with viral proteins

Cucumber mosaic virus movement protein was found to interact with ascorbate oxidase gene of plant and methyltransferase gene of virus. Similarly, RNA dependent RNA polymerase gene showed interaction with ascorbate oxidase. In BLAST analysis, sequence showed similarity to 16s ribosomal gene of *Cucumis sativus*.

Development of diagnostics and molecular characterization of viruses infecting plum and cherry (Funded by Department of Biotechnology, Govt. of India)

A multiplex RT-PCR was developed for the simultaneous detection of four major cherry viruses viz., *Cherry virus A* (CVA), *Cherry necrotic rusty mottle virus* (CNRMV), *Prunus necrotic ringspot virus* (PNRSV) and *Little cherry virus -1* (LChV-1) infecting sweet cherry. The genome of CNRMV was approximately 8.4 kb with 7 ORFs excluding the poly (A) tail. Five of these ORFs were conserved among all fovea-, allexi-, potex and carlaviruses and coded for a methyltransferase/ helicase/polymerase polypeptide, the triple gene block movement proteins and the coat protein. Two further ORFs, 2a and 5a, were completely nested within ORFs 2 and 5, respectively differentiating it from Foveavirus and Potexvirus. A region of 2203 nt was sequenced and submitted to the GenBank. The region covers ORF2, ORF2a, ORF3, ORF4, ORF5, ORF5a and 3'-UTR regions of the CNRMV genome (**Table 22**).

Table 22 Products coded by the different ORFs in the genome of CNRMV

Gene	Protein	Size (kDa)
ORF2	Triple gene block 1	25
ORF2a	Unknown protein	13
ORF3	Triple gene block 2	12
ORF4	Triple gene block 3	7
ORF5	Coat Protein	30
ORF5a	Unknown protein	16

Complete genome of *Cherry virus A* (CVA)

Sweet cherry (*Prunus avium* L.) is an important deciduous temperate fruit crop in the Western Himalayan region of India. In order to determine the health status of cherry plantations and the incidence of CVA, orchards in the states of J&K and H.P. were surveyed. The incidence was 28 and 13% from J&K and H.P., respectively. Complete genome was amplified and amplicon of about 7.4kb was cloned and sequenced (7379bp). The genome organization was similar to that of isolates characterized earlier, coding for two ORFs, in which ORF2 was nested in ORF1. The complete sequence was 81% similar to that of the type isolate with 5' and 3' UTRs of 54 and 299 nucleotides, respectively.

Bacterial diversity and soil enzyme activity

A culture independent survey of the bacterial diversity in rhizosphere soils of diseased (scab, S2) and disease free (S14) apple trees was conducted to assess their role in disease suppressiveness. The phylotypes and their frequency distribution in cloned libraries indicated that the phylotype did not represent a single group. Rarefaction curve **(Fig. 59),** Shannon and Simpson diversity indices exhibited insignificant differences between the samples in bacterial community composition. Chitinase and β-1,3 glucanase activities **(Fig. 60)** were higher in samples from disease free trees as compared to scab infected ones. In disease free and diseased rhizospheres, dominance of uncultured bacteria was 70 and 72.5%, respectively in partially sequenced representative 80 clones.

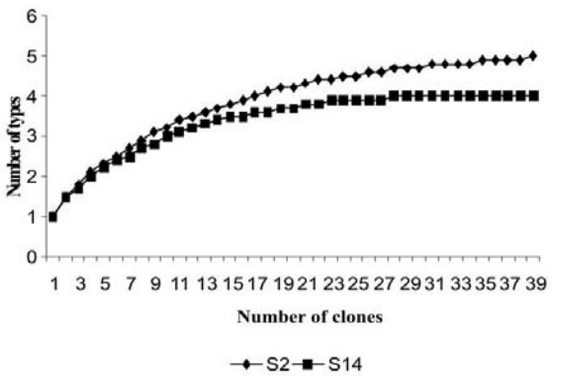
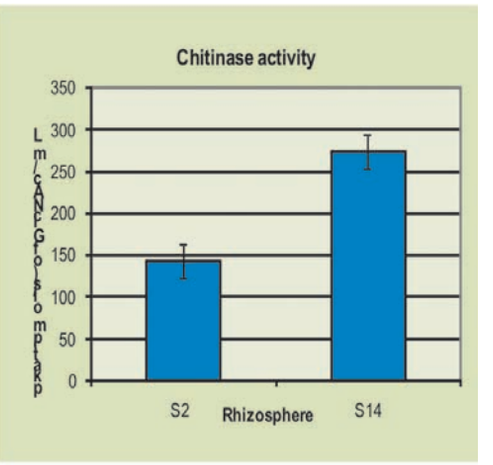


Fig. 59 Rarefaction curve showing differnce in type richness of the libraries



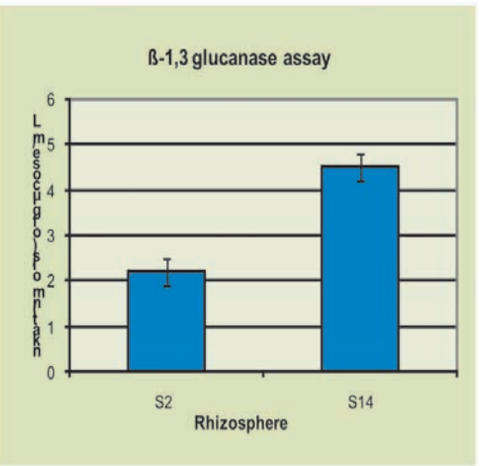


Fig. 60 Antifungal enzyme activities in soil suspension a) chitinase and b) β-1,3-glucanase

Selection and differentiation of *Bacillus* spp. antagonistic to *Fusarium oxysporum* f.sp. *lycopersici* and *Alternaria solani* infecting tomato

In dual culture assays, antagonistic *Bacillus* spp. displaying *in vitro* production of siderophore, chitinase and β-1,3-glucanase were identified. In greenhouse studies, seed bacterization and soil application of *B. atrophaeus* S2BC-2 challenge inoculated with *Fusarium oxysporum* f.sp.

lycopersici (FOL) and *Alternaria solani* (AS) recorded low percent disease index of 25.3 and 28.7 respectively, over non-bacterised pathogen control (44.3 and 56.4). The low disease incidence promoted tomato growth with high vigour index (8041.2) and fresh plant weight (82.5 g). Analysis of root and leaf samples in rhizobacterial treatment challenged with FOL and AS revealed maximum induction of chitinase (1.9 and 1.7 U/mg of protein, respectively) and β-1,3-glucanase (23.5 and 19.2 U/mg of protein, respectively). In native gel activity assays, the rhizobacterial treatment on challenge inoculation revealed strong expression of three high intensity PO isoforms along with one low intensity isoform**.** PPO induction was noticed only in presence of pathogen in the root and leaf samples (**Fig. 61**). In studies on genetic diversity of the *Bacillus* strains, amplified rDNA restriction analysis (ARDRA) was highly discriminant than repetitive extragenomic palindromic (REP)-PCR and allowed grouping of the strains and differentiation of the antagonistic strains from other isolates.

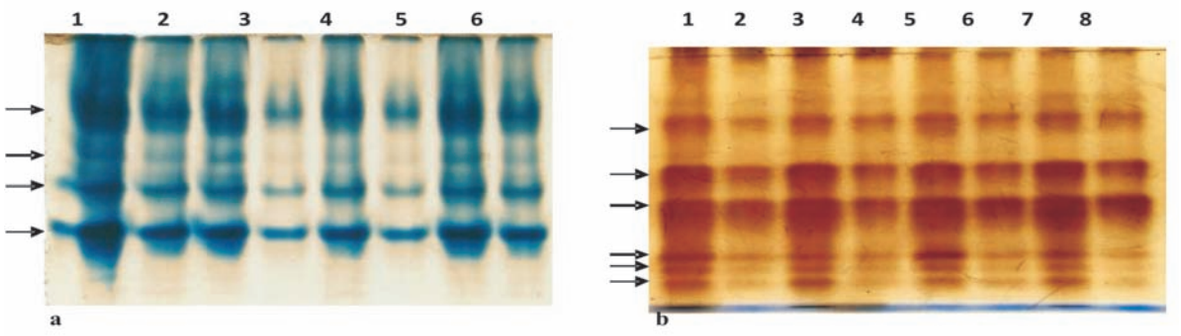


Fig. 61 Native-PAGE analyses of induced a) PO and b) PPO in tomato roots and leaves by S2BC-2. Lanes 1 & 5: plants treated with S2BC-2 challenged with FOL and AS, respectively, Lanes 2 & 6: plants treated with S2BC-2, Lanes 3 & 7: pathogenic control 4 & 8: untreated control; arrows indicate the isoforms

PROJECTS FUNDED BY CSIR UNDER EMPOWER SCHEME

- 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)?"
- Identification of de-novo non-coding transcripts in human brain (HUNT)
- Growing plants in the dark

RURAL DEVELOPMENT

CSIR-800 MISSION

CSIR-800 mission is the flagship project of the Council of Scientific and Industrial Research (CSIR) that started during the 11th five year plan. The project aimed at providing solutions in the area of health, agriculture and energy for better livelihood of 800 million people in the country. At IHBT Palampur, 9 projects were initiated based on exclusive technologies developed at the institute. Major activities included showcase of technologies in rural exhibitions, hands on training, 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 dissemination. A brief account of the achievements on each activity is as below:

TEA

Capacity building of youth for mechanical pruning, skiffing and harvesting of tea shoots

To promote tea farm mechanization, trainings were imparted to rural youths and tea planters of Kangra. A total number of 15 demonstrations and training programmes were conducted, wherein 411 trainees participated. IHBT motivated the growers for the mechanization of China hybrid tea plantations (500 ha) in Palampur zone to mitigate labour shortage

Demonstration of tea pruning, skiffing and plucking machines

Details of trainings on tea mechanization imparted

Training	Date	No. of participants	Venue
Demonstration of mechanical tea plucking	20.09.2010	6	IHBT Farm
	21.09.2010	5	Chowki, Palampur
Importance of different tea machines for garden management, demonstration & training on tea skiffing	03.11.2010	65	Tandol, Palampur
	18.1.2010	26	IHBT Palampur
	28.01.2011	24	IHBT Palampur
	31.01.2011	29	IHBT Palampur
	02.02.2011	45	Chambi , Dharamshala
	04.02.2011	59	Bir, Jogindernagar
	09.02.2011	45	Bhattu, Baijanath
	18.02.2011	69	Langu-Sakri, Baijnath
Demonstration & training of rejuvenation pruning by machine	22 & 23.02.2011	06	Kandwari, Palampur
Importance of different machines towards management of tea farm operations	23.02.2011	32	Uttrala, Baijnath

Advisory services

Tea husbandry demonstration plots were maintained at 5 locations for sustained productivity and quality. Advisory services were extended to the growers of all tea zones in Kangra valley at weekly intervals.

Field visits

Tea Zones	No. of visits	Advisory services
Palampur & Dharmshala	48	Quality plucking, tipping, pruning and skiffing operations, mechanisation of farm operations, pest and nutrient management
Baijnath & Bir, Jogindernagar	43	

Training programmes organized

A total number of 14 training-cum-demonstrations were imparted to the growers on different aspects of tea husbandry and technology. Six exposure visits of 178 growers from remote locations were organised with the support of State Agriculture Department, H.P.

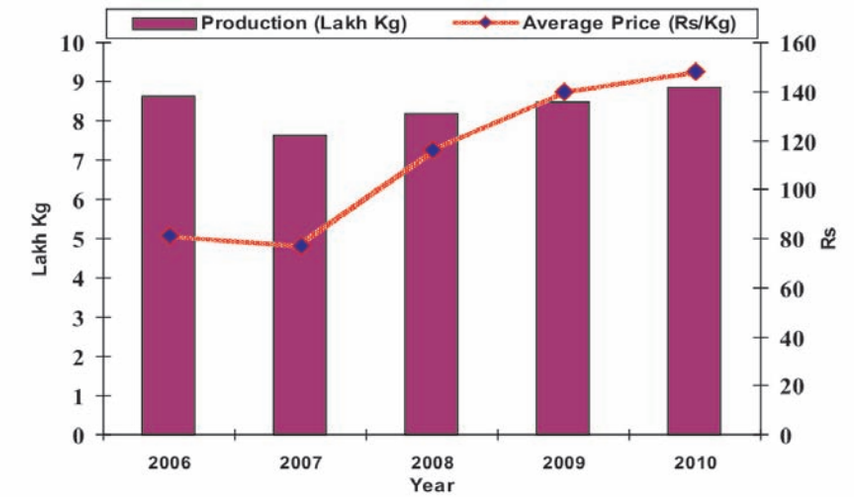
Theme	Venue	Date	No. of participants
Training-cum-discussion on production of quality tea	Sehal, Baijnath	27.08.10	77
	Chambi, Dharmshala	31.08.2010	40
	Chauntra, Bir	03.09.2010	37
	Thandole, Palampur	03.11.2010	65
Training-cum-demonstration on mechanical plucking	IHBT, Palampur	30.09.2010	05
	Hoodle, Dharmshala	06.10.2010	11
	Chowki, Palampur	11.10.2010	09
Training-cum-demonstration on new tea plantation	Thandole, Palampur	14 & 19.01.2011	05
Training programme on role of fertilizer and its dosage for quality tea production	Chambi, Dharmshala	02.02.2011	45
	Keori, Bir	04.02.2011	95
	Sansal, Baijnath	09.02.2011	52
Strategies for development of dilapidated tea plantations and management of first flush quality crop	Langhu-Sakri, Baijnath	18.02.2011	74
	Uttarala, Baijnath	23.02.2011	36
	Gopalpur, Dharmshala	21.03.2011	40

Training-cum-demonstration of tea plantation management

Exposure visits of the tea growers at Institute's Tea Experimental Farm

Zones	Date	No. of growers
Baijnath	08.11.2010	25
Dharmshala	12.11.2010	26
Bir	19.01.2011	26
Palampur	28.01.2011	24
Baijnath	31.01.2011	29
Bir & Dharmshala	26.02.2011	48

Consistent improvement was recorded in the productivity and quality of Kangra tea. Tea production of the state reached to 8.84 lakh kg with a growth rate of 5.3% over the past 3 years. The total revenue generated was Rs. 148.08 showing an increase of 30.6%.



Impact of advisory services on production and revenue generation in H.P.

FLORICULTURE

Transfer of production technology for cut flower and virus tested planting materials

Motivation of growers through advisory visits and trainings, and distribution of planting materials by IHBT led to extension of area under cultivation of commercial flower crops. This impacted their socio-economic status.

Extension of area under commercial floriculture crops

Crop	Area(ha)	Location (districts)
Gerbera	1.00	Una, Hoshiarpur and Kangra
Lilium	2.50	Kangra, Lahaul & Spiti, Mandi, Kullu and Solan
Gladiolus	3.00	Kangra, Mandi , Kullu and Una
Marigold	4.00	Kangra, Mandi, Chamba and Una
Chrysanthemum	0.30	Kangra, Mandi and Solan
Carnation	1.0	Kangra, Bilaspur, Chamba and Solan
Total	**11.80**	

Advisory visits were made to the growers' field in Kangra, Una, Bilaspur, Mandi, Kullu, Shimla and Lahaul & Spiti districts of H.P. to enhance the yield and quality of Asiatic hybrid lily, chrysanthemum, marigold, gladiolus, rose, alstroemeria and bird of paradise. The transfer of agrotechnology of lilium in Lahaul & Spiti district was realized by the flower growers through the sale of cut flowers worth Rs. 50 lacs at Delhi flower market.

IHBT played a catalytic role in the promotion of commercial floriculture in the state. Area under floriculture increased steadily from 30 ha (1993-94) to 813 ha with an estimated turnover of Rs 77.26 crores in the current year. Presently, 3000 farmers are engaged in floriculture in H.P.

Advisory visits to lilium and carnation plantations (H.P.)

Multiplication and distribution of planting materials

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

Mass multiplication a) chrysanthemum and b) agapanthus

Demonstration plots

Demonstration plots of gerbera in Una and Asiatic hybrid lily, alstroemeria, chrysanthemum and rose in Kangra districts of H.P. were established.

Demonstration plots of a) chrysanthemum and b) gerbera

Trainings imparted

Trainings	Date	No. of participants
Cultivation and post harvest technology of commercially important cut flower crops	21-23.2.2011	41
	15.3.2011	19
Cultivation and post harvest technology of lilium	20.10.2010	12
Five hundred and twenty farmers visited the demonstration plots of commercially important cut flowers crops at IHBT.		

Training-cum-demonstration on cultivation and post harvest technologies of commercially important cut flower crops

Workshop

A workshop on Floriculture in the Future was organized on May 13, 2010 at IHBT. Prof.V. L. Chopra, former Member of Planning Commission, GOI, presided over the workshop. A lecture on Scope of commercial floriculture in India was delivered by the chief guest, Dr. Avtar Singh, President of M/s Beauscape Farms, Ludhiana. Seventeen scientists from Indian Agricultural Research Institute, New Delhi, National Botanical Research Institute, Lucknow and IHBT participated.

MAPS

Promoting large scale cultivation of medicinal, aromatic and other high value crops

Planting materials of stevia, damask rose, lavender, rosemary, ginkgo, scented geranium, large cardamom were generated en masse and supplied to farmers and state departments of Haryana, Punjab, Uttrakhand, J&K and H.P. An additional area of 21.66 ha was brought under these crops.

Details of distribution of seeds and planting materials of MAPs

Crop	Planting material supplied	Area covered (ha)	State
Damask rose (*Rosa damascena*)	93721 sapling	10.45	H.P., Punjab & Uttrakhand
Stevia (*Stevia rebaudiana*)	12558 seedling 13 kg seed	0.31 6.05	H.P., Punjab, J&K & Uttrakhand
Lavender (*Lavandula angustifolia*)	24452 sapling	1.20	H.P., Punjab & J&K
Wild marigold (*Tagetes minuta*)	6 kg seed	2.00	H.P., Punjab & Uttrakhand
Rosemary (*Rosmarinus officinalis*)	5559 sapling	0.25	H.P., Punjab & J&K
Muskbala (*Valeriana jatamansi*)	26110 sapling	0.01	H.P. & J&K
Ginkgo (*Ginkgo biloba*)	504 sapling	0.80	H.P. & J&K
Aloe, ashwagandha, large cardamom, geranium, eucalyptus, jasmine, mulhati and lemon balm	-	0.50	J&K, H.P., Punjab & Uttrakhand

Total area (ha) covered = 21.66
Total 5000 nursery plants of *G. biloba* were raised to cover additional 40 ha of land

Additional demonstration plot (1.2 ha) was established at village Sarna, Gurdaspur, Punjab. Training on lavender oil extraction using direct fired essential oil distillation was imparted to the farmers at Jassaurgarh during June 2010. A total of 12 demonstration and training programmes were conducted wherein 543 trainees participated. The extension activities were supported by State Horticulture Departments of J&K, Punjab and H.P., DRDA H.P., State Forest Department, H.P., Tribal Development Trust, Arunachal Pradesh, Green Foundation, Deharadun, Uttrakhand and CSK HPKV, Palampur, H.P.

Lavender cultivation in apple orchard, Chamba

Promotion of wild marigold cultivation

IHBT promoted wild marigold as kharif, autumn and rabi season crops under varying agro-climatic conditions. Intercropping with maize was popularized in hilly regions. Essential oil production increased from 3 to 5 tonnes during the year.

Wild marigold cultivation at farmers' field

Trainings imparted

Training	Date	No. of participants	Venue
One day workshop on medicinal & aromatic plants	17.08.2010	71	Chamba, H.P.
Rural technologies of IHBT & CMERI for the farmers. NGOs & entrepreneurs of Arunanchal Pradesh	18-19.09.2010	20	Pasighat, Arunachal Pradesh
Exposure-cum-demonstration on agro technologies of medicinal & aromatic crops at experimental farm of IHBT, Palampur	19.10.2010	31	IHBT, H.P.
Awareness and demonstration on medicinal & aromatic crops production at experimental farm of IHBT, Palampur	26.10.2010	40	IHBT, H.P.
Exposure-cum-demonstration on agro technologies of medicinal & aromatic crops at experimental farm of IHBT, Palampur	11.12.2010	40	IHBT, H.P.
Demonstration and training on medicinal & aromatic plants at IHBT, Palampur	05.01.2011	35	IHBT, H.P.
Training on medicinal & aromatic crops production and demonstration at experimental farm of IHBT, Palampur	18-20.01.2011	18	IHBT, H.P.
Demonstration and training on nursery techniques of medicinal & aromatic plants at IHBT, Palampur	21.01.2011	110	IHBT, H.P.

Exposure-cum-demonstration on agro technologies of medicinal & aromatic crops at experimental farm of IHBT, Palampur	25.02.2011	69	IHBT, H.P.
Awareness and demonstration on horticultural and allied activities of IHBT, Palampur	26.02.2011	54	IHBT, H.P.
Awareness and demonstration on herbal crops and bamboo nursery at IHBT, Palampur	28.02.2011	20	IHBT, H.P.
Awareness and demonstration on horticultural and allied activities of IHBT, Palampur	16.03.2011	35	IHBT, H.P.

Demonstration of mobile essential oil distillation unit

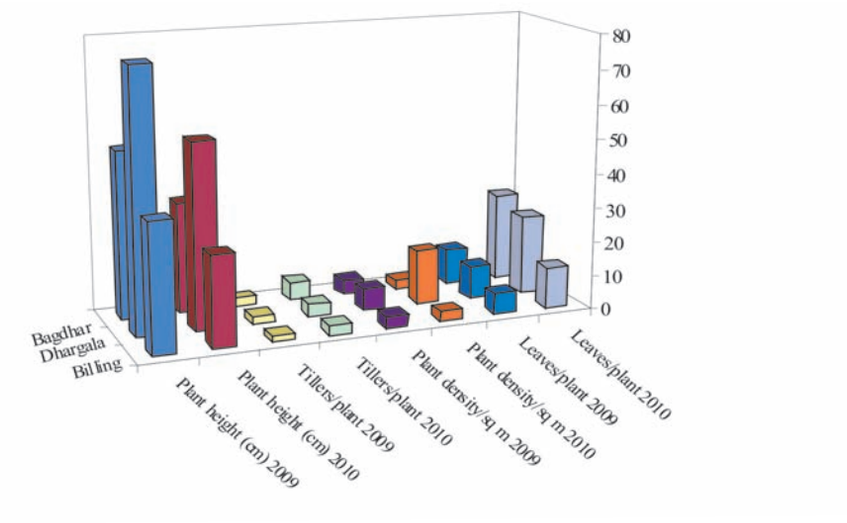
Mobile essential oil distillation unit launched in the previous year was exhibited in different locations to create awareness on processing of herbals and aromatics for income generation. *Eucalyptus citriodora* leaves (207 kg) were distilled to produce 2.68l oil with 1.3% yield. Distillation of lavender spikes (283.5 kg) was demonstrated in 3 batches to farmers of village Pritmas, Distt. Chamba (H.P.) and 2.58l of oil was produced with an average yield of 0.91%. Distillation of 149 kg fresh leaves of *E. hybrida* to produce 1.50l oil with 1.0% yield was also demonstrated to 20 farmers at village Ballah. A demonstration was conducted at Society for Technology & Development, Technology Resource Centre of CAPART at Village Malori, Distt. Mandi on 11th and 12th October, 2010 by distilling *Tagetes minuta* and *Artemisia* spp.

Demonstration of curcuma and hedychium cultivation in agro-forestry system

Cultivation of important medicinal plants like *Curcuma aromatica* and *Hedychium spicatum* based on market demand in agro-forestry system is likely to augment income and improve socio-economic standard of the rural community. Therefore, the area under curcuma and hedychium cultivation was extended in Joint Forestry Management.

Demonstration plots of curcuma and hedychium in forestry system were established at 4 locations of Chamba district viz., Ahla (Dalhousie), Nayagran (Bharmour), Dhargala (Churah), Bagdhar

(Dalhousie), and one location of Kangra district, Billing (Uhl). Curcuma did not emerge in Ahla and Nayagran, which could be attributed to their high altitude (>2100 amsl). The crop growth in 2009 and 2010 is shown. The plant density of curcuma declined in the second year of the active growth at Bagdhar and Billing demonstration plots as compared to that in 2009. However, the increase was distinct at Dhargala. The height of curcuma declined in 2010 in all the three demonstration plots whereas the number of tillers and leaves per plant increased.



Performance of *Curcuma aromatica* in forest area

In 2010, the plant density of hedychium increased in three plots, with exception to Ahla. Amongst all the plots, the crop at Dhargala showed better growth whereas that at Ahla exhibited poor growth.

Plantation of Hedychium under joint forest management program

The target crops at all the five demonstration plots were maintained by the participating community with technical inputs from IHBT.

Demonstration of curcuma and hedychium cultivation in agro-forestry system

Training	Date	No. of participants
Curcuma and hedychium cultivation	October 12, 2010	15
	October 13, 2010	15
	October 14, 2010	15
	October 27, 2010	15

Utilization of locally available plant raw materials for fetching high prices

A pilot scale process was standardized for extraction of β-aescin (1.2% w/w) from *Aesculus indica* seeds. A total of 400 g aescin was produced from 7 batches.

In another study, oil was also extracted from rose and apple seeds. Apple seed oil contained linoleic (50.77%), oleic (38.78%), palmitic (7.85%) and stearic (1.93%) acids. In rose seed oil, linoleic acid (45.38-54.58%), linolenic acid (13.67-24.75%), oleic acid (11.97-21.08%), palmitic acid (6.54-12.97%), stearic acid (3.37-5.79%) and arachidic acid (0.85-1.99%) were the major fatty acids.

In characterization and value addition of major chemical constituents of *C. deodara*, the yields of wood essential oils and extracts from the hydro distillation and percolation of wood chips were 0.98% and 14.50%, respectively, on dry weight basis. A total of 34 and 26 constituents were identified in the oil and woodchip extracts, respectively by GC-MS. Himachalene (23.53%-68.52%) and atlantone (15.02%-61.60%) were the major constituents. The fragrance was improved to sweet, fruity and slight woody note.

Training on distillation of essential oils from local aromatic resources

Training	Date	No. of participants	Zone
Distillation of essential oils from local aromatic resources	16.7.2010	45	Village Ballah, Kangra
Extraction of aromatic oils	11-12.10.2010	30	Village Nagwain, Mandi

POME AND STONE FRUITS

Virus tested planting material production technology for apple, plum and cherry

Virus free rootstocks and budwood of apple, plum and cherry were developed for distribution to the farmers for enhanced production of quality fruits. Apple plants were distributed to cover an area of about 90 ha.

APPLE (*Malus domestica*)

Survey

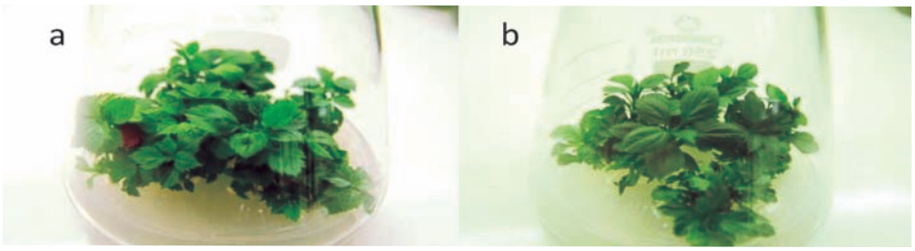
In June, 2010, farmers' field and nurseries that supply apple rootstock and budwood were surveyed for virus incidence in Shimla district. Multiple virus infection due to ACLSV, APMV, ASPV and ASGV, and Apple scar skin viroid infections were found to be widespread in the surveyed orchards. However, 145 out of 250 trees of cvs Starkrimson, Vance Delicious, Oregon Spur, Red Chief and Silver Spur were free from virus and viroid.

Additional area covered with virus free plants

Virus free cultures of apple were provided to M/s Rajat Biotech, Bilaspur, Neva Plantations, Kangra and Monal Biotech, Una, H.P. A total number of 90,000 nursery plants produced by these units were supplied to growers to cover 81ha area.

Culture establishment

In vitro cultures of apple rootstocks M111 and M793 were established using nodal segments (Fig. 1 a and b). Cultures of cvs. Red Chief and Red Fuji were also established.



***In vitro* cultures of a) M111 and b) M793**

Cultivar Red Chief was found to be infected with ACLSV, APMV, ASPV, ASGV and Apple scar skin viroid. Meristem tips of the *in vitro* shoots were subjected to chemotherapy (0-80 mg/l ribavirin) for virus elimination.

BAMBOO SPECIES

Promotion and utilization of bamboos

Seeds of four new edible species namely *Dendrocalamus asper*, *D. barbatus*, *D. tibeticus* and *D. yunnanensis* were introduced from China. Plants (44,101) raised from these seeds were supplied to Delhi Parks and Garden Society; Department of Environment, New Delhi for Commonwealth Games; National Bamboo Mission; Directorate of Horticulture, Govt. of Sikkim; State Forest Department, H.P.; Indian Army; CSK HPKV, Palampur; individual farmers and others to cover more than 100 ha in various states. Nurseries of different bamboo species are being maintained at IHBT for mass multiplication and nearly 3.5 lakh plants of 12 varieties of edible bamboo were raised.

Proximate analysis of edible bamboo shoots of *Phyllostachys pubescens*, *D. asper, D. hamiltonii* and *Bambusa bambos* was carried out. The study revealed that these are good sources of dietary fibre and minerals .

Proximate analysis of edible bamboo shoots (%)

Sample	Moisture	Protein	Fat	Fibre	NDR	ADF	Lignin	Ash
Phyllostachys pubescens	92.06	3.70	0.39	1.29	2.70	2.15	0.57	0.66
Dendrocalamus asper	88.82	3.43	0.30	1.20	2.65	2.60	0.62	0.64
D. hamiltonii	91.06	3.40	0.29	1.50	3.10	2.91	0.67	0.68
Bambusa bambos	89.05	3.72	0.25	1.42	3.05	2.84	0.78	0.76

Mineral composition of edible bamboo shoots (mg/100g)

Sample	Cu	Na	K	P	Se	Mg	Ca
Phyllostachys pubescens	0.19	4.00	459	55	0.8	3.0	13
Dendrocalamus asper	0.25	4.10	503	59	0.7	4.5	11
D. hamiltonii	0.29	4.80	533	61	0.8	3.9	15
Bambusa bambos	0.15	3.50	521	65	1.1	3.5	12

Designing, construction and testing of a portable charcoal kiln was completed for the benefit of bamboo planters, rural people and foresters. A demonstration was carried out to advocate the use of bamboos as an alternate to *Pinus* and *Quercus* spp. for charcoal making

The portable drum kiln

Bamboo charcoal produced at IHBT

Training	Date	No. of participants	Participants
Bamboo propagation and its management	13.05.2010	03	Dy. Director Horticulture, Kangra at Dharam-shala / PCDO-Palampur
Hardening of tissue culture raised plants	10.06.2010	11	B. Tech. students
Bamboo propagation methods	15.06.2010	21	Officials from Forest Division of Haryana, Training Circle Pinjore
Plant tissue culture & bamboo propagation	26.07.2010	30	DDM, NABARD, Jandpur, Shimla
Plant tissue culture & bamboo propagation	27.07.2010	30	AGM, NABARD, Hamirpur

Plant tissue culture & bamboo propagation	28.07.2010	30	NABARD, Una
Plant tissue culture & bamboo propagation	29.07.2010	29	DDM, NABARD, Kullu
Plant tissue culture & bamboo propagation	20.09.2010	05	Harayana Forest Deptt., Conservator of Forest, Development Circle, Haryana
Method of bamboo propagation	19.01.2011	40	State Forest Department, Forest Training Institute, Sunder Nagar, H.P.
Total		199	

Showcase of IHBT's exclusive rural sector technologies

IHBT participated in CSIR Technofest-2010 organized as part of an India International Trade Fair (IITF) during 14-27 November, 2010 at Pragati Maidan, New Delhi. The exhibition was organized to showcase CSIR's expertise in the field of Science & Technology through 15 theme pavilions, particularly on agriculture and floriculture. Rural technologies and products covering stevioside, mobile distillation unit, natural colours and dyes, medicinal and aromatic plants, mini distillation unit, floriculture, biofertilizer, tea wine and RTDs, bamboo charcoal and plant virus testing kits were displayed. Industry partners of IHBT such as M/s Andel Equipments Pvt. Ltd., Mohali and M/s Mahindra Shubhlabh Pvt. Ltd., Mohali also participated along with their products/technology. Several visitors, entrepreneurs and farmers visited the stalls. The showcased theme pavilions bagged a bronze medal.

IHBT exhibited its technologies and products in a four-day "Rural Technology Mela" organised by National Institute of Rural Development (NIRD) at its Rural Technology Park, Hyderabad during 2-5 February, 2011. The mela was organized to provide platform for technology developers, users and self help groups to take advantage of various technologies available in different parts of the country. IHBT's technologies on stevioside, natural colours and dyes, cultivation and extraction of essential oils, floriculture and value added tea products were appreciated by visitors. IHBT bagged the best stall award for displaying its innovative processes and products.


RURAL TECHNOLOGY MELA

NIRD

NATIONAL INSTITUTE OF RURAL DEVELOPMENT

(Ministry of Rural Development, Govt. of India)

Rajendranagar, Hyderabad - 30.

Certificate of Best Stall

This is to certify that Smt. / Sri. SUKHJINDER SINGH & from INSTITUTE OF HIMALAYAN BIO-RESOURCE TECHNOLOGY, PALAMPUR State HIMACHAL PRADESH have participated in the Rural Technology Mela from 2nd to 5th, February 2011 organised by Rural Technology Park, NIRD, Hydrabad and has been awarded as Best Stall of the year.

Dy. Director General

Director General

A two day demonstration-cum-workshop on rural technologies was organised by Central Mechanical Engineering Research Institute (CMERI), Durgapur and IHBT, Palampur during 18-19 September, 2010 at Doni-Polo Tea Estate, East Siang, Arunachal Pradesh (ArP). Its aim was to showcase the technologies to the farmers, NGO's and entrepreneurs of the state in collaboration with Tribal Development Foundation (TDF), Itanagar. IHBT's rural technologies on sustainable development and utilization of bioresources were showcased.

IHBT along with 5 other CSIR institutes exhibited its technologies in Agrovision 2011 from 4-7 March, 2011. More than 1000 farmers visited the CSIR stall and showed interest in commercial cultivation of stevia, damask rose, gerbera and gladiolus.

IHBT is providing technical assistance to IIIM Jammu on commercial floriculture. IHBT technologies and rural development activities were exhibited at an Exhibition and Flower Show-2011 organised by IIIM during March 13-14, 2011.

Monitoring of annual progress of CSIR- REWNET 800 projects

The third review meeting was organised for monitoring the annual progress of CSIR 800 Mission under the chairmanship of Dr. P.S. Ahuja, Director, IHBT Palampur, H.P. during 11-12 June, 2010 at IHBT. The investigators of 36 projects and the Cluster Director, Dr. P.G. Rao, and members Mr. A.K. Kundalia and Dr. A.K. Singh participated in this meeting at IHBT.

SUPPORT SERVICES

SUPPORT SERVICES

Engineering Service Unit

New facilities for regulatory research, computational biology, bioinformatics and food & nutraceuticals were created. Major construction works were completed for expanding the present laboratory infrastructure for microbiology, biochemistry and molecular biology.

Regulatory Research Centre (RRC)

The construction of the RRC spanning in a total area of 3334m^2 was completed in the current year. Besides housing animals such as mice, rats and rabbits, the centre has a state of the art facility for conducting regulatory research on bioactive molecules/products. The animal facility of the centre is registered under CPCSEA (No.1381/ac/10/ CPCSEA) and approved for animal breeding and toxicological studies.

Studio for Computational Biology & Bioinformatics (SCBB)

The centre is equipped with bioinformatic tools for conducting research on Next Generation Sequencing, miRNAs and non-coding elements, epigenomics, regulomics and systems biology.

Food and Nutraceutical Laboratory

The laboratory was established for the development of plant based value added products and is well equipped with instruments for nutritional profiling and quality assessment of developed nutraceuticals/products.

Project Planning, Monitoring & Evaluation Cell

- Annual plan for 2011-2012 provided by the scientists was compiled and progress reports prepared by respective PIs of Supra Institutional, Network and Rural Development Projects were submitted to CSIR Hqs.
- Following services were launched into Intranet:
  - Online personal store inventory and EL/HPL information of staff

- Upload and display of notification in Hindi

- Designed a webpage for farmer support
- Monitored in-house projects
- Facilitated the monitoring of sponsored projects
- Conducted 44th and 45th Research Council Meetings on October 8-9, 2010 and March 11-12, 2011, respectively at IHBT, Palampur.
- Facilitated training of 58 students as winter and summer trainees in different divisions of the institute
- Furnished information on 25 cases under RTI Act
- Organized National Technology Day, IHBT Foundation Day, CSIR Foundation Day and National Science Day celebrations on behalf of the institute
- Three workshops were organized under DSIR sponsored project entitled "Technology and Innovation Management Centre, Palampur". The best practices on ornamentals, tea and MAPs was launched in the TIM website. Developed database on techno-management need of food, tea, herbal and floriculture industry.

Status of ongoing projects

Types of project		No. of project (s)
Inhouse		
	MLP	24
	OLP	9
	STS	09
Supra Institutional		1
Network		**5**
Rural Development		9
Sponsored		
	Government Agencies	61
	Private Agencies	08

IHBT-Knowledge Resource Centre (IHBT-KRC)

IHBT-KRC continued to apprise scientific and technical staff of the institute and also other academia in and around Palampur (H.P.) by providing relevant knowledge resources and reference and referral service. Following were the major achievements:

- Collection of the centre was further enriched with addition of 185 scientific and technical books, subscription of 155 journals in print and 4000 plus online full text journals
- In-house databases and fulltext online journals under CSIR e-Journals Consortium were made available
- Scientific and technical staff were provided 256 books/journals on Inter Library Loan
- Databases of books/journals were updated with 4690 new additions
- Orientation on library resources and services were provided to 47 new users
- Library resources were consulted by more than 9729 visitors
- Routine services like document delivery, scanning, document setting, copying, printing, binding etc. were provided
- Compiled citation reports for 26 scientists of the institute and other authors on specific topics
- Facilitated the preparation and printing of IHBT annual report, different technical bulletins, brochures etc

Computer Cell

Network facilities were provided to scientific, technical and administative staff on more than 265 data nodes over the fiber backbone. Wi-fi and videoconferencing facility with a fleet of servers from HP, IBM, SUN were maintained. The internet facility through dedicated leased line was increased from 256 Kbps to 8 Mbps throughout the campus including hostels and staff residences. Network security hardware like Unified Threat Management Solutions, IDS and Anti-Virus on client server based model and SMTP spam/virus protection software etc, and its policies were made and deployed to protect IHBT resources centrally. The DNS (Domain Name Server), WEB, Email and Proxy servers on Linux were managed routinely.

The centre provided services to users in diagnosing problems related to network, computers and peripherals. Local Area Network was extended to the newly constructed Regulatory Research Centre.

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पश्चिमी हिमालय क्षेत्र में आर्थिक महत्व की जैवसंपदा के आधार पर मूल्यवर्धित पौधों, उत्पादों तथा प्रक्रमण विधियों द्वारा औद्योगिक सामाजिक और पर्यावरणीय लाभ हेतु शोध एवं विकास सेवाएं प्रदान करने के लक्ष्य के साथ–साथ संस्थान भारत सरकार की राजभाषा नीति के कार्यान्वयन एवं हिंदी भाषा के माध्यम से विज्ञान के प्रचार–प्रसार में सतत् प्रयासरत है। इस दिशा में संस्थान ने 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 समाचार पत्रों, पत्रिकाओं, रेडियो, 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 2010–11 की प्रमुख उपलब्धियां निम्न प्रकार से हैं:

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संस्थान ने रजत जयंती वर्ष के उपलक्ष्य में एक ऑनलाइन तिमाही न्यूजलेटर शुरु करने का निर्णय लिया था इसी क्रम में अब तक इसके आठ अंक तैयार करके संस्थान की वेबसाइट में उपलब्ध है।

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कम्प्यूटर पर कार्य करने के दौरान दिन–प्रतिदिन आने वाली कठिनाइयों को दूर करने के लिए संस्थान ने दिनांक 23 .07. 2010 को राष्ट्रीय सूचना विज्ञान केन्द, भारत सरकार के साथ एक प्रशिक्षण कार्यशाला का आयोजन किया।

अपनी प्रस्तुति में श्री केवल कृष्ण, निदेशक (तकनीकी), राष्ट्रीय सूचना विज्ञान केन्द्र, भारत सरकार ने यूनिकोड को सक्रिय करने के बारे में क्रमबद्ध रूप से बताया। उन्होंने बताया कि अब हिंदी टाइपिंग जाने बिना भी हिंदी में टाइपिंग की जा सकती है, इसका उन्होंने व्यावहारिक प्रशिक्षण भी प्रदान किया। इसके अतिरिक्त उन्होंने श्रुतलेखन, अनुवाद सॉफ्टवेयर आदि के बारे में जानकारी दी।

if'k{k.k

वरिष्ठ अनुवादक श्री संजय कुमार ने राजभाषा विभाग द्वारा राष्ट्रीय सूचना विज्ञान केन्द्र के माध्यम से 9–11 अगस्त, 2010 के दौरान जयपुर में आयोजित किए गए प्रशिक्षण कार्यक्रम में प्रतिभागिता की।

ykdfi;; foKku y[ku rFkk i dk'ku

संस्थान की ओर से इस अवधि में 5 लोकप्रिय विज्ञान लेख 'विज्ञान प्रगति,' 2 विश्व कृषि संचार तथा कुछ लेख दैनिक समाचार पत्रों में प्रकाशित हुए।

संस्थान के 2009–10 के वार्षिक प्रतिवेदन में प्रकाशन के लिए शोध एवं विकास गतिविधियों का हिन्दी अनुवाद एवं संपादन तथा अन्य सामग्री का संपादन, टंकण एवं संकलन किया। गुलाब की खेती की खेती विषय पर एक बुलेटिन भी प्रकाशित किया गया तथा पुराने बुलेटिनें को पुनः मुद्रित कराया गया।

njn'kZu okrk

वर्ष के दौरान 12 वार्ताएं दूरदर्शन के शिमला केन्द्र से कृषि दर्शन कार्यक्रम के अन्तर्गत प्रसारित हुईं।

fgUnh fnol lekjksg

संस्थान में हिन्दी दिवस समारोह–2010 दिनांक 14 सितम्बर 2010 से संस्थान परिसर में आयोजित किया गया। संस्थान के निदेशक डा. परमवीर सिंह आहूजा ने अपने संबोधन में संस्थान की गतिविधियों पर प्रकाश

डाला तथा बताया कि कैसे संस्थान अपने शोध को सरल राजभाषा हिंदी में विभिन्न माध्यमों से जन–जन तक पहुंचाने का कार्य कर रहा है। उन्होंने वैज्ञानिकों तथा शोध छात्रों से आह्वान किया कि वे आने वाले समय में वैज्ञानिक उपलब्धियों को आम जनता तक पहुंचाने के लिए ज्यादा से ज्यादा हिन्दी विज्ञान लेख लोकप्रिय पत्रिकाओं एवं दैनिक समाचार पत्रों में प्रकाशित करें।

समारोह के मुख्य वक्ता हिमाचल प्रदेश कृषि विश्वविद्यालय, पालमपुर के कुलपति डॉ. एस. के. शर्मा ने 'कृषि जैवविविधता प्रबन्धन' पर संभाषण दिया। उन्होंने बताया कि भारत विश्व के जैवविविधता समृद्ध देशों में से एक है। विश्व में फसलों, पशुओं, मछलियों, कीटों आदि में जितनी विविधता इस देश में है उतनी किसी ओर देश में नहीं है। उन्होंने इस जैवविविधता के सरंक्षण और प्रबन्धन पर बल दिया क्योंकि जलवायु परिवर्तन आदि समस्याओं से कई प्रकार की विविधता नष्ट हो चुकी है या होने की कगार पर है। अतः सामुहिक प्रयास करके ही इस जैवविधता को बचाया जा सकता है।

fp=dkj f'kfoj dk vk;kstu

संस्थान भाषा कला व संस्कृति से संबन्धित कार्यक्रमों का आयोजन समय–समय पर करता रहता है। संस्थान ने 13 –15 दिसम्बर, 2010 को हिमाचल कला संस्कृति भाषा अकादमी से साथ मिलकर एक चित्रकार शिविर आयोजन किया। शिविर का उद्घाटन करते हुए संस्थान के निदेशक डॉ. परमवीर सिंह आहूजा ने कहा कि किसी भी संस्थान और राष्ट्र की पहचान भाषा, कला एवं संस्कृति के माध्यम से होती है और विज्ञान और कला में आपसी गहरा संबन्ध है। अकादमी के सचिव डॉ. तुलसी रमण ने कहा कि चित्रकला, कविता और संगीत के माध्यम से समाज का वास्तविक सत्य व्यक्त होता है। इनसे व्यक्ति–मानस का परिष्कार होकर सुसंस्कृत समाज बनता है और फिर सांस्कृतिक राष्ट्र का निर्माण होता है।

उद्घाटन सत्र में चित्रकार एवं कला समीक्षक श्री विजय शर्मा ने पहाड़ी चित्रकला के ऐतिहासिक एवं सौंदर्यबोधपरक महत्त्व पर प्रकाश डाला। कलाकार सुरजीत सिंह ने सुझाव दिया कि इस तरह के संस्थानों को कला समृद्ध करने के लिए विभिन्न विधाओं से जोड़ना चाहिए। उल्लेखनीय है कि इस त्रिदिवसीय 'शिविर' में पहाड़ी चित्रकला के दो गुरु कलाकार ओम सुजानपुरी और विजय शर्मा के अतिरिक्त मार्डन आर्ट के वरिष्ठ कलाकार सुरजीत सिंह, चमन शर्मा तथा शर्मीला शर्मा के अतिरिक्त दो युवा चित्रकार नेहा शर्मा तथा इसरो देवी भी शामिल हुए।

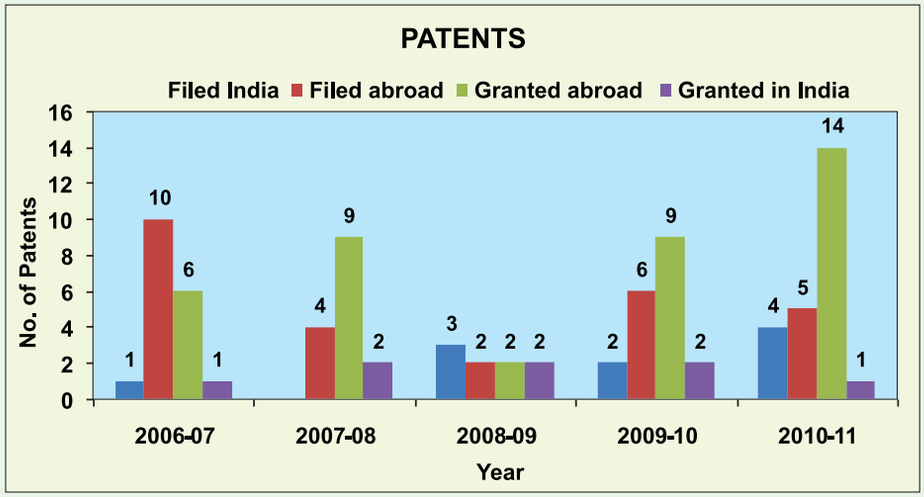
lkaLdfrd l/;kvksa dk vk;kstu

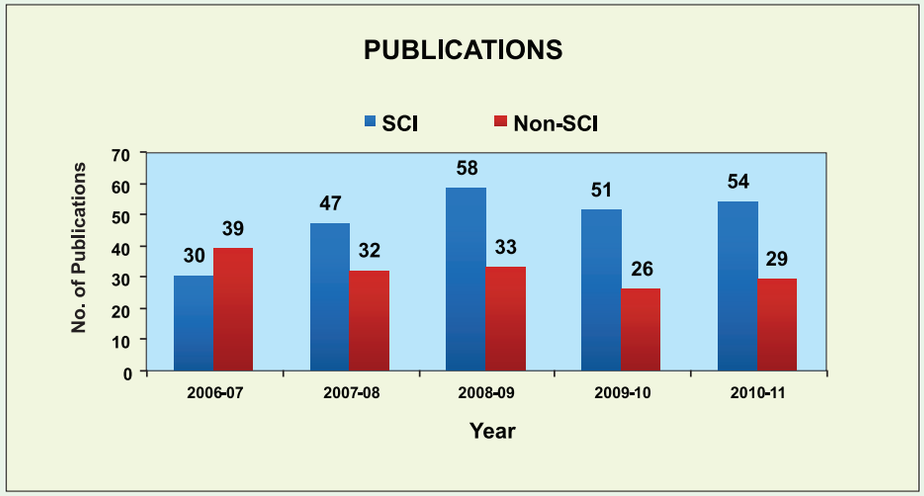
संस्थान ने स्टीविया और फर्न पर आयोजित अन्तर्राष्ट्रीय संगोष्ठियों एवं शांति स्वरुप भटनागर स्मारक टूर्नामेंट के दौरान चौधरी सरवन कुमार हि.प्र. कृषि विश्वविद्यालय के छात्रों व संस्थान के रिसर्च स्कॉलर एवं कर्मियों के परिवार के सदस्यों के सहयोग से सांस्कृतिक संध्याओं का आयोजन किया।

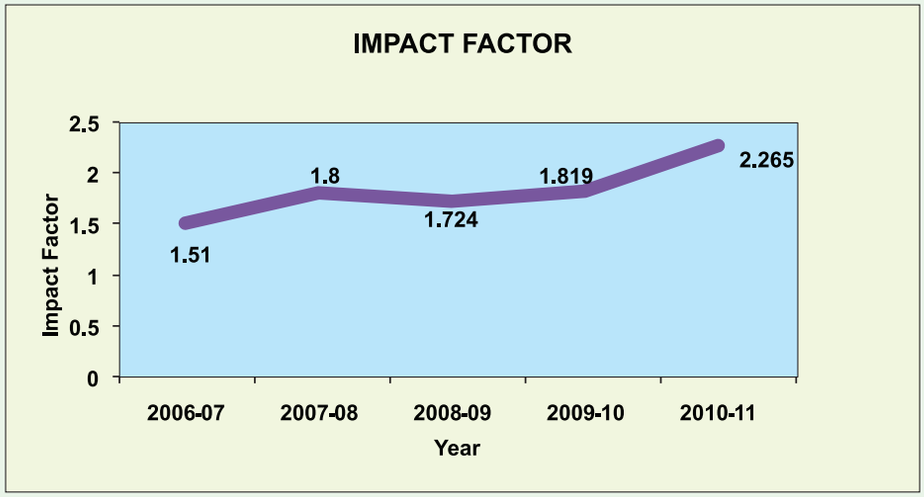
vU; fofo/k dk;Z

संस्थान द्वारा किये जा रहे शोध कार्यो को आम जनता तक पहुंचाने के उद्देश्य से समाचार पत्रों में विभिन्न लेख प्रकाशित किए गये। इसके साथ ही संस्थान द्वारा आयोजित किए जाने वाले विभिन्न समारोहों जैसे सतर्कता 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। संस्थान के प्रशासन के स्थापना एंव सामान्य अनुभागों के कार्यों में भी अनुभाग सहयोग करता है।

PATENTS, PUBLICATIONS, HUMAN RESOURCE DEVELOPMENT AND PUBLICITY







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TECHNICAL BULLETIN/BROCHURE RELEASED

IHBT Annual Report-2009-10

गुलाब की व्यावसायिक खेती की तकनीक –सीएसआईआर–आई.एच.बी.टी., पालमपुर–हि.प्र.

Brochure of International Symposium on Ferns and Fern Allies: Diversity, Bioprospection and Conservation, CSIR-IHBT, Palampur (HP)

Proceedings International Symposium on Ferns and Fern Allies: Diversity, Bioprospection and Conservation, CSIR-IHBT, Palampur (HP)

IHBT Herbarium Catalogue, CSIR-IHBT, Palampur (HP)

Souvenir Symposium on Prospects of Stevia, CSIR-IHBT, Palampur (HP)

IHBT Tech Profile

DOORDARSHAN PROGRAMMES

Topic	Date of Telecast	Name of Expert
Telecasts on Doordarshan Kendra Shimla under *Krishi Darshan* Programme		
Cultivation and post harvest technology of lilium cut flower crop	15.04.2010	Dr. Markandey Singh
Cultivation scope of kutki	18.05.2010	Dr. Varinder Singh & Dr. RK Sud
Treatment of bamboo culms for enhancing their shelf-life	18.06.2010	Dr. Anil Sood, Sh. Om Parkash & Dr. RK Sud
Tea garden management practices for harvesting high volume rain flush crop	02.07.2010	Dr. RK Sud
Mobile distillation unit for aromatic crops for the growers of Himachal Pradesh	20.08.2010	Er. GD Kiranbabu
Cultivation practices for chrysanthemum	07.09.2010	Dr. Markandey Singh
Bird of Paradise – a high value floriculture crop	19.11.2010 25.11.2010 (Repeat)	Sh. D Dhyani
Diversity of ferns and their economic importance	09.12.2010 29.12.2010 (Repeat)	Dr. Brij Lal & Dr. Alka Kumari
Multiplication techniques and nursery management of chrysanthemum	31.03.2011	Dr. Markandey Singh & Dr. RK Sud
Telecasts on Doordarshan Kendra Shimla under General Programme		
Foundation day celebrations of IHBT	07.06.2010	Dr. PS Ahuja
Telecasts on the Palampur Cable Network (PCCN), Darpan TV		
Charcoal making from bamboo	07.07.2010	Dr. Anil Sood
Importance of National Science Day	28.02.2011	Dr. PS Ahuja

AWARDS

PS Ahuja: Professor Pran Nath Memorial Award-2007, the Indian Fern Society, Chandigarh.

Sudesh Kumar: CSIR Young Scientist Award- 2010 for research contribution in the field of Biological Sciences.

Gopaljee Jha: INSA (Indian National Science Academy) Young Scientists Award- 2010 in the field of plant sciences

Nandini Sharma, Upendra K Sharma, Ajai P Gupta Devla, Arun K Sinha ,Brij Lal, PS Ahuja (2010) Dr. P.D. Sethi Award-2009 for the best Indian research papers using HPTLC.

Upendra K Sharma, Nandini Sharma, Arun K Sinha, Neeraj Kumar, Ajai P Gupta Devla, and **Paramvir S Ahuja:** (2010) Dr. P.D. Sethi Annual Award for the best paper in Pharmaceutical analysis (Certificate of merit award)

G Bhardwaj, AK Yadav, S Singh and **A Sharma** (2010) First prize in poster presentation in Symposium on Prospects of Stevia, IHBT, Palampur, September 24-25.

Birhane Nebiyu, Kindie Habtamu Kifle, Worku Tadele, Rakesh Kumar, Bikram Singh, Anil Sood and **PS Ahuja: (**2010) Third prize in poster presentation in Stevia symposium held at IHBT Palampur from September 24-25.

RECOGNITION

PS Ahuja: Fellow, the Indian Fern Society, Chandigarh

RD Singh: Nominated Technical Members of the State Medicinal Plants Board, Department of Ayurveda, Shimla, Govt. of HP

Brij Lal: Nominated Technical Members of the State Medicinal Plants Board, Department of Ayurveda, Shimla, Govt. of HP

Madhu Sharma: Elected Member, Plant Tissue Culture Association (India)

Sukhjinder Singh: Best Stall award at Rural Technology Mela organised by Rural Technology Park, National Institute of Rural Development, Ministry of Rural Development, Govt. of India, Hyderabad

PS Ahuja: (2010) Chaired the session in Indo-Italian workshop on Bacteria & Fungi for Fundamental Sustainability, Amity University Campus, NOIDA, November 29.

PS Ahuja: (2011) Co-Chaired the session in 17th Conference of National Magnetic Resonance Society on Magnetic Resonance in Pharmaceuticals**,** Guru Nanak Dev University (GNDU) Amritsar, Punjab, March 1-4.

Sanjay Kumar: Member, the Scientific Advisory Committee of J&K State Council for Science & Technology.

Sanjay Kumar: Co-Chaired the technical session on Himalayan Biodiversity on December 21, 2010 during International Workshop on "Biodiversity and Climate Change" organized by Centre for Oceans, Rivers, Atmosphere and Land Sciences, Indian Institute of Technology, Kharagpur, India.

Ph.D./M.Sc/ M. PHARMA/ B. Tech SUPERVISED

Awardee	Title of theses	Superviser	University / Institute
Ph.D. Awarded			
Abhishek Kumar	Synthetic studies of some bioactive C-alkylated phenolics and heteroaromatic compounds using green methodologies	AK Sinha	GNDU, Amritsar / IHBT
Neeraj Kumar	Study towards biologically active molecules involving phytochemical investigation of medicinal plants as well as synthesis of glutarimide analogue	Bikram Singh	Panjab University, Chandigarh / IHBT
Musharof M Hossain	Development of *in vitro* protocols for mass propagation and conservation of some economically important orchids	Madhu Sharma	Panjab University, Chandigarh / IHBT

M.Sc. /M. Pharma Dissertation/Report Supervised			
Amol Kalia	Polyphasic characterization of thermophilic bacteria.	Arvind Gulati	GNDU, Amritsar
Anu Walia	Evaluation of antimicrobial potential of *Cedrus deodara*	Bikram Singh	MM College of Pharmacy, Mullana, Ambala
Archit Parmar	Synthesis of 2-amino-1,4-naphthoquinone from aromatic nitro compounds using heterogeneous catalyst and evaluation of their biological potential	Bikram Singh	Global College of Pharmacy, Anandpur Sahib, Ropar
Aruna Narang	Selection of antagonistic and fusaric acid tolerant *Trichoderma* species	V Shanmugam	GNDU, Amritsar

Arvind Sharma	Isolation characterization and quantification of isolated components from *Picrorrhiza kurrooa*	Vijai K Agnihotri	Baba Isher Singh College of Pharmacy, Gagra (Moga)
Charu Bhardwaj	Suzuki-Miyaura cross coupling reaction under different solvent and basic conditions	Pralay Das	Dr. B.R. Ambedkar NIT, Jalandhar
Dimple Sharma	Isolation, characterization and Pharmacological investigation of secondary metabolites from *Asparagus racemosus* growing in Western Himalayan region	Bikram Singh	Lord Shiva College of Pharmacy, Sirsa
Jyotsna Dayma	Role of polyphenols in *Agrobacterium* mediated genetic transformation of plants	Amita Bhattacharya	CSK HPKV, Palampur
Karamvir Kaur	Partial purification and characterization of extracellular protease from psychrotrophic bacteria	Ramesh C Kasana	GNDU, Amritsar
Monolina Pal	Green protocol for aza-Michael reactions: a useful media for natural product synthesis	Pralay Das	Banasthali Vidyapith, Rajasthan
Navneet Bhullar	Characterization and screening of thermophilic bacteria for industrially important enzymes	Arvind Gulati	GNDU, Amritsar
Nisha Bhatia	Genetic transformation of apple rootstock MM106	Amita Bhattacharya	Suresh Gyan Vihar University, Jaipur
Prateek Sharma	Development of green process for biologically active cinnamic acid derivatives synthesis through Heck coupling reaction	Pralay Das	Shoolini University, Solan
Ravi Gautam	Biotechnological improvement of *Bacopa monieri*	Amita Bhattacharya	Dolphin PG Institute of Biomedical and Natural Science, Dehradun
Savita Meshram	Isolation, purification and screening of bacteria for cyclodextrin glycosyl transferase production	Ramesh C Kasana	Dr. H.S. Gour University, Sagar
Sheenam Aery	Development of methodologies towards synthesis of secondary metabolites	Pralay Das	Banasthali University, Rajasthan
Soni Thakur	Chemical and pharmacological investigation of *Curcuma aromatica* growing in Western Himalayan Region	Vijai K Agnihotri	Sobhit University Meerut

Vikrant Arya	Pharmacognostical and Phytochemical investigation of *Crataegus oxycantha* Linn. Fruits	Bikram Singh	ASBASJSM College of Pharmacy, Bela, Ropar
B Tech Report Supervised			
Ila Chawla	Validation of Shikimate kinase gene expression due to *Cucumber mosaic virus* infection	V Hallan	Thapar Institute, Patiala
Kanika Bajwa	Comparision of the heterologous expression of Apple stem grooving virus coat protein gene in different expression vector	AA Zaidi	DY Patil institute of Biotechnology and Bioinformatics, Pune
Shashank Sharma	*Agrobacterium* mediated genetic transformation of apple rootstock B9	Amita Bhattacharya	Jaipur Engineering College & Research Centre, Jaipur

INVITED LECTURES

AK Sinha: Relevance of green chemistry in natural product chemistry and synthetic organic chemistry, National Seminar on chemistry biology interface: Recent Trends. P.G. College Ranikhet, Almora, Uttarakhand, October 28-30, 2010.

AK Sinha: Green approaches for the synthesis of bioactive compounds, National Conference on Green Chemistry-Recent Trends and Applications. DAV College, Amritsar, (Pb.), September 28-29, 2010.

Arvind Gulati: Stress tolerant and rhizosphere competent plant growth promoting microbial inoculants for improving agriculture productivity. Amity Institute of Microbial Technology, Amity University, Noida, (U.P.), March 23, 2011.

Ashu Gulati: Application of electronic sensors for predicting tea quality, National Bilingual Conference on Agrionics and Food Processing Instrumentation, CSIO, Chandigarh, (U.T), September 26-28, 2010.

Ashu Gulati: Orthodox black tea and application of E-vision and E-tongue, DST Workshop on Tea Quality Enhancement and Rapid Measurement", Tea Research Association, Tocklai, Jorhat, (Assam), September 3, 2010.

MK Singh: Commercial cultivation technology of Gerbera and Rose, training programme for farmers, Department of Horticulture, Una, (H.P.), April 20, 2010.

MK Singh: Protected cultivation technology of lilium and alstroemeria, summer school on Protected Cultivation for Enhanced Profitability, CSK HPKV, Palampur, (H.P.), September 6, 2010.

Neeraj Kumar: Chemical investigations of medicinal plants used in ayurveda & popular publications, RoTP programme organized by Ayush on Dravyaguna, Rajiv Gandhi Govt. Ayurvedic College, Paprola (H.P.), September 16, 2010.

Neeraj Kumar: Quality standards of medicinal plants, RoTP programme organized by Ayush on Dravyaguna, Rajiv Gandhi Govt. Ayurvedic College, Paprola (H.P.), September 16, 2010.

Neeraj Kumar: Recent analytical techniques for quality control of medicinal plants and their herbal formulations, RoTP programme organized by Ayush on Quality Control & Pharmacognosy for Teachers of Ayurveda, Siddha and Unani Colleges dealing with medicinal plants, ISM Joginder Nagar (H.P.), June 17, 2010.

Neeraj Kumar: Traditional knowledge guided investigation of Himalayan medicinal plants for biologically active molecules, RoTP programme organized by Ayush on Quality Control & Pharmacognosy for Teachers of Ayurveda, Siddha and Unani Colleges dealing with medicinal plants, ISM Joginder Nagar (H.P.), June 17, 2010.

Neeraj Kumar: Stereochemistry and isomerism, In-House-In Service Training for Teachers of Army School, Yol Cantt, Dharmshala (H.P.), May 28, 2010.

Pralay Das: Chemistry and its diversity, Gaur Mahavidyalaya, Malda, West Bengal, December 8, 2010.

Pralay Das: Chemistry and diversity, In-House-In Service Training for Teachers of Army School, Yol Cantt, Dharmshala (H.P.), May 28, 2010.

PS Ahuja: In Science Camp under the Internship Programme Innovation of Science Pursuit for Inspired Research (INSPIRE) of DST, GNDU, Amritsar, (Pb.), May 24-25, 2010.

PS Ahuja: Salient Biotechnological Achievement at IHBT. Biotechnica Chandigarh-2010, Panjab Univrsity, Chandigarh (U.T.), November 17, 2010.

PS Ahuja: Recent efforts in characterization, cultivation and conservation of some important medicinal plants, International Conference on Challenging and Emerging Dimensions in Medicianl/Herbal Plants and their Products: A Global Perspective, Chennai Trade Centre, Chennai, (TN), November 26-28, 2010.

PS Ahuja: Chief Guest and keynote speaker in the National Symposium on Frontiers and Avenues in Plant Sciences, Shiva College, University of Delhi, Delhi, January 20, 2011.

PS Ahuja: Keynote address during the Workshop on Techniques for *in vitro* pharming isolation and characterization of secondary metabolites for sustainance of medicinal plants, Department of Botany, CCS University, Meerut (U.P.), March 7, 2011.

RD Singh: Perspective of medicinal and aromatic plants cultivation under protected environments, Summer School on Protected Cultivation for Enhanced Profitability, CSK HPKV, Palampur, (H.P.), September 22, 2010.

Raja Ram: Propagation of commercially imortant cut flower crop by tissue culture, training programme for farmers, Department of Horticulture, Una, (H.P.), April 20, 2010.

Sanjay Kumar: Understanding altered molecular dynamics in Himalayan ecosystem: implications for agricultural research under climate change scenario, International Conference on Preparing Agriculture for Climate Change organized by the Punjab Agriculture University, Ludhiana, (Pb.), February 7, 2011.

Sanjay Kumar: Agri-instrumentation for tea, genomics and environment, One day workshop during Golden Jubilee Celebration of CSIO, CSIO, Chandigarh, (U.T.), February 23, 2010

Sanjay Kumar: Bioprospecting genes, enzymes and processes from Himalayan flora for plant adaptation and synthetic biology, Central University of Punjab, Bathinda (Pb.), September 28, 2010.

Sanjay Kumar: Exploratory studies on climate change and adaptation of species complexes at technical session on Himalayan Biodiversity, International Workshop on Biodiversity and Climate Change" organized by Centre for Oceans, Rivers, Atmosphere and Land Sciences, Indian Institute of Technology, Kharagpur, (W.B.), December 19-22, 2010.

Som Dutt: Biotechnology: platform for sustaining mankind and nature, organized under DBT sponsored star college project scheme, Bioscience Division, Govt. College Dharmshala, (H.P.), October 29, 2010.

Subhash C Yadav: Development of antidiabetic Nanomedicine from Stevioside (2011), International Symposium on the Safe Use of Nanomaterials at Indian Institute of Toxicology Research, Lucknow, (U.P.), February 1-3, 2011.

V Shanmugam: Fusaric acid detoxification and chitinase expression in an antagonistic *Trichoderma harzianum* S17TH. BARD, Workshop on Trichoderma: Molecular mechanisms and applications of biocontrol in agriculture, Haifa, Israel, October 12-15, 2010.

GUEST LECTURES

Prof. AS Brar: Vice Chancellor, GNDU, Amritsar, (Pb.) New development and structure determination of polymers by NMR spectroscopy, April 9, 2010.

Dr. Ankit Walia: Canada, Protein kinase regulation, April 19, 2010.

Dr. Arabinda Mitra: Executive Director, Indo-US Science and Technology Forum (IUSSTF), Indo-US Science and Technology Cooperation: Prospective and opportunities, May 7, 2010.

Dr. Ganesh Bagler: Max-Planck Institute for Molecular Genetics, Computational modeling of protein structure using network analysis, MPI, Germany, May 18, 2010.

Prof. Daya Singh Sandhu: Fulbright-Nehru Senior Research Scholar, GNDU, Amritsar, (Pb.), Mental health, June 2, 2010.

Dr. Bal Ram Singh: Director, Botulinum Research Center, University of Massachusetts, Dartmouth, Botulinum neurotoxin vs. neuromedicine - basic and applied research, June 7, 2010.

Prof. Jean Kallerhoff: Associate Professor, Plant Biotechnology and Environmental Sciences, ECOLAB, INTP-ENSAT, Approaches towards sustainability, June 8, 2010.

Dr. Marina Barba: Director, Consiglio per la Ricerca e la sperimentazione in Agricoltura, Centro di Ricerca per la Patologia Vegetale, Rome, Plant Pathology Research Center: Main activities, July 2, 2010.

Sh. Kewal Krishan: Computer and Unicode, NIC, New Delhi, July 23, 2010

Prof. ML Sharma: Panjab University, Chandigarh, Plants sample preparation technique for ultramicrotomy and limitation, September 3, 2010.

Dr. Heike Schneider: Head, Research Division Transport Dynamics, Institute of Chemistry and Dynamics of the Geosphere, ICG-3,Phytosphere, Forschungszentrum Julich GmbH, Wilhelm-Johnen-Strabe, Julich, Germany, Phenotyping, November 19, 2010.

Dr. SK Sharma:Vice Chancellor, CSK HPKV, Palampur, (H.P.), Genetics as a career, January 24, 2011.

Dr. Gagan Garg: Assistant Professor, IIT Mandi, (H.P.), Mathematics, January 25, 2011.

Prof. S Ananthakrishnan: Adjunct Professor and Raja Ramanna Fellow, Pune University, Radio Astronomy, January 27, 2011.

Dr. Lalji Singh: Bhatnagar Fellow and Former Director, CCMB, Hyderabad, (A.P.), Mystery of our origin, January 27, 2011.

Dr. Lalji Singh: Bhatnagar Fellow and Former Director, CCMB, Hyderabad, (A.P.), Science of establishing individual identity: past, present and future, January 28, 2011

Dr. Vasudevan Ramesh: University of Manchester, March 4, 2011.

Dr. Heike Schneider: Head, Research Division, Transport Dynamics, Institute of Chemistry and Dynamics of the Geosphere, ICG-3, Phytosphere, Forschungszentrum Julich GmbH, Wilhelm-Johnen-Strabe, Julich, Germany, Do Acid Mucopolysaccharides play a major functional role in regulating plant water relations?, March 15, 2011.

Dr. Heike Schneider: Head, Research Division Transport Dynamics, Institute of Chemistry and Dynamics of the Geosphere, ICG-3, Phytosphere, Forschungszentrum Julich GmbH, Wilhelm-Johnen-Strabe, Julich, Germany, Nondestructive phenotyping– new approaches to evaluate resource use efficiency and stress tolerance of various model and crop plants, March 23, 2011.

Prof. Gerhard Kost: Department of Systematic Botany and Mycology, Head of the Herbarium Marburgense, Germany, Mycorrhiza-driving force of evolution, March 28, 2011.

TRAINING/WORKSHOP/MEETING ORGANIZED

Brain storming session on Floriculture in the Future, May 13, 2010: 17 participants; Coordinator: **Dr. Markandey Singh**

3rd meeting of the monitoring committee, CSIR on Rural, SC/ST, Women, North East & Tribal (RSWNET) Sector, June 11-12, 2010; Coordinator: **Dr. Virendra Singh**

Workshop on The Bioinformatics of Next Generation Sequencing, June 17-18, 2010: 16 participants; Coordinator: **Dr. Ravi Shankar**

Training on Identification, demarcation and benchmarking the ecological attributes of permanent plots for long-term monitoring and data recording, July 1-16, 2010: participants were the scientific /technical personnel and research scholars of CSIR-IIIM, Jammu; Coordinator**: Dr. Amit Chawla**

IHBT-Industry interactive meet under DSIR sponsored project entitled Technology & Innovation Management Centre at IHBT, Palampur, July 09, 2010: 9 participants; Coordinator: **Dr. Aparna Maitra Pati**

Meeting of scientists of National Remote Sensing Centre (NRSC-ISRO), Hyderabad and Institute of Himalayan Bioresource Technology, CSIR, Palampur, for initiating a joint collaborative program under the Geospatial Decision Support for Greening India Initiative – Resilience and Mitigating perspectives of Indian Vegetation under Climate Change, IHBT Palampur, July 28-29, 2010; Co-ordinator: **Er. Amit Kumar**

Workshop on Medicinal and Aromatic Plants at Chamba under DSIR sponsored project entitled Technology & Innovation Management Centre at IHBT, Palampur, August 17, 2010: 71 participants; Coordinator: **Dr. Aparna Maitra Pati**

IHBT- Herbal Industry interactive meet under DSIR sponsored project entitled Technology & Innovation Management Centre at IHBT, Palampur, August 23, 2010: 24 participants; Coordinator: **Dr. Aparna Maitra Pati**

IHBT-Food Industry interactive meet under DSIR sponsored project entitled Technology & Innovation Management Centre at IHBT, Palampur, August 27, 2010: 14 participants; Coordinator: **Dr. Aparna Maitra Pati**

Meeting of the Ayurvedic Pharmacopoeial Committee (an apex scientific body constituted by Govt. of India) at IHBT, September 8, 2010; Coordinator: **Dr. Brij Lal**

Training programme on Agrotechonology of medicinal and aromatic plants to the delegates of ETHIO Agri CEFT, Plc. Ethiopia at IHBT Palampur, September 16-October 15, 2010: Coordinator: **Dr. Rakesh Kumar**

Training on Biological sample handling and specimen preparation for transmission electron microscopy (TEM), September 27 - October 1, 2010, 15 participants; Coordinator: **Dr. Subhash Chandra Yadav**

Workshop on Cultivation of Himalayan aromatic oils for fragrances and flavors, organized by IHBT, Himalayan Phytochemical and Grower Association in association with Essential Oil Association of India, October 3, 2010, 44 participants; Coordinator: **Dr. Bikram Singh**.

Training programme on Medicinal & Aromatic Plant Production, January 18-20, 2011, 20 participants; Coordinator: **Dr. Virendra Singh**

INSPIRE (Innovation in Science Pursuit for Inspired Research) Internship– 2010 Science Camp, January 24-28, 2011, 143 participants; Coordinator: **Dr. Aparna Maitra Pati**

Demonstration-cum-training programme on Cultivation and post harvest technology of commercially important cut flower crops, February 21-23, 2011: 41 participants; Coordinator: **Dr. Markandey Singh**

Demonstration-cum-training programme on Cultivation and post harvest technology of commercially important cut flower crops, March 15, 2011: 19 participants; Coordinator: **Dr. Markandey Singh**

Training on Handling and safe use of Scanning Electron Microscope, March 28-31, 2011, 8 Participants; Coordinator: **Dr. Subhash Chandra Yadav**

CONFERENCES/SYMPOSIA ORGANIZED

Symposium on Prospects of Stevia organized by IHBT Palampur on September 24-25, 2010: 100 participants; Conveners: **Dr. Sanat Sujat Singh** and **Dr. Ashok Kumar Yadav**

International Symposium on Ferns and Fern Allies: Diversity, Bioprospection and Conservation, November 10-12, 2010: 80 participants; Organizing Secretary: **Dr. Brij Lal**

Symposium on Magnetic Resonance in Pharmaceuticals and 17th Conference of National Magnetic Society, organized by GNDU, Amritsar and IHBT Palampur at GNDU, Amritsar from March 1-4, 2011; Coconvener: **Dr. Neeraj Kumar**

National symposium cum workshop on Application of TEM in Advance Nanobiology and Life Sciences, October 4-8, 2010: 45 participants; Convener: **Dr. Subhash Chandra Yadav**

VISITS ABROAD

Rakesh Kumar: To present paper at 7th BIOMET Conference at Albert-LUDWIGS-Univ. of Freeburg, Germany, April 12-14, 2010.

PS Ahuja and **RK Sharma:** To attend International Conference on progress of 1000 Plant Animal Reference Genomes Project and 2010 International Symposium on Tea (*Camellia sinensis)* Genome, Shenzhen, China, May 13-14, 2010.

Markandey Singh and **Sukhjinder Singh:** Exposure visit to scientific institutions in Taiwan under the scheme National Programme for training of scientists and technologists working in Govt. sector, Department of Science and Technology, Government of India, May 31-June 4, 2010.

V Shanmugam: To attend workshop on *Trichoderma*: Molecular Mechanisms and Applications of Biocontrol in Agriculture Technion-IIT, Haifa, Israel, October 12-15, 2010.

TRAININGS IMPARTED

Fifty eight (58) students from different Institutes/ Universities:

- Banasthali University, Rajasthan
- Thapar University, Patiala
- Shaheed Udham Singh College of Engg. & Tech., Tangori, Mohali
- Kanya Gurukul Mahavidyalaya, Haridwar
- Dr. DY Patil College of Biotech. & Bioinformatics, Pune
- Jaipur Engg. College & Research Centre, Jaipur
- Dr HS Gour University, Sagar
- Guru Nanak Dev University, Amritsar
- Dr. BR Ambedkar NIT, Jalandhar

- Punjab University, Chandigarh
- Punjabi University, Patiala
- Amity University, Noida
- Univ. Instt. of Engineering & Technology, Punjab University, Chandigarh
- Jaypee Univ. Instt.of Information Tech. Waknaghat, Solan
- Beant College of Engg. & Tech., Gurdaspur
- Suresh Gyan Vihar University Jaipur
- Maharishi Markendeshavar University, Mullana, Ambala
- Punjab Technical University, Jalandhar
- Baba Isher Singh College of Pharmacy, Gagra, Moga
- Amar Shaheed Baba Ajit Singh, Jujhar Singh Memorial Postgraduate College of Pharmacy, Bela, Ropar
- Rayat Institute of Pharmacy, Railmajra, Ropar
- Lord Shiva College of Pharmacy, Sirsa
- Shoolini University, Solan

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 y 115, 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, Uttrakhand
- Commission for Scientific and Technical Terminology, Govt. of India, New Delhi
- CSK Himachal Pradesh Krishi Vishwavidyalaya, Palampur, H.P.
- District Rural Development Agency, Mandi, Himachal Prdaesh
- Dr.YS Parmar University of Horticulture and Forestry, Nauni, Solan, H.P.
- Govt. of Mizoram, Aizwal, Mizoram

- 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
- Panjab University, Chandigarh (UT)
- Punjab Agricultural University, Ludhiana, Punjab
- Punjabi University, Patiala, Punjab
- Sant Longowal lnstitute of Engg. Tech., Longowal, Sangrur, Punjab
- Space Applications Centre (SAC), ISRO, Ahmedabad, Gujarat
- Tea Research Association, Tocklai, Assam
- The Chief Conservator of Forests (Admn.) cum Project Director, Punchkula, Haryana
- TN Medical College & BYL Nair Ch. Hospital, Mumbai Central, Mumbai
- United Planters Association of South India (UPASI), Valparai, Tamil Nadu
- Uttrakhand Bamboo and Fiber Development Board (UBFDB), Dehradun, Uttrakhand

Private

- Andel Equipment Pvt. Ltd., Mohali, Punjab
- Aroma Aromatics and Flavours, Baddi, Solan, H.P.
- Baba Ghulam Shah Badshah University, Rajouri, J&K
- Contractor Agro Processing Pvt. Ltd., Ahmedabad, Gujarat
- Crystal Phosphate, Karnal, Haryana
- Jagat Foundry, Batala, Punjab
- Jallan Trinitea Processing Pvt. Ltd., Gurgaon, Haryana
- Kanan Devan Hills Plantation Pvt. Ltd., Munnar, Kerala
- Kangra Valley Extraction Pvt. Ltd., Chandigarh, (UT)
- 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, J&K
- 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
- Vadamalai Consultancy Services, Bangaluru, Karnataka

NGO

- Yog Manav Vikas Trust, Banikhet, H.P.
- Farmer First Foundation, New Delhi

MEMORANDUM OF UNDERSTANDING (MoU)

Date	Agreement with	Purpose
June 16, 2010	NHPC, Nagwain, District- Mandi, Himachal Pradesh (Head Quarter at Faridabad, Haryana)	Plantation/ revegetation of 10 nos. closed dumping sites of Parbati H.E. Project Stage-II through Integrated Biotechnological approach
August 28, 2010	Punjabi University, Patiala	Revalidation
September 10, 2010	Wildlife Wing, Forest Department, Himachal Pradesh	Assessment of floral and habitat diversity and collection of data to compare / monitor vegetation of Great Himalayan National Park (GHNP), Wildlife Sanctuaries (WLFs) as part of Long Term Ecological Monitoring"
September 22, 2010	M/s Himachal Pradesh Horticultural Produce Marketing & Processing corporation Limited (HPMC), Nigam Vihar, Shimla - 171002	Processing of apple pomace for value added product development
September 23, 2010	Department of Clinical Pharmacology, TN Medical College & BYL Nair Ch. Hospital Mumbai	Pertaining to the research targeting immunomodulatory activities of isolated and synthesized compounds
January 5, 2011	M/s Crystal Phosphate, 106, Shastri Grain Market, Karnal, Haryana	Synthesis of 5- Bromo-2-(3-Chloropyridin-2-yl)-2H-pyrazole-3-carboxylic acid
February 25, 2011	M/s Krishna Food & Seeds Processors Plot No. 26, Industrial Area Gurdaspur, Punjab	Cultivation and post harvest technology of commercially important cut flower crops

MEETING ATTENDED

Amit Kumar: Himachal Pradesh secretariat, Shimla, Application of geo-informatics in developmental planning- Gujarat experiences, November 10, 2010.

Brij Lal: CSIR, New Delhi, Second Sectoral Monitoring Committee Meeting on CSIR Network Projects, March 23, 2011.

Brij Lal: HRDC, Ghaziabad, Uttar Pradesh, Task Force Meeting of Comprehensive Traditional Knowledge Digital Library (CTKDL), April 26, 2010.

RD Singh and **Arvind Gulati**: NBRI, Lucknow, Brain storming session for the network project Bioprospection and Plant diversity for the XII Five Year Plan, September 28-29, 2010.

SK Uniyal: Department of Biotechnology, New Delhi, a meeting of Expert Group to take forward Indian Bioresource Information Network, June 25, 2010.

SK Vats and **Brij Lal**: Shimla, WWF- India and State Council for Science, Technology and Environment Consultation Meeting: Voices from High Altitudes- Mainstreaming in State Action Plan on Climate Change (SAPCC), January 17, 2011.

PARTICIPATION IN EXHIBITIONS

MK Singh, Mukhtiar Singh, Sukhjinder Singh, Sanjay Kumar, Ajay Parmar, Arvind K Verma, VS Dhadwal and **Khushal Chand Katoch:** CSIR Technofest (Agri. Theme), Pragati Maidan, New Delhi, November 14-17, 2010.

MK Singh: Agrovision-2011, Reshambagh, Nagpur, March 4-7, 2011.

MK Singh: Flower Show, Rotary Bhawan, Palampur (HP), March 20, 2011.

Sanjay Kumar, Arvind K Verma and **Sukhjinder Singh**: State Level Holi Mela, March 17-20, 2010.

Sanjay Kumar: Flower Show, Kangra Ghati Greesham Utsav, Police Ground Dharmashala, Dharmshala, June 6, 2010

Sukhjinder Singh: Rural Technology Mela at National Institute of Rural Development (NIRD), Hyderabad, February 2-5, 2011.

Virendra Singh and **Sukhjinder Singh**: Seminar-cum-demonstration on MAPs at Pasighat, Arunachal Pradesh, September 17-18, 2010.

VISITORS

- Prof. AS Brar, Vice Chancellor, GNDU. Amritsar, April 09, 2010
- Dr. Ankit Walia, Canada, April 19, 2010

- Dr. Arabinda Mitra, Executive Director, Indo-US Science and Technology Forum (IUSSTF), May 7, 2010
- Dr. Ganesh Bagler, Max-Planck Institute for Molecular Genetics, Germany, May 18, 2010
- Prajapita Brahma Kumaries: Ishwariya Vishwa Vidyalaya, Palampur at IHBT, May 22, 2010
- Prof. Daya Singh Sandhu, Fulbright-Nehru Senior Research Scholar, GNDU, Amritsar, June 02, 2010
- Dr. Bal Ram Singh, Director, Botulinum Research Center, University of Massachusetts, Dartmouth, June 7, 2010
- Prof. Jean Kallerhoff, Associate Professor, Plant Biotechnology and Environmental Sciences, University Strasbourg, France, June 8, 2010
- Dr. Marina Barba, Director, Consiglio perla Ricercaela sperimentazione in Agricoltura, Centrodi Ricerca perla Patologia Vegetale, Rome, Italy, July 02, 2010
- Prof. ML Sharma, Panjab University, Chandigarh, September 3, 2010
- Dr. Ilio Montanari Jr., CPQBA-UNICAMP. Caixa Postal 6171. 13081-970 Campinas-SP, Brazil, September 24-25, 2010
- Mr. Nebiyu Birhane, Mr. Habtamu Kifle Kindie and Mr. Tadele Worku, Ethio Agri Ceft Plc, Addis Ababa, Ethiopia, September 24-25, 2010
- Dr. Marc Storms, FEI, The Netherlands, October 4-8, 2010
- Ms. Vandana Srivastava IDAS, Joint Secretary and Financial Adviser, October 25, 2010
- Dr. Joanne M Sharpe, Treasurer, International Association of Pteridologists, USA, November 10-12, 2010
- Christopher Roy Fraser-Jenkins, Royal Botanic Garden, Edinburgh, UK, November 10-12, 2010
- Annette Schölch, D-69121, Heidelberg, Langgewann 22, Germany, November 10-12, 2010
- Monica Palacio-Rios, Instituto de Ecología, A.C., Mexico, November 10-12, 2010
- Dr. Heike Schneider, Head, Research Division Transport Dynamics, Institute of Chemistry and Dynamics of the Geosphere, ICG-3,Phytosphere, Forschungszentrum Julich GmbH, Wilhelm-Johnen-Strabe, Julich, Germany, November 18-22, 2010 and March 11-23, 2011
- Dr. A Bagchi, Assistant Professor, University of Minnesota, USA, January 6, 2011
- Dr. Gagan Garg, Assistant Professor, IIT Mandi, H.P., January 25, 2011
- Prof S Ananthakrishnan, Adjunct Professor & Raja Ramanna Fellow, Electronic Science Deptt., Pune University, Ganeshkhind, Pune, January 26-29, 2011
- Dr. Lalji Singh, Bhatnagar Fellow and Former Director, CCMB Hyderabad, January 27-29, 2011
- Dr. Umesh K Sharma, Scientist, DST, India, January 28, 2011
- Dr. Vasudevan Ramesh, University of Manchester, UK, March 4, 2011
- Dr. Gerhard Kost, Professor, Department of Systematic Botany and Mycology, Head of the Herbarium Marburgense, Germany, March 28, 2011

GROUP VISITORS

Visitors	No. of visitors
Students from Educational Institutes	834
Farmers, NGOs and Govt. Officials	964
Total Visitors	**1798**

IMPORTANT EVENTS
(2010-2011)

National Technology Day

The institute celebrated the National Technology Day on May 11, 2010 and Prof. CL Khetrapal, Director, Centre of Biomedical Magnetic Resonance, Lucknow delivered the key note lecture on "The century of interdisciplinary research". Prof. Furqan Qamar, Vice Chancellor of the Central University, Himachal Pradesh was the Guest of Honour on this occasion. The function was presided over by Prof. PK Seth, Chief Executive Officer, Biotech Park, Lucknow.

IHBT Foundation Day

The institute celebrated its 28th Foundation Day on June 7, 2010. Dr. Rajesh S Gokhale, Director, IGIB, New Delhi delivered the Foundation Day lecture on "Synthetic genomics harnessing the power of genomics to solve global challenges". Presiding over the function, Prof. KL Chopra, Former Director, IIT Kharagpur addressed the august gathering on the topic entitled "Ethical Issues for Science & Technology".

Exposure Visit

Four days exposure visit from June 28–July 1, 2010 to Puspa Gujral Science City, Kapurthala, Chandigarh and Industrial Area, Baddi was organized for school children under DSIR sponsored project entitled "Technology and Innovation Management Center at IHBT, Palampur". Total 30 students along with science teachers from two schools i.e. Govt. Sr. Sec. School, Khalet and S. Shobha Singh Govt. High School, Andreta participated.

Students and teachers with IHBT staff members

हिन्दी दिवस

हिन्दी दिवस समारोह के अवसर पर कुलपति, सी. एस.के.हि.प्र. कृषि विश्वविद्यालय, पालमपुर मंगलवार दिनांक 14.09.2010 को संस्थान के सभागार में ''कृषि जैवविविधता प्रबंधन'' विषय पर संभाषण दिया।

Symposium

The institute organised symposium on "Prospects of Stevia" during September 24-25, 2010 with an objective to provide platform for researchers, academicians and industrialists to interact and discuss various issues related to development of this crop at national level.

Prof. VL Chopra inaugurated the symposium by lighting the lamp

Participants of the symposium

CSIR Foundation Day

CSIR Foundation Day was celebrated on September 26, 2010 and Prof. KK Bhutani, Director, NIPER Mohali delivered the foundation day lecture on "Drug Discovery and Development: Necessity in Indian Context".

On this occasion, Chief Guest Prof. Prem Kumar Dhumal, Hon'ble Chief Minister of Himachal Pradesh inaugurated the "Regulatory Research Centre". Prof.VL Chopra, Former Member, Planning Commission presided over the function

Technology adoption award to flower grower

Sh. Ranjit Singh, a progressive flower grower initiated cultivation of commercial cut flowers like lilium and chrysanthemum at VPO Chachian, Kangra (H.P.). In view of the income realized by the grower by adopting IHBT technologies, he was awarded "Technology Adoption Award-2009" by IHBT.

CSIR FOUNDATION DAY

Prof. Prem Kumar Dhumal, Hon'ble Chief Minister, as Chief Guest on CSIR Foundation Day

Release of technical bulletin on Rose

CSIR Technology Adoption Award to Sh. Ranjit Singh on Foundation Day

Inauguration of Regulatory Research Centre (RRC)

Prof. Prem Kumar Dhumal, Hon'ble Chief Minister, H.P. inaugurating the RRC on September 26, 2010

A view of RRC

Workshop

Workshop on Himalayan aromatic oils for fragrances and flovours was jointly organized by IHBT, Essential Oil Association of India, Delhi & Himalayan Phytochemical and Grower's Association (H.P.) on October 3, 2010.

Symposium-cum-Workshop

A Symposium-cum-workshop on Application of TEM in Advance Nanobiology and Life Sciences was jointly organized by IHBT, Icon Analytical and FEI The Netherlands on October 4-8, 2010.

International Symposium on Fern

International Symposium on Ferns and Fern Allies: Diversity, Bioprospection and Conservation was organized during November 10-12, 2010 with the sponsorship of Indian Fern Society, Chandigarh. The symposium was attended by 80 participants including foreign delegates.

Fernery at IHBT

A Fernery was inaugurated by Prof. SS Bir, FNA, FNASc, Professor Emeritus of Botany, Punjabi University, Patiala, Punjab on November 10, 2010.

Prof. SS Bir inaugurated the Fernery

A view of the Fernery

CSIR Technofest-2010
(November 14-27, 2010)

IHBT AT CSIR TECHNOFEST-2010

INSPIRE

Students, teachers and IHBT faculty

The institute organised INSPIRE Internship–2010 Science Camp from January 24-28, 2011, sponsored by the Department of Science and Technology, Govt. of India, New Delhi. The camp was attended by 143 students.

Motivation of meritorious students of H.P. towards S&T under INSPIRE programme

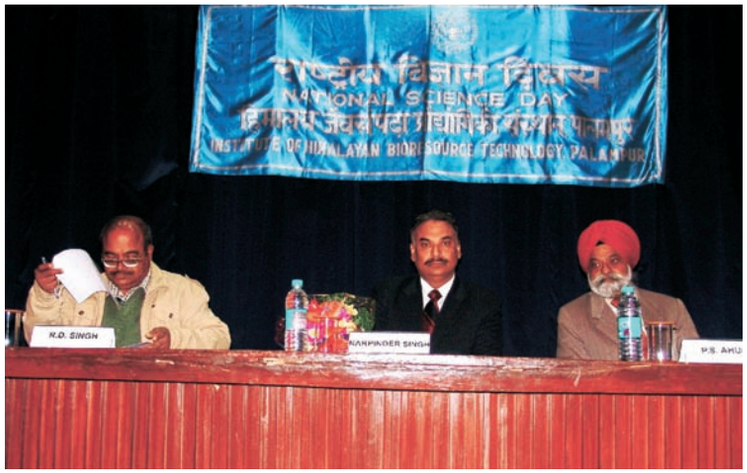
Shanti Swarup Bhatnagar Memorial (Indoor Zonal) Tournament

The institute and CSIR Sports Promotion Board, New Delhi organized SSBMT during February 10-12, 2011. A total of 170 sport persons from 10 CSIR laboratories participated in the badminton, bridge, carom, chess etc.

A view of games

National Science Day

The institute celebrated National Science Day by observing Open Day on February 28, 2011 and students from schools in and around Palampur were apprised of the scientific research activities of the institute. Professor Dr. Narpinder Singh of GNDU, Amritsar, Punjab delivered a talk on "Food in India: Security and Post-harvest Processing- A Challenge".



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

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

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

Prof. KN Ganesh
Director
Indian Institute of Science Education and Research, Sutarwadi, Pashan, Pune-411 021

ERMANENT INVITEE

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

MEMBER SECRETARY

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

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

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

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

Dr. Rajesh Jain
Joint Managing Director
Panacea Biotec Ltd., New Delhi-110 044

DIRECTOR

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

MANAGEMENT COUNCIL

CHAIRMAN

Dr. PS Ahuja
Director
CSIR-Institute of Himalayan Bioresource Technology
Palampur-H.P.

MEMBERS

Dr. Ram A Vishvakarma
Director
CSIR-Indian Institute of Integrative Medicine
Jammu-J&K

Dr. Bikram Singh
Scientist
CSIR-Institute of Himalayan Bioresource Technology, Palampur-H.P.

Dr. Sanjay Kumar
Scientist
CSIR-Institute of Himalayan Bioresource Technology, Palampur-H.P.

Dr. Aparna Maitra Pati
Scientist
CSIR-Institute of Himalayan Bioresource Technology, Palampur-H.P.

Dr. Sanjay Uniyal
Scientist
CSIR-Institute of Himalayan Bioresource Technology, Palampur-H.P.

Dr. Sudesh Yadav
Scientist
CSIR-Institute of Himalayan Bioresource Technology, Palampur-H.P.

Dr. Raja Ram
Principal Technical Officer
CSIR-Institute of Himalayan Bioresource Technology, Palampur-H.P.

Sh. Sunil Kumr
Finance & Accounts Officer
CSIR-Institute of Himalayan Bioresource Technology, Palampur-H.P.

MEMBER SECRETARY

Sh. RK Dhar
Controller of Administration
CSIR-Institute of Himalayan Bioresource Technology, Palampur-H.P.

IHBT Staff

Director
Dr. PS Ahuja

Scientist Gr. IV(6)
Dr. Anil Sood

Scientist Gr. IV(5)
Dr. RD Singh
Dr. Arvind Gulati
Dr. Bikram Singh
Dr. Sanjay Kumar
Dr. SAA Zaidi
Dr. AK Sinha
Dr. Virendra Singh
Dr. HP Singh
Dr. Madhu Sharma

Scientist Gr. IV(4)
Er. KK Singh
Sh. D Dhyani
Dr. Ashu Gulati
Dr. Brij Lal
Dr .RK Sud
Dr. Amita Bhattacharya
Dr. Aparna Maitra Pati
Er. GD Kiran Babu
Dr. Gopi Chand

Scientist Gr. IV(3)
Dr. SK Vats
Dr. Markandey Singh
Dr. V Shanmugam
Dr. Vipin Hallan
Dr. Sanjay K Uniyal
Dr. RK Sharma
Er. Amit Kumar
Dr. Y Sreenivasulu
Dr. Sudesh Kumar

Scientist Gr. IV(2)
Dr. Sanat Sujat Singh
Dr. Rakesh Kumar
Dr. Som Dutt
Dr. RC Kasana
Dr. Shashi Bhushan
Dr. Gopaljee Jha
Dr. Gireesh Nadda
Dr. Neeraj Kumar
Dr. Chandra Shekher Seth
Dr. Pralay Das
Dr .Vijai K Agnihotri
Dr. Amit Bafana
Dr. Ravi Shankar
Dr. Probir Kumar Pal
Dr. Subhash Chandra Yadav
Dr. Anil K Singh

Scientist Gr. IV(1)
Dr. Partha Ghosh
Er. Mohit Sharma
Dr. Ashok Kumar
Dr. Yogesh B Pakade

Principal Technical Officer
Sh. RKBindal
Dr. Raja Ram

Senior Technical Officer (3)
Sh. Mukhtiar Singh
Dr. RK Ogra
Sh. Om Prakash

Senior Technical Officer (2)
Dr. Kiran Kaul
Sh. RK Tandon
Sh. RS Shekhawat

Senior Technical Officer (1)
Sh. Sukhjinder Singh
Er. Sandeep Tripathi

Technical Officer
Sh.Vikrant Gautam
Sh. Ramdeen Prasad
Sh. JS Bisht
Sh. Rakesh Verma
Sh. Anil Kumar

Technical Assistant
Sh. Ramjee Lal Meena
Sh. Sanjay Kumar
Ms. Arti Katiyar
Sh. Jasbeer Singh
Sh. Mukesh Gautam
Sh. Sanjoy K Chanda
Sh. Om Parkash
Sh. Digvijay Singh
Sh. Prashanta Kumar Behera
Ms. Vijay Lata Pathania
Sh. Pabitra Gain
Ms. Meenakshi
Sh. Shiv Kumar
Sh. Arvind Kumar

Senior Technician (2)
Sh. Santosh Kumar
Sh. Gian Chand
Sh. Janak Singh
Sh. VS Dhadwal
Sh. Khushal Chand
Sh. Dhruv Kumar
Sh. Ajay Parmar
Sh. Karandeep
Sh. Om Prakash

Senior Technician (1)
Sh. Kewal Chand

Technician (2)
Sh. Bhushan Kumar
Sh. Harmesh Chand
Sh. Ramesh Kumar
Sh. Dhraub Kumar
Sh. Parveen Kumar
Sh. Kuldip Singh

Technician (1)
Sh. Sanjay Kumar
Sh. Avinash Chander Rana
Sh. Sandeep Sood
Sh. Ranjeet Singh
Sh. Ajay Kumar
Sh. Susheel Kumar
Sh. Surjeet Singh
Sh. Arvind Kant
Smt. Jasveer Kaur
Sh. Vikas Kumar

Lab Assistant
Sh. Naresh Kumar
Sh. Prem Parkash

Lab Attendant (1)
Sh. Baldev Singh
Sh. Shyam Lal
Ms. Rajni Devi Chettri
Sh. Yam Bahadur Chettri
Sh. Jagdish Chand
Sh. Uttam Chand
Sh. Balak Ram
Sh. Kuldip Singh
Sh. Balwant Raj

Sh. Girja Nand
Sh. Deepak Sood
Ms. Anupma Saini
Sh. Shamsher Singh

Controller of Administration
Sh. RK Dhar

Finance & Accounts Officer
Sh. Sunil Kumar

Private Secretary
Sh. JK Prashar

Section Officer (Gen.)
Sh. Rajesh Punia

Section Officer (S&P)
Sh. Ajay Sharma

Senior Translator
Sh. Sanjay Kumar

Senior Stenographer
Sh. Didar Singh

Assistant Gr. I (General)
Sh. DR Mishra
Sh. Shanti Kumar
Sh. Raj Kumar

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

Assistant Gr. I (S&P)
Smt. Vimla Devi

Security Assistant
Sh. Karan Singh Guleria

Assistant Gr. II (Gen.)
Sh. Parveen Singh
Ms. Santosh Kumari
Sh. Baldev
Sh. Kiran Kumar

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

Assistant Gr. II (S&P)
Sh. Rajeev Sood
Sh. Puneet Kumar

Assistant Gr.I II (Gen.)
Smt. Pooja Awasthi

Driver
Sh. Partap Chand
Sh. Braham Dass

Coupon Clerk
Sh. Anand Sharma

Cook
Sh. Oman Singh
Sh. Karan Singh

Peon
Sh. Thaman Bahadur
Sh. Nand Lal

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

Bearer
Sh. Bipan Kumar

Wash Boy
Sh. Shankar

Tea Maker
Sh. Bipan Gurang

Farash
Ms. Rujala Devi

Safaikarmchari
Ms. Krishna Devi

NEWLY JOINED

Scientific & Technical Staff

Scientist

Dr. Anil Kumar Singh	07.03.2011

Sr. Tech. Officer (1)

Dr. Avnesh Kumari	13.01.2011 (A/N)

Technical Officer

Sh. Vivesh Sood	21.01.2011
Sh. Vinayak S Madnalwar	21.02.2011
Sh. Mahesh Sukapaka	24.02.2011

Technical Assistant

Sh. Arvind Kumar Verma, Tech. Asstt. Gr.III(1)	09.07.2010

Administrative Staff

Stores & Purchase Officer

Sh. Surinder Kumar	27.12.2010

Section Officer

Sh. Inderjit Singh	22.11.2010

Executive Asstt

Sh. Vipin Kumar,	29.10.2010
Sh. Laxmi Narayan Pandey	20.12.2010

SUPERANNUATION

Sh. Brajinder Singh, Tech. Officer Gr. III(5)	31.12.2010

VOLUNTARY RETIREMENT SCHEME

Ms. Renu Sood, Sr. Stenographer	04.09.2010
Sh. Amar Singh, Helper	25.01.2011

TRANSFER

Sh. VK Julka, Stores & Purchase Officer to CSIR Complex, New Delhi	21.04.2010
Sh. Darshan Singh, Section Officer (F & A), IIIM, Jammu	21.04.2010
Sh. Devanand, Asstt.(Gen.) to NML Jamshedpur, Jharkhand	14.10.2010
Sh. Kailash Chand, Asstt. (S&P) to NISCAIR, Delhi	29.12.2011
Sh. Akhilesh Kumar, Asstt. (S&P) to AMPRI, Bhopal, MP	04.03.2011

RESIGNED

Dr. D K Tewary, Scientist Gr. IV(2)	04.05.2010
Dr. Vineeta Tripathi, Scientist Gr. IV(1)	17.06.2010
Dr. Manoj K Modi, Scientist Gr. IV(2)	03.09.2010
Sh. Vijay R Thakre, Tech. Officer	13.09.2010

Scientist Fellow
Dr. Amit Chawla
Dr. Shivani
Dr. Ganesh B Bagler

Principal Investigators
Dr. Alka Kumari
Dr. Jyoti Bhardwaj
Dr. Lakhmir Singh

CSIR-TWAS Fellow
Sh. Richard Chalo Mouki
(Post Graduate Fellow)

Senior Research Fellow
Sh. N Ajit Singh
Ms. Priyanka Sood
Ms. Rupali Mehta
Sh. Arun Kumar
Sh. Karan Acharya
Sh. Praveen Rahi
Sh. Vikas Jaitak
Sh. Pankaj Bhardwaj
Ms. Kiran Devi
Sh. Upendra Kumar Sharma
Ms. Tanuja Rana
Sh. Vikas
Ms. Nandini Sharma
Sh. Vikrant Jaryan
Ms. Bandna
Sh. Rakesh Kumar
Ms. Pushpinder Kaur
Ms. Abha Chaudhary
Ms. Devinder Kaur
Sh. Upendra Sharma
Sh. Vinay Kumar
Sh. Vineet Kumar
Ms. Archana Thakur
Ms. Naina Sharma
Ms. Yashika Walia
Ms. Karnika Thakur
Ms. Parul Gahlan
Ms. Reenu Kumari
Sh. Dharminder Sharma
Ms. Shammi Bhatti
Ms. Rupali Jandrotia
Sh. Vishal Kumar

Junior Research Fellow
Sh. Sewa Singh
Sh. Anish Kaachra
Sh. Ramdhan
Sh. Praveen Guleria
Ms. Amrina Shafi
Ms.Rimpy Diman
Sh. Arun Kumar Shil
Sh. Nitul Ranjan Guha
Sh. Yogesh Abaso Thopate
Ms. Pritu Pratibha
Sh. Sandeep Kumar
Ms. Mrigaya Mehra
Ms. Sushila Sharma
Ms. Shalu
Sh. Indu Barwal
Sh. Andhare Nitin Hauserao
Ms. Vandna Chawla (JRF-INSPIRE FELLOW)
Sh. Aditya Kulshreshtha

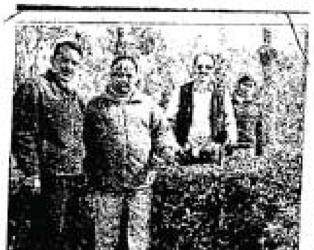
आईएचबीटी से लौटे छात्र सम्मानित

हिमाचल जैव संपदा प्रोद्यौगिकी संस्थान में संगोष्ठी का आयोजन

मधुमेह से लड़ेगा गुणकारक स्टीविया

आईएचबीटी में दो दिवसीय कार्यशाला शुरू

पांच दिवसीय अनुसंधान कार्यक्रम आयोजित



वैज्ञानिकों से प्रेरणा लें छात्र : डा. शर्मा

सीएसआईआर इटनीशिप कार्यक्रम शुरू

पालमपुर में फलों-फूलों के विषाणुओं पर मंथन

हिमालय जैव संपदा प्रौद्योगिकी संस्थान में दो दिवसीय संगोष्ठी शुरू

लाहौल घाटी में खुलेगा उच्च जीव विज्ञान केन्द्र

चाय की गुणवत्ता सुधार के उपाय बताए

50 चाय उत्पादकों ने लिया भाग

वैज्ञानिक तकनीकों पर मंथन

National workshop on CSIR technologies begins

प्रदेश के 54 पुष्प उत्पादकों ने आईएचबीटी कार्यशाला में लिया भाग

पुष्प विकास पर हुआ मंथन

स्टीविया की खेती की पर्याप्त संभावनाएं : पीएस आहूजा

पर्यावरण संरक्षण में सहायक है फ

सगंध तेल पौधों के अधिक दोहन से प्रजातियां खतरे में

'शोध करते रहें वैज्ञानिक'

आई.एच.बी.टी. में हिन्दी दिवस मनाया

Camp on research in science concludes

फूलों से लदेगा लाहुल-स्पीति

आईएचबीटी के विशेषज्ञों ने शीत मरुस्थल में नई फसलों की संभावनाएं तलाशीं

पर्यावरण संरक्षण में मदद करता है फर्न : प्रो. शर्मा

औषधि एवं सुगंध उत्पादन की दी जानकारी

15 हजार लगाकर कमाए 27 हजार