ISSN-0971-8842

वार्षिक प्रतिवेदन

Annual Report

2012-13

सी.एस.आई.आर.–हिमालय जैवसंपदा प्रौद्योगिकी संस्थान

पालमपुर– (हिमाचल प्रदेश) भारत

CSIR-Institute of Himalayan Bioresource Technology

Palampur, Himachal Pradesh, India

MISSION

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

Thrust Areas

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

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With Best Compliments from

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Director

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Director's desk.....

The overall ecology of research at CSIR-IHBT witnessed a qualitative shift and importantly was grounded to local realities. It has been an exciting journey from shaping the science at CSIR-IHBT to shaping the rural economy based on science done at CSIR-IHBT. I am once again fortunate to portray the important events of the first year of the XIIth plan i.e. 2012 – 2013.

The initiative at Ribling in Keylong further expanded our horizon in the Western Himalayan Region. Our activities were intensified with the opening of our formal office and construction of a road to the site. In addition to the establishment of *Hippophae* germplasm resource centre, a herbal garden is being developed. Further, our quest to decipher the mechanism that confers adaptive advantage and fitness to species at high altitudes paid dividends through our experiments with *Caragana jubata*. The three traits that confer this advantage are- i) quick acclimation capability, ii) role of chaperones in protection and iii) concomittent high growth and developmental activity. Importantly all the genes associated with these activities were identified, characterized and validated.

CSIR-IHBT consolidated its foray in food technology by launching snack products such as "Lauli Puff-Nutri Bar" and "Lauli Puff-Healthy Snack", a widely grown, underutilized non-cereal grain i.e. buckwheat. Extrusion products were also developed from apple pomace- an unutilized waste from apple processing industry. The Institute also developed fortified mango bars and puffed rice bars to cater to National Nutritional Programme.

In silco integrative network biology approach for therapeutic purpose identified Schinidt-Ruppin A-2 viral oncogene homolog (SRC) as a promising drug target for asthma with its role in respiratory mechanism. The functioning of our Regulatory Research Centre broadened the scope of our work on the use of products, biomolecules and nanoparticles by *in vitro* and *in vivo* experiments. Our chemical sciences group developed nanocatalyst, metal phthalocyanine based catalyst and ionic liquid mediated organic synthesis of bioactive molecules having anti-malarial and anti-diabetic activities. Galanthamine alkaloids from *Zephyranthes grandiflora* were characterized and profiled chemically. These compounds are important acetycholinesterase inhibitors used for the treatment of Alzheimer's disease. Our efforts also led to the development of an improved process for obtaining 90% pure steviol glycosides.

For the promotion of apple orchardists in J&K and HP, CSIR-IHBT extended its fungal and viral diagnostic kits for field evaluations. At the fundamental level, the transcriptome of the apple scab fungus was elucidated so as to establish the basis of infection and its control. Virus free root stock cultures of apple were also supplied to commercial tissue culture laboratories. Over expression of thaumatin like protein (*TLP*) gene from tea into potato exhibited tolerance to two important fungal pathogens i.e. charcoal rot and late blight. Interestingly, genome wide expression profiling

of NAC transcription factor family in potato provides a direction to breeding for stress tolerance in this important crop.

An intensified and sustained training schedule was implemented for floriculture and medicinal and aromatic plants to the farmers. CSIR-IHBT on its annual day releases "The Himalayan Wonder", a thornless 'bud sport', thereby adding grace to the beauty of roses. Our scientist also introduced a purple coloured chimera, "Himalayan Glory" from the cv "First Red".

In order to tackle the problem of forest fires during summers, CSIR-IHBT provided digitized fire maps of four forest divisions to the State Forest Department, HP. This service is being sought by other regions across the Himalayan zone. Our activities with NHPC on reclaiming of dumping sites concluded successfully and invoked interest for further interactions.

The year witnessed the development of AcSIR block having space for interphasing with farmers and industry under the Technology Innovation Management (TIM) programme.

Challenging qualitative achievements are possible only through active support of CSIR Headquarter and our funding agencies. The guidance of our Research Council and Management Council and its prioritization of the projects and development program proved invaluable. In the changing global S&T scenario and the emphasis of private participation in our latest S&T policy, team CSIR-IHBT braces itself to rise to the occasion.

Paramvir Singh Ahuja

निदेशक की कलम से.....

सीएसआईआर–हिमालय जैवसंपदा प्रौद्योगिकी संस्थान, पालमपुर ने एक बार पुनः समग्र अनुसंधान वातावरण में गुणवत्तायुक्त परिवर्तन देखा है और यह महत्वपूर्ण रूप से स्थानीय वास्तविकता के धरातल पर है। सीएसआईआर–आईएचबीटी में विज्ञान को एक सही दिशा देने से लेकर ग्रामीण आर्थिकी को अपने वैज्ञानिक शोध से एक अग्र दिशा देने तक एक बहुत ही रोमांचक यात्रा रही है। मैं एक बार पुनः सौभाग्यशाली हूँ कि मुझे 12वीं योजना के प्रथम वर्ष 2012–13 की महत्वपूर्ण उपलब्धियों को आपके समक्ष रखने का मौका मिला है।

केलांग के रिबलिंग में हमारे संस्थान की पहल से पश्चिमी हिमालय क्षेत्र के उच्च पर्वतीय जलवायु युक्त स्थानों में शोध व विकास को गति मिली है। लाहौल में हमारी गतिविधियों को गति देने एवं साकार करने के लिए एक कार्यालय खोल दिया गया है तथा इसके लिए एक संपर्क मार्ग का भी निर्माण किया गया। रिबंलिग क्षेत्र में हिपोफी जर्मप्लाज़म एकत्रण केन्द्र के साथ–साथ एक वानस्पतिक उद्यान भी तैयार किया जा रहा है। *केरागाना जुबाटा* पर हमारे परीक्षणों ने हमारी जिज्ञासा के गूढ़ क्रियाविधि को उच्च जलवायुयुक्त क्षेत्रों की प्रजातियों के अनुकूलन विशेषता और स्वस्थता की पुष्टि की है। तीन विशेषताएं जिनने इस श्रेष्ठता को पुष्ट किया है i) त्वरित अनुकूलन क्षमता ii) रक्षण में संरक्षक की भूमिका और iii) सहवर्ती उच्च वृद्धि और विकास गतिविधियां। इसमें सबसे महत्वपूर्ण यह है कि इन गतिविधियों में सहायक जीन्स की पहचान, लक्षणचित्रण और मानकीकरण कर लिया गया है।

लाहौल में बकव्हीट से 'लाहौली पफ' पर ध्यान केन्द्रित और निवेश करके सीएसआईआर–आई.एच.बी.टी. ने खाद्य प्रौद्योगिकी के क्षेत्र में अपने दावे को और मजबूत किया है। हमारे वैज्ञानिकों ने सेब के भुक्तशेष से सफलतापूर्वक उत्पाद विकसित किए हैं। संस्थान ने 'मेंगो बार' और 'पफ्ड राइस बार' को भी विकसित किया है जो कि राष्ट्रीय पोषण कार्यक्रम की जरुरतों को पूरा करने में सहायक होंगे।

नैदानिक दृष्टि से *इन सिलिको* समन्वियत नेटवर्क जीवविज्ञान विधि द्वारा सिनिट–रूपिन ए–2 वायरल ऑन्कोजीन होमोलॉग (SRC) को दमा के लिए संभावित औषधि के रूप में पहचान कर ली गई है। एक विकसित विधि द्वारा शुद्ध स्टेवियॉल ग्लाइकोसाइड्स (90%) का उत्पादन कर लिया गया है। हमारे विनियामक अनुसंधान केन्द्र के कार्य–कलापों की *इन–विट्रो* और *इन–विवो* परीक्षणों द्वारा हमारे उत्पादों, जैव अणुओं और सूक्ष्मकणों को विकसित करने में अग्रणी भूमिका निभायी। हमारे रसायन वैज्ञानिकों के समूह ने .मलेरियारोधी, मधुमेहरोधी और जैवसक्रिय अणुओं के लिए नेनो केटालिस्ट, मेटल पेथालोसिनिन आधारित उत्प्रेरण और आयोनिक लिक्विड मेडिएटिड आरगेनिक सिंथेसिज को विकसित कर लिया है। एल्जाइमर्स की रोक के लिए गलांथामिन अल्कालॉयड, महत्वपूर्ण एसिटीकोलीनेस्टरेज निरोधक को लक्षणचित्रित कर लिया गया है और *झेफाइरैंथिस ग्रैण्डीफ्लोरा* में रसायनिक प्रोफाइल कर लिया गया है। ये यौगिक महत्वपूर्ण एसिटीकोलीनेस्टरेज रोधी है जो कि एल्जाइमर रोग के निदान के लिए प्रयुक्त होते हैं।

जम्मू और कश्मीर एवं हिमाचल प्रदेश के सेब उत्पादकों को प्रोत्साहित करने के लिए संस्थान ने प्रक्षेत्र मूल्यांकन के लिए फफूंद और विषाणु नैदानिक किट प्रदान की है। मूलभूत स्तर पर सेब के स्कैब फफूंद के ट्रांसक्रिप्टोम को समझा है, ताकि संक्रमण के आधार को स्थापित और इसे नियंत्रित किया जा सके। सेब के विषाणु मुक्त मूल स्कंद संवर्धों को व्यावसायिक उतक संवर्धन प्रयोगशालाओं को प्रदान किए गया है। चाय से आलू में *टीएलपी* जीन के ओवर एक्सप्रेशन से चारकोल रॉट में सहनशीलता प्रदर्शित हुई और लेट ब्लाइट के रोग लक्षणों को अवरोधित कर दिया गया है। आलू में एनएसी टांसक्रिप्शन फैक्टर समूह में जिनोम वाइड एक्सप्रेशन प्रोफाइलिंग ने इस फसल में दबाव सहनशीलता हेतु संकरण के लिए दिशा को प्रदान की है।

किसानों के लिए पुष्प, औषधीय एवं सगंध पौधों के क्षेत्र में एक गहन और लगातार चलने वाले प्रशिक्षण कार्यक्रमों का वार्षिक कलैंडर तैयार किया गया है। सुन्दरता में चार चांद लगाने के लिए सीएसआईआर–आईएचबीटी ने अपने वार्षिक स्थापना दिवस के अवसर पर कांटा रहित गुलाब 'द हिमालयन वंडर' नामक प्रजाति को जारी किया है। हमारे वैज्ञानिकों ने 'फर्स्ट रेड' प्रजाति से परपल रंग के किमेरा को विकसित किया है, जिसे 'हिमालयन ग्लोरी' नाम दिया गया है।

सीएसआईआर–आईएचबीटी ने हिमाचल प्रदेश के 4 वन मण्डलों के डिजीटल वन अग्नि मानचित्र प्रदान किए हैं, ताकि क्षेत्र के अग्नि संभावित क्षेत्रों की पहचान की जा सके। इस प्रकार की सेवाएं हिमालय के अन्य क्षेत्रों से भी मांगी जा रही हैं। एनएचपीसी के साथ मलवाग्रस्त क्षेत्रों में पुनः हरियाली लाने की दिशा में हमारे प्रयासों को सराहा गया है और इसे आगे बढ़ाने में रुचि दिखाई जा रही है।

इस वर्ष वैज्ञानिक और नवोन्मेष अनुसंधान अकादमी के अकादमी ब्लाक को बनाया जा रहा है, जिसमें प्रौद्योगिकी नवोन्मेष प्रबन्धन के अन्तर्गत किसानों और उद्यमियों के लिए एक मंच होगा।

हमारी चुनौतीपूर्ण गुणवत्तायुक्त उपलब्धियां सीएसआईआर मुख्यालय और हमारे वित्तपोषित संस्थाओं के सक्रिय सहयोग के कारण ही संभव हो सकीं है। हमारी अनुसंधान परिषद और प्रबन्ध परिषद के मार्गदर्शन और इनकी परियोजनाओं और विकास गतिविधियों में प्राथमिकता हमारे लिए अमूल्य सिद्ध हुई हैं। वैश्विक स्तर पर बदलते विज्ञान और प्रौद्योगिकी परिदृश्य में हमारी विज्ञान और प्रौद्योगिकी नीति के अन्तर्गत निजी क्षेत्र की भागेदारी के महत्व को समझते हुए टीम सीएसआईआर–आईएचबीटी ने अपनी कमर कस ली है।

परमवीर सिंह अहलावत

(ijeohj flag vkgyko)

CHARACTERIZATION AND MANAGEMENT OF HIMALAYAN BIORESOURCES

FIELD SURVEY

Botanical surveys, inventorization, mapping and collection of plant materials were continued in the current year for introduction and conservation of plants. Consequently, 13 field surveys were conducted to different localities of Himachal Pradesh (HP) (**Table 1**).

Table 1 Details of the field survey during 2012-2013

Month	Areas surveyed	Objectives
April 2012	Holi and Nayagran, Chamba district	Floristic survey
April 2012	Mohal and Manali, Kullu district	Floristic survey
May 2012	Tiari, Deol, Holi and Kuarsi, Chamba district	Ecological and ethnobotanical studies
May 2012	Kangra, Shahpur and Trilokpur, Kangra district	Collection of ferns and fern allies
June 2012	Tandi and Gondla, Lahaul and Spiti district	Collection of ferns and fern allies
June 2012	Barot, Baragran, Panihartu and Plachak, Kangra district	Floristic survey
July 2012	Chamba, Holi, Yada and Jalsu, Chamba district	Ecological studies and floristic survey
July 2012	Gaggal, Shahpur and Trilokpur, Kangra district	Survey and collection of ferns
August 2012	Chamba, Kalel, Banjli and Rupin, Chamba district	Floristic and ethnobotanical survey
August 2012	Rajnagar, Bharmour, Hadsar, Dharol and Garola, Chamba district	Ecological studies and floristic survey
August 2012	Gwaltikar, Kangra district	Survey and mapping of ferns and fern allies
October 2012	Rakh, Khaniara and Dharamshala, Kangra district	Survey and mapping of ferns and fern allies
October 2012	Gaggal, Shahpur and Trilokpur, Kangra district	Survey and mapping of ferns and fern allies

Landuse/landcover mapping of Bilaspur district of HP

A landuse/landcover classification of Bilaspur district was carried out using LANDSAT TM satellite data (**Fig. 1a**) of February 5, 2010. The district was classified into 7 broad classes namely habitations, water bodies, barren land, scrub land, grassland, crop land and forest (**Fig. 1b**). The result showed that 29.8% geographical area of Bilaspur is under forest followed by scrub land (23.93%), grass land (16.98%), crop land (15.78%), water bodies (9.72%), barren land (2.86%) and habitation (0.8%).

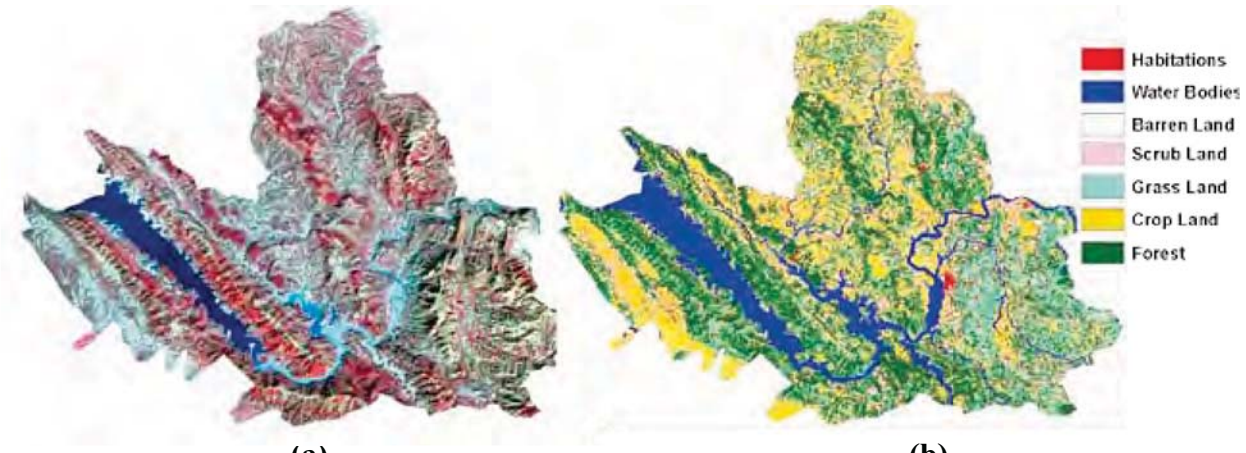


Fig. 1 (a) LANDSAT TM image (b) landuse/landcover map of Bilaspur

Preparation of digital forest fire maps

The digital fire maps of Dharamshala, Nurpur, Palampur and Chamba forest divisions of HP were prepared in Remote Sensing (RS) and Geographic Information System (GIS) environment. The maps provide information on frequency spread and locations of forest fire sites (**Fig. 2**).

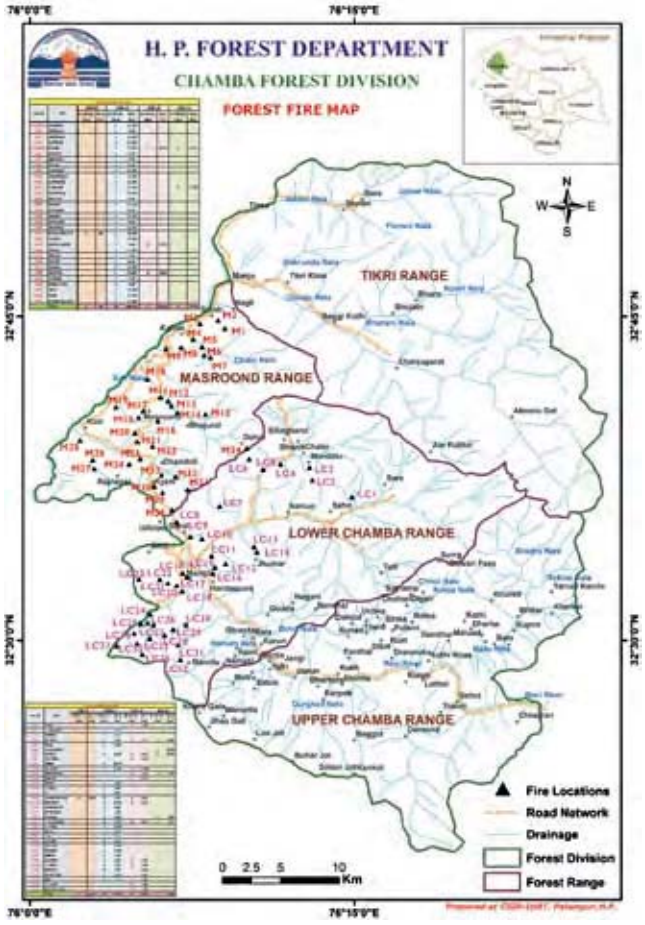


Fig. 2 Digital forest fire map of Chamba forest division of HP

Relocation of species

Concerns regarding the status of *Eremostachys superba* Royle ex Benth. (family Lamiaceae) in wild and its possible extermination are serious. The species was re-collected from HP after a gap of ~72 years. It was found growing in two localities only i.e., Kangra and Una districts with a total population of ~500 individuals.

Fig. 3 Inflorescence of *Eremostachys superba*

The species occurs in the sub-Himalayan tracts up to 1000 m, has a thick rootstock and a rosette of lyrate leaves that are produced in winter season. *E. superba* attains a height of more than a meter and the plant is hard to ignore when in full bloom (**Fig. 3**). The inflorescence is a spike with yellow, zygomorphic flowers.

Plant invasion studies

Invasion by exotic species is a prime threat to biodiversity. Information on their expanse is thus, pivotal for effective management of bioresources. Area of Occupancy (AOO) by *Sapium sebiferum* (L.) Roxb. - an invasive species in HP was worked out. Three methods namely Aerographic method (AM), Cartographic method (CM) and Cartographic method by conglomerates (CMC) were deployed and compared for the same. As expected, the three results varied amongst themselves, with AOO being 1127.58, 4046.00 and 734.12 sq km for AM, CM and CMC, respectively. Based on field surveys and observations, CMC was found to give the most reliable estimates (**Fig. 4**).

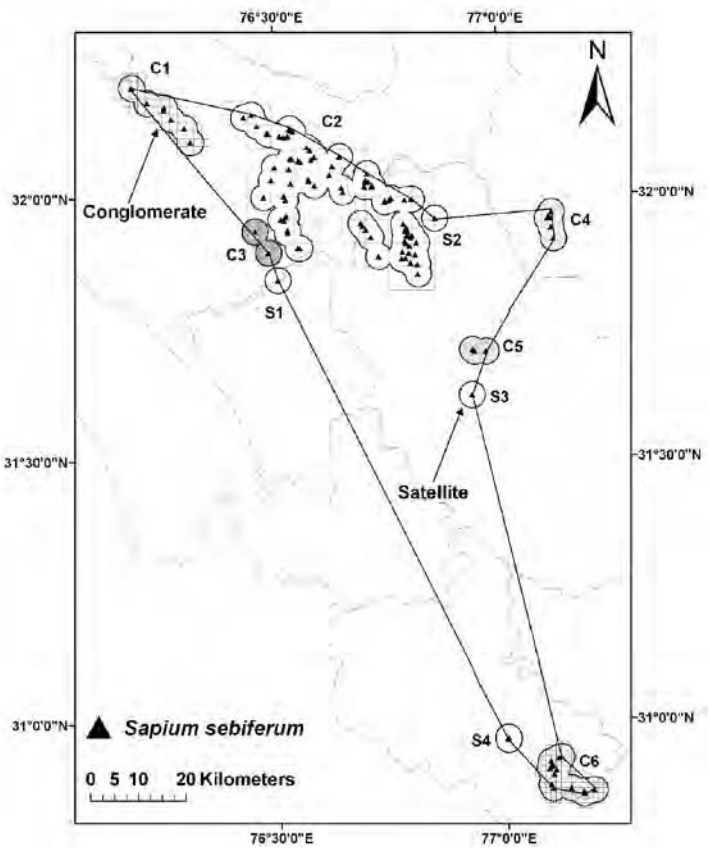


Fig. 4 Area of occupancy of *Sapium sebiferum* based on CMC

Trade in medicinal plants

Nagchhatri, scientifically referred to as *Trillium govanianum* Wall. ex. D. Don [Syn. *Trillidium govanianum* (D. Don) Kunth)] (family Melanthiaceae) is a native plant of Himalaya that usually prefers shady areas and is distributed from Pakistan to

Bhutan between the altitudinal ranges 2400-3800 m asl. During the last two years, unregulated collection and illegal trade of the species was observed. The plant is a small herb, about 15-25 cm in height and has a central inconspicuous purplish brown flower borne at the apex of the stem that is surrounded by leaves. Leaf is broadly ovate, acute, three in number with a conspicuous petiole (**Fig. 5**). It is reported to contain trillarin and is used in preparation of steroidal and sex hormones**.** The underground part i.e., the tuber of the plant is the key material for trade (**Fig. 6**).

Between Palachak and Panihartu locations in the Dhauladhar Wildlife Sanctuary, ~100 herb collectors were reported to be camping and rampantly extracting the remaining species. Interactions with herb collectors (n=10) revealed that plant is being sold at rates between ₹1000 to 1500/kg dry weight. A collector collects 8-10 kg of fresh tubers in a day. Average fresh weight of the tuber of a mature plant was found to be 3.13±1.57 g which reduced to 1.59±0.79 g (n=5) on drying.

Fig. 5 Nagchhatri flower growing in wild

Fig. 6 The collected material for trade

Ethnobotanical studies

Folk knowledge of the *Gaddi* community on utilization of plants was documented through interviews. Information on traditional uses of 45 plant species was recorded. *Hedychium* (swellings), *Rumex* (antidote), *Rabdosia* (stomachache), *Urtica* (internal injuries), *Asparagus* (dysentery), *Plantago* (itching), *Geranium* (boils & blisters), *Phytolcacca* (vegetable), *Berberis* (edible fruits), *Ficus* (edible fruits), and *Pteris* (to ward off evil spirit) are the commonly used plant species.

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

Field tours to the alpine regions in Dhauladhar mountain range (Kangra district) were conducted. *Cryptogramma stelleri* (Gmel.) Prantl. was collected from wet, rocky outcrops on the carpet of a thick moss layer. Commonly, the plant is referred to as slender rock brake, fragile rock brake and steller's rock brake. A creeping scaly rhizome, ephemeral nature of fronds, absence of hydathodes and tetrahederal-globose spores with verrucate and smooth exine are characters of this species. The plant is a new addition to the fern Flora of HP (**Fig. 7**).

Five different ferns *viz. Adiantum capillus-veneris, A.incisum, Pteridium* spp., *Equisetum* spp., *Diplazium maximum* and *D. esculentum* were extracted with MeOH:H_2O (80:20, v/v) and screened for pesticidal activities against insect and mite pests.

Fig. 7 *Cryptogramma stelleri* collected from the alpine regions of Kangra district is a new record for HP

Preparation of distribution maps of pteridophytes in Himachal Pradesh

Distribution maps of *Asplenium* spp. and *Diplazium* spp. of pteridophytes were prepared by collating co-ordinate information of their occurrence from published sources. This was then overlaid on the geographical map of HP using Geographic Information System (GIS) techniques (**Fig. 8**).

The maps depict the presence of 19 species of *Asplenium* (*A. adiantum-nigrum*, *A. aitchisonii*, *A. alternifolium*, *A. anogrammoides*, *A. ceterach*, *A. dalhousiae*, *A. ensiforme*, *A. fontanum*, *A. indicum*, *A. kukkonenii*, *A. laciniatum*, *A. pekinense*, *A. punjabense*, *A. septentrionale*, *A. tenuicaule*, *A. trichomanes*, *A. trichomanes-ramosum*, *A. unilaterale* and *A. yunnanense)* and 5 species of *Diplazium* (*D. esculentum*, *D. giganteum*, *D. longifolium*, *D. spectabile* and *D. squamigerum*) in HP.

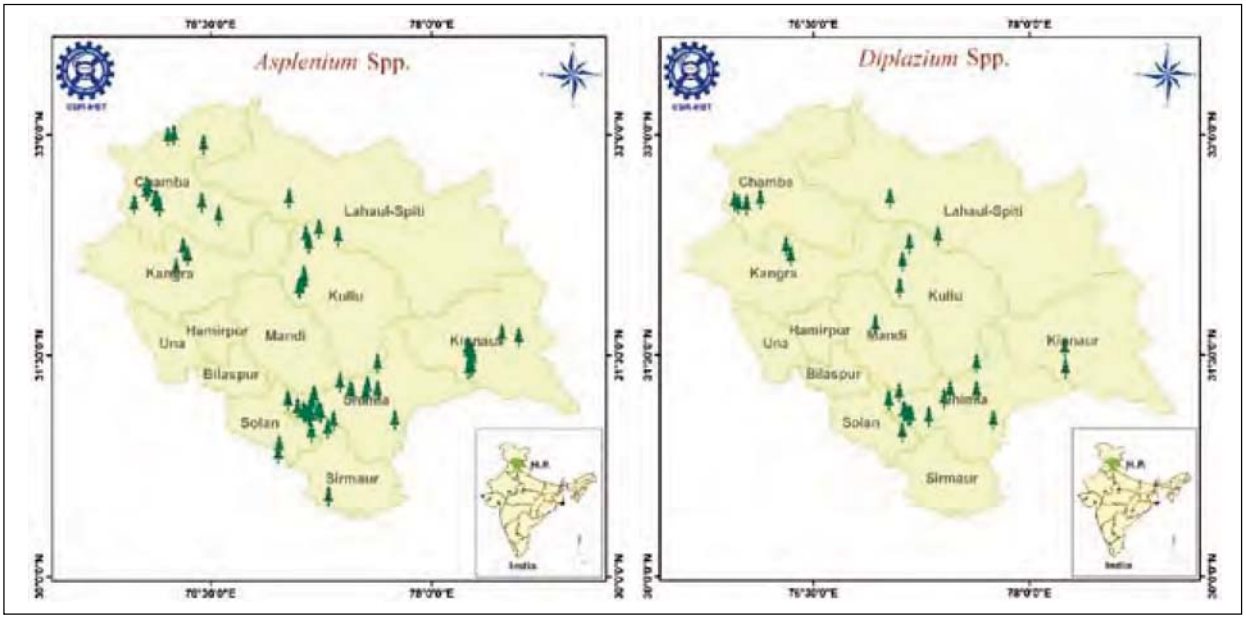


Fig. 8 Distribution of *Asplenium* spp. and *Diplazium* spp. in Himachal Pradesh

Introduction of unique ferns in CSIR-IHBT fernery

Fern species were successfully introduced in the CSIR-IHBT fernery. Of these, 5 are native of western Himalaya while the remaining are from South India (**Table 2**). Ferns introduced from HP are *Botrychium virigeanum*, *Asplenium cetrach, Dryopteris redacto-pinnata, Woodsia alpina* and *Polystichum nepalense. B. virigeanum* and *W. alpina* are under the critically endangered category of International Union for Conservation of Nature and Natural Resources (IUCN).

Table 2 Pteridophytes introduced in the CSIR-IHBT fernery

Species	Native place
Acrostichum aureum	South India
Dicranopteris linearis	North-East Himalaya & South India
Dryanaria quercifolia	Himalayan region & South India
Lygodium macrophyllum	South India
Psilotum nudum	Himalayan region & South India
Pteris confusa	South India
Pityrogramma calomelons	Himalayan region & South India
Pyrrossia adansons	Eastern Himalaya & South India
Nephrolepis variegated	South India

Enrichment of herbarium

Herbarium is a repository of processed and systematically arranged plant specimens for reference and research. About 700 voucher specimens (250 pteridophytes and 450 angiosperms) were collected from various localities of HP. Amongst the plants collected, 33 species are new addition to the herbarium of the Institute (PLP). These new additions are *Lysimachia chenopodioide* Watt ex Hook. f. (Primulaceae), *Euphorbia hispida* Boiss. (Euphorbiaceae), *Astragalus hosackioides* (Royle ex Benth.) Benth., *Rhynchosia himalensis* Benth. ex Baker, *Argyrolobium flaccidum* (Royle) Jaub. (Fabaceae), *Launaea secunda* (C. B. Clarke) Hook. f., *Hypochaeris radicata* Linn., *Onopordum acanthium L., Hieracium vulgatum* Fries, *Echinopus cornigerus* (Asteraceae), *Verbena officinalis* Linn. (Verbenaceae), *Cornus oblonga* Wall. ex Roxb. (Cornaceae), *Circaea cordata* Royle (Onagraceae), *Persea duthiei* (King ex Hook. f.) Kostermans (Lauraceae), *Scutellaria grossa* Wall. ex Benth. (Lamiaceae), *Ziziphus oxyphylla* Edgew (Rhamnaceae), *Quercus baloot* Griff. (Fagaceae), *Notholirion thomsonianum* (D. Don) Stapf (Liliaceae), *Arabis pterosperma* Edgew. (Brassicaceae), *Jasminum parkeri* Dunn (Oleaceae), *Actaea spicata* L. (Ranunculaceae), *Boschniakia himalaica* J. D. Hooker & Thomson (Orobanchaceae), *Thalictrum alpinum* Linn. (Ranunculaceae), *Allium victorialis* Linn. (Amaryllidaceae), *Onosma hypoleucum* M. Johnston (Boraginaceae), *Kickxia ramosissima* (Wall.) Janch. (Scrophulariaceae), *Boerhavia chinensis* (Linn.) Aschers & Schweinf. (Nyctaginaceae), *Cortusa brotheri* Pax ex Lipsky (Primulaceae), *Turgenia latifolia* (L.) Hoffm. (Apiaceae), *Lythrum salicaria* Linn. (Lythraceae), *Melissa axillaris* (Bentham) Bakhuizen f. (Lamiacae) and *Phryma leptostachya* Linn. (Phrymaceae).

HIGH ALTITUDE BIOLOGY AND CLIMATE CHANGE

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

The harsh and hostile environment of the cold desert in Spiti valley, district Lahaul and Spiti, HP is characterized by high radiation, temperature and extreme scarcity of water. The molecular mechanism that confers survival fitness to *C. jubata*, a perennial shrub of this region was deciphered and a dominance of genes encoding chaperones was found. Genes associated with growth and development (**Fig. 9**) and 11 late embryogenesis abundance protein genes (*LEA*s) belonging to six groups were observed at low temperature (LT). While some showed constitutive expression, others were over-expressed within 3 h of exposure to LT. The sustenance of the species in the harsh environment of high altitude was attributed to the simultaneous up-regulation of six groups of *LEAs*. Genes associated with growth and development such as *early light inducible protein*, *CjABA inducible*, *CjCDPK*, *indole acetic acid inducible protein*, *auxin responsive factor 7*, *MYB transcription factor 133*, *rare cold inducible 2A* (*CjRCI2A*), *cold acclimation responsive2*, *cold acclimation specific* and *mammalian cell entry family protein* were also regulated in response to LT. Expression of all these genes was observed in the species growing in its natural habitat of Kibber-Gete area of Lahaul & Spiti district, HP.

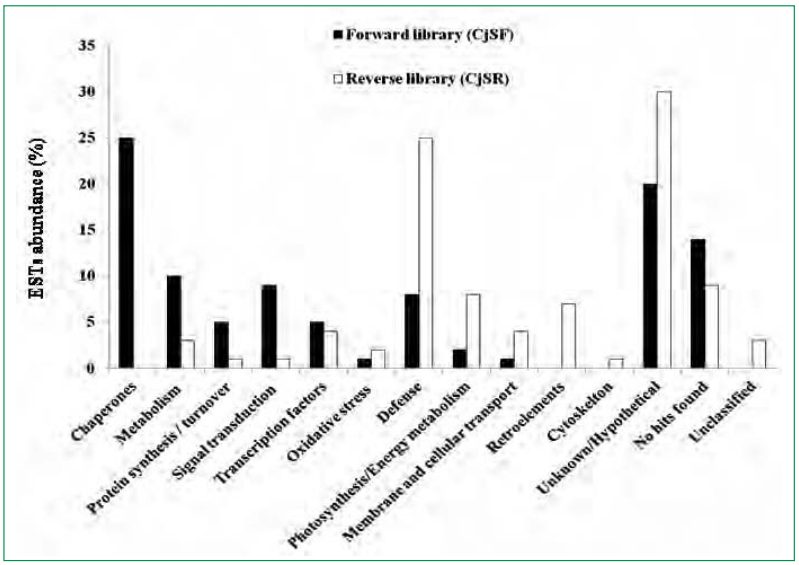


Fig. 9 Functional analyses of genes obtained from suppression subtractive hybridization library (SSHL) of leaf tissues of *Caragana jubata* exposed to 25°C (control, CO) and 4°C (low temperature, LT). Transcripts were functionally classified according to Munich Information Center for Protein Sequences (MIPS, http://www.helmholtz-muenchen.de/en/ibis)

Kinetics of gene expression suggested rapid adjustability of the *C. jubata* cellular machinery in less than an hour in its niche environment. This was reflected in LT mediated photosynthetic acclimatory response (**Fig. 10**). Probably such molecular and physiological plasticity allowed *C. jubata* to survive the harsh environment of Himalayan cold desert.

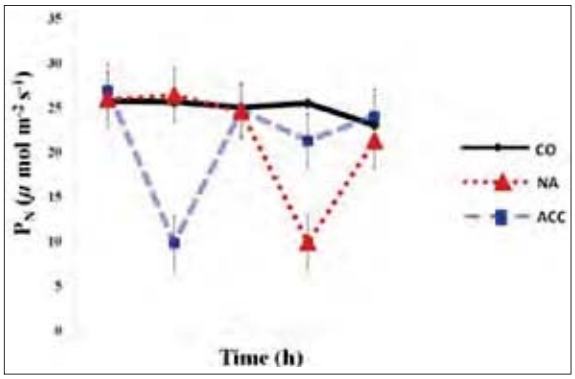


Fig. 10 Low temperature mediated photosynthetic acclimation in *C. jubata*. Net photosynthetic rates (P_N) in control exposed to 25°C throughout the experiment (CO), non-acclimated plants initially exposed to 25°C for 120 h followed by exposure to 4°C for 192 h, and then to 25°C (NA) and acclimated (ACC) plants exposed to a cycle of 4 and 25°C for 0, 72, 120 and 192 h, respectively

Isolation and characterization of microorganisms from the Indian trans-Himalayas

Work was initiated on diversity analysis and characterization of microorganisms in novel niches, including high altitude lakes and glaciers of the Indian trans-Himalaya region (**Fig. 11**). A total of 1540 bacteria, 66 actinomycetes and 150 fungi were isolated on different media and grouped into 60 morphotypes.

In continuation to earlier work, the bacterial morphotypes showed relatedness with *A. cryoconiti*, *A. nitroguajacolicus*, *A. citreus*, *A. scleromae*, *A. gandavensis*, *A. sulfonivorans*, *A. oxydans*, *Bacillus simplex*, *B. nanhaiensis*, *B. subtilis*, *Blastomonas natatoria*, *Chryseobacterium greenlandense*, *Enterobacter ludwigii*, *Erythromicrobium ramosum*, *Exiguobacterium indicum*, *Janthinobacterium lividum*, *Kocuria rosea*, *Leclercia adecarboxylata*, *Micrococcineae bacterium*, *Massilia timonae*, *Paenibacillus macquariensis*, *Pantoea eucrina*, *Phyllobacterium*

Fig. 11 Lakes and glaciers in the Indian trans-Himalayan regions of Lahaul and Spiti, HP

myrsinacearum, Pseudomonas cedrina, P. arsenicoxydans, *P. frederiksbergensis, P. mandelii*, *Rhodococcus cercidiphylli*, *Variovorax boronicumulans, Yersinia intermedia* and *Y. aldovae*, and the morphotypes of actinomycetes showed relatedness with *Streptomyces michiganensis, S. cirratus, S. luridiscabiei, S. xanthochromogenes*, and *S. subrutilus* based on 16S rRNA gene sequencing. The fungal morphotypes showed highest identity with *Aspergillus niger, Aspergillus* sp., *Cadophora* sp., *Coniothyrium* sp., *Chaetomium* sp., *Fusarium solani, Fusarium* sp., *Geomyces* sp., *G. vinaceus, Penicillium dipodomyicola, P. vinaceum,* and *Xylaria* sp. based on ITS region sequencing (**Table 3**).

Table 3 BLASTn search results of the microorganisms from lakes and glaciers of the Indian trans-Himalayan region of Lahaul and Spiti, HP

Bacteria			
Isolate	**Most closely related species**	**Isolate**	**Most closely related species**
IHB B 10167	*Pseudomonas cedrina* subsp. Cedrina strain CFML 96-198	IHB B 6315	*Streptomyces subrutilus* strain DSM 40445
IHB B 10144	*Leclercia adecarboxylata* GTC 1267(T)	IHB B 10205	*Streptomyces cirratus* strain NRRL B-3250
IHB B 10223	*Yersinia intermedia* ATCC 29909(T)	IHB B 10281	*Arthrobacter citreus* strain DSM 20133
IHB B 10209	*Enterobacter ludwigii* DSM 16688(T)	IHB B 10392	*Pseudomonas mandelii* strain CIP 105273
IHB B 10103	*Pseudomonas frederiksbergensis* strain JAJ28 98	IHB B 10118	*Kocuria rosea*
IHB B 10104	*Arthrobacter nitroguajacolicus* G2-1(T)	IHB B 10090	*Exiguobacterium indicum* HHS31(T)
IHB B 10127	*Arthrobacter scleromae* YH-2001(T)	IHB B 10118	*Kocuria rosea* DSM 20447(T)
IHB B 10170	*Arthrobacter sulfonivorans*	IHB B 10380	*Paenibacillus macquariensis* subsp. *macquariensis* NCTC 10419(T)
IHB B 10102	*Arthrobacter oxydans* DSM20119(T)	IHB B 10403	*Arthrobacter cryoconiti* Cr6-08(T)
IHB B 10140	*Arthrobacter scleromae* YH-2001(T)	IHB B 10410	*Rhodococcus cercidiphylli* YIM 65003(T)
IHB B 10156	*Pseudomonas cedrina* subsp. *cedrina* CFML 96-198(T)	IHB B 6464	*Janthinobacterium lividum* DSM 1522(T)
IHB B 10156	*Pseudomonas cedrina* subsp. *cedrina* CFML 96-198(T)	IHB B 6474	*Pseudomonas arsenicoxydans* VC-1(T)
IHB B 10172	*Pseudomonas cedrina* subsp. *cedrina* CFML 96-198(T)	IHB B 6491	*Yersinia aldovae* ATCC 35236(T)
IHB B 10204	*Streptomyces michiganensis* NBRC 12797(T)	IHB B 10370	*Phyllobacterium myrsinacearum* IAM 13584(T)
IHB B 10215	*Variovorax boronicumulans* BAM-48(T)	IHB B 10397	*Bacillus nanhaiensis* JSM 082006
IHB B 10292	*Bacillus simplex* NBRC 15720(T)	IHB B 10017	*Janthinobacterium lividum* DSM 1522(T)
IHB B 10173	*Pseudomonas cedrina* subsp. *cedrina* CFML 96-198(T)	IHB B 10086	*Pantoea eucrina* LMG 2781(T)
IHB B 10290	*Bacillus simplex* NBRC 15720(T)	IHB B 9110	*Micrococcineae bacterium*
IHB B 10201	*Bacillus subtilis* subsp. *inaquosorum* BGSC 3A28(T)	IHB B 9353	*Erythromicrobium ramosum*

Bacteria			
Isolate	**Most closely related species**	**Isolate**	**Most closely related species**
IHB B 10212	*Chryseobacterium greenlandense* UMB34(T)	IHB B 9354	*Erythromicrobium ramosum*
IHB B 9528	*Pseudomonas arsenicoxydans*	IHB B 9355	*Blastomonas natatoria*
IHB B 9529	*Pseudomonas jessenii*	IHB B 9526	*Arthrobacter gandavensis*
IHB B 9530	*Exiguobacterium sibiricum*	IHB B 9527	*Massilia timonae*
Actinomycetes			
IHB B 10181	*Streptomyces cirratus* strain NRRL B-3250	IHB B 10203	*Streptomyces xanthochromogenes* strain NRRL B-5410
IHB B 10154	*Streptomyces luridiscabiei* strain S63	IHB B 10213	*Streptomyces subrutilus* strain DSM 40445
IHB B 10192	*Streptomyces cirratus* strain NRRL B-3250	IHB B 10319	*Streptomyces cirratus* strain NRRL B-3250
IHB B 10202	*Streptomyces cirratus* strain NRRL B-3250		
Fungi			
IHB F 2431	*Cadophora* sp. REF041	IHB F 2409	*Coniothyrium* sp. CBMAI 1031
IHB F 2401	*Aspergillus niger* isolate F7-02	IHB F 2411	*Fusarium solani*
IHB F 2405	*Penicillium vinaceum* isolate 533	IHB F 2406	*Xylaria* sp. XF10
IHB F 2428	*Fusarium* sp. C4	IHB F 2432	*Cadophora* sp. REF034
IHB F 2422	*Aspergillus* sp. BMP3039	IHB F 2413	*Chaetomium* sp. DoF12
IHB F 2412	*Penicillium dipodomyicola* strain ACBF	IHB F 2430	*Geomyces vinaceus*

Screening of microorganisms from the Indian trans-Himalayas for antimicrobial activity

Six hundred thirty cultures were raised from lake sediments and glacier soils of Lahaul and Spiti valley. Of these, 82 cultures showed antimicrobial activity against one or more test organisms. Activities of 30 cultures against *Bacillus subtilis* MTCC 121, 18 cultures against *E. coli* MTCC 739, 62 cultures against *Micrococcus luteus* MTCC 2470, 5 cultures against *Pseudomonas aeruginosa* MTCC 2453, 42 cultures against *Staphylococcus aureus* MTCC 96, 22 cultures against *Staphylococcus aureus* MLS 16 MTCC 2940, 15 cultures against *Raoultella planticola* MTCC 530, 11 cultures against *Staphylococcus aureus* (MRSA) ATCC 43300, and 7 cultures against *Klebsiella pneumoniae* ATCC 43816 were also observed.

The bacterial cultures showing antimicrobial activity having relatedness with *Arthrobacter citreus*, *A. nitroguajacolicus, A. oryzae*, *Bacillus mycoides*, *B. cereus*, *B. endophyticus*, *B. licheniformis*, *B. mycoides*, *B. subtilis*, *Ewingella americana*, *Pseudomonas cedrina*, *P. frederiksbergensis*, *P. orientalis* and *Serratia proteamaculans*. The actinomycetes cultures with antimicrobial activity showed relatedness with *Streptomyces cirratus*, and the fungal cultures with antimicrobial activity showed relatedness with *Aspergillus niger*, *Chaetomium globosum* and *Penicillium dipodomyicola* (**Fig. 12**).

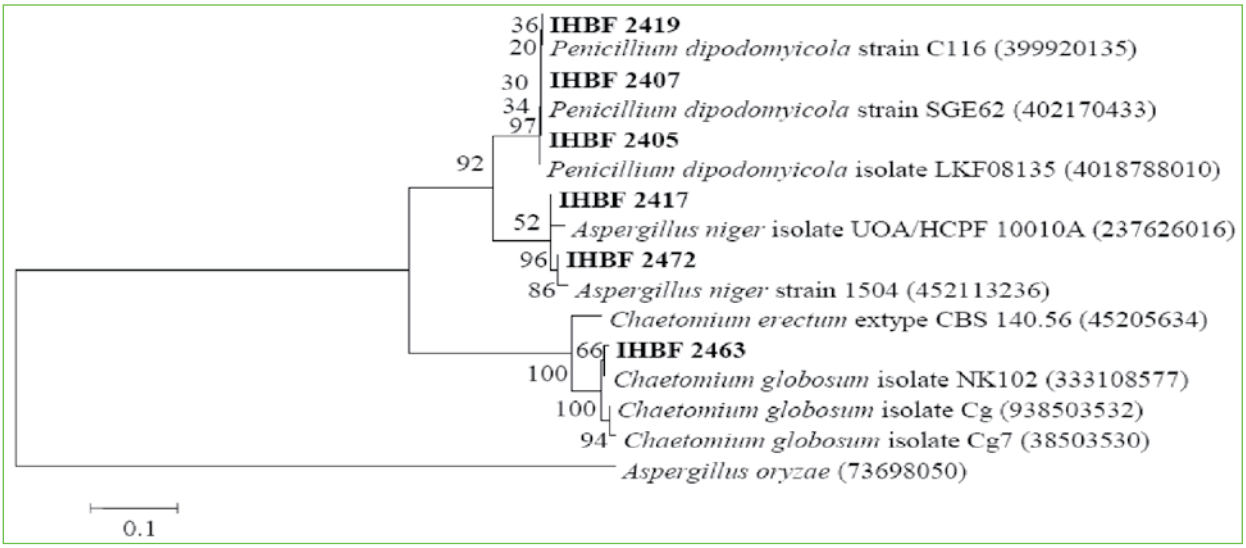


Fig. 12 Phylogenetic tree of fungal-isolates cultured from lake sediments and glacier soils.

Effects of elevated CO_2 and temperature on growth and biomass production of *Trifolium repens* and *Rumex nepalensis*

An understanding of the ongoing global climate change is required for its mitigation and for future crop production. Thus, the impact of the changes in atmospheric CO_2 and global warming due to elevated CO_2 and temperature on *T. repens* and *R. nepalensis* was studied using Free Air CO_2 Enrichment ring (FACE) and Free Air Temperature Enrichment (FATE). Pot culture experiment was conducted by growing *T. repens* and *R. nepalensis* under non limiting water condition. Total dry biomass of *T. repens* at FACE was significantly higher than FATE. In *R. nepalensis*, total dry biomass was higher in FATE up to 90 days after sowing as compared to FACE and ambient conditions. However, at maturity the biomass of *R. nepalensis* was higher under ambient conditions as compared to FACE and FATE (**Fig. 13**).

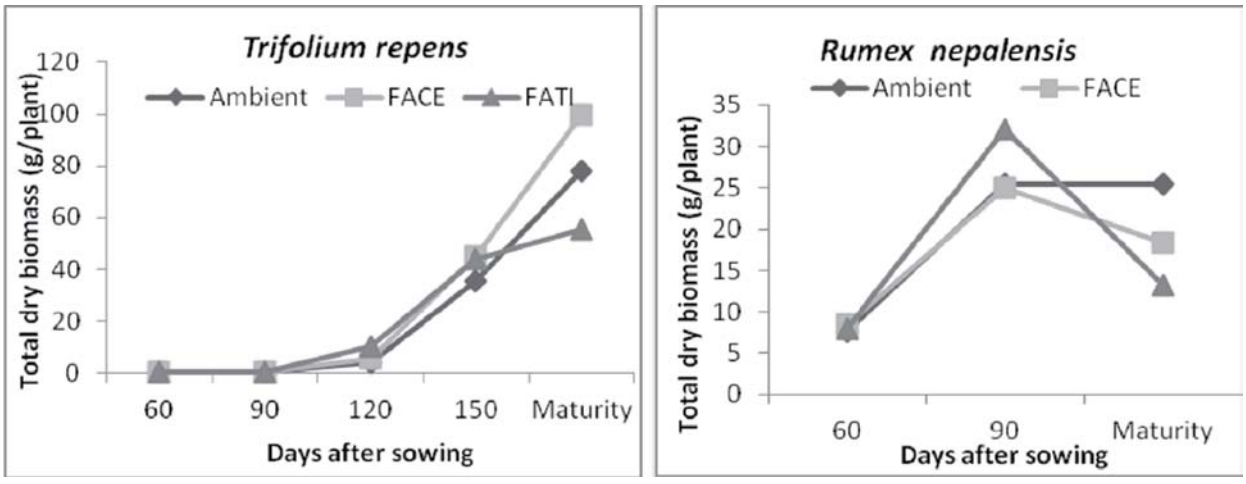


Fig. 13 Effect of elevated CO_2 and temperature on total dry biomass.

In another study, the insect pests *viz.*, aphid in *Valeriana jatamansi; Spodoptera litura* in *Trifolium repens* and blue beetle in *Rumex* sp. were reported under FACE (Free Air Carbon Dioxide Enrichment) and FATE (Free Air Temperature Enrichment) facilities. The aphids caused damage to the leaves and flowers of *V. jatamansi* by sucking the plant sap, whereas, the plants of *T. repens* and *Rumex* sp. were defoliated by *S. litura* and blue beetle.

Plant diversity: Studying adaptation biology and understanding/exploiting medicinally important plants for useful bioactives

Permanent monitoring plots were set up in Lahaul & Spiti with two at Pin Valley National Park and one at Ribling peak area (**Table 4**).

Table 4 Characteristics of the established PMP

Plot No.	Locality	Forest type	Dominant species	Altitude (m)	Aspect
1	Serun, Pin valley (1 ha)	Dry alpine scrub	*Arnebia euchroma*	3962	West
2	Sumna, Pin valley (1 ha)	Dry alpine scrub	*A. euchroma, Ephedra gerardiana Caragana* sp.	4224	East
3	Ribling peak (0.1 ha)	Alpine meadow	*Saussurea* and *Rhodiola* spp.	4500	South West

The densities of selected species (per m^2) and the diversity indices were worked out (**Table 5**). The chemical characteristics of the top layer of soils sampled from these plots were also evaluated (**Table 6**).

Table 5 Density and diversity of vegetation in the permanent plots at Pin valley

Sl. No.	Species	Serun	Sumna
1	*Caragana jubata*	227	160
2	*Ephedra gerardiana*	880	14
3	*Lonicera* spp.	253	-
4	*Rosa* spp.	-	1627
5	*Arnebia euchroma*	0.5	0.03
6	*Bupleurum longicaule*	0.1	-
7	*Pleurospermum* sp.	0.23	-
8	*Selinum candollii*	-	0.1
Total	**Species Richness**	**6**	**5**
Shrubs	Shannon's diversity index **H´**	**1.23**	**0.72**
Herbs	Shannon's diversity index **H´**	**2.39**	**1.69**

Table 6 Soil characteristics of the two sites in Pin valley

Plot	pH	Electrical conductivity (milli mhos/cm)	Sand (%)	Silt (%)	Clay (%)	Available nitrogen (%)	Total nitrogen (%)	Total carbon (%)
1	7.36 ± 1.18	0.182 ± 0.17	86.9 ± 1.85	2.77 ± 1.08	10.33 ± 2.31	0.01 ± 0.00	0.31 ± 0.102	1.35 ± 1.17
2	6.53 ± 0.47	0.08 ± 0.04	82.7 ± 1	7.97 ± 1.16	9.33 ± 0.58	0.038 ± 0.00	0.29 ± 0.02	1.08 ± 0.13

Vegetation and land cover classification of Landsat TM satellite images of Pin Valley National Park and Rupi-Bhabha Wild Life Sanctuary was performed.

Establishment of germplasm resource centre (Funded by Department of Biotechnology, Govt. of India)

In order to raise characterized germplasm from different regions of the country, a national level repository of *Hippophae* was established in 2 ha area at Churbhut Phat (32°33'58" N latitude 76°58'21"E longitude and 3263 m asl altitude) near Marbal, Malang and Baring villages of Tandi panchayat, Tehsil Keylong, Distt. Lahaul & Spiti (HP) (**Table 7**). A descriptor database of the morphologically and chemically characterized germplasm was developed for the organization and sustainable utilization of the germplasm resources.

Table 7. Accessions available at Germplasm Resource Centre

Institute	No. of characterized germplasm	No. of germplasm received	No. of germplasm in nursery	No. of germplasm plantation in field
CSKHPKV, Palampur	188	160	-	159
Gauhati University	154	60	12	-
GB Pant University Campus Ranichauri	146	77	-	-
Jammu University	238	119	121	-
TERI-NE	96	16	-	-
Total	746	442	133	143

REMEDIATION OF ENVIRONMENTAL PROBLEMS

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

The earlier work on revegetation of dumping sites was continued in the current year. The selected 10 dumping sites of NHPC are located in three valleys *viz*., Manikaran (DS-01, DS-02 and DS-03), Garsa (DS-06) and Sainj (DS-08, DS-09, DS-12, DS-13a & -13b, DS-14L & -14U, DS-16) of Kullu district, HP. The elevation of the sites ranges from 1403 m to 2221 m asl. The sites vary in terms of aspect, slope (gradient) and area. Owing to the steep slope of the dumping sites, a network of retaining walls made of stacked stone-filled gabions tied together with mild steel wire-net was made by NHPC throughout the dumping sites for their stabilization. Except DS-12 and DS-13b, all the sites were divided into several grids. Then the medium comprising of forest soil or garden soil, well decomposed compost or manure and peat moss was filled into gunny bags and used for planting.

Considering the agro-climatic conditions of the dumping sites, 11 tree species were selected for plantation along with shrubs and herbs for under canopy growth. Mainly, *Aesculus indica*, *Ailanthus*

excelsa, Alnus nepalensis, Pinus wallichiana, Cedrus deodara, Populus nigra, Robinia pseudoacacia, Salix tetrasperma, Punica granatum, *Quercus leucotrichophora* and bamboo sp. were selected. Trees were planted during spring (March- April) and rains (July- September). A total of 14,370 tree saplings were planted in all the 10 dumping sites. Seeds of *Berberis lycium,* a shrub species, and herbs namely, *Rumex hastatus, R. nepalensis, Tagetes minuta, Trifolium alexandrinum* and *Plantago ovata* were also sown in natural sites. Pellet form of seeds were also used to restore the under-canopy flora (**Fig. 14**). A consortium of selected plant growth promoting rhizo-bacteria (PGPR) formulated by the Institute was also applied at the collar level of the tree saplings in field or in the polybags at nursery stage. About 1 year after planting, observations were recorded on the rate of survival or establishment of the saplings at each dumping site. The rate of survival ranged from 69.2% (DS-01) to 96.6% (DS-13b). The average survival rate was 85.4%. The height of the planted trees was recorded at 1 year interval after the date of planting.

Fig. 14 Dumping sites before (left) and after greening (right)

Prospecting of bioactive molecules in pteridophytes for metal loaded industrial wastes and their metabolic adaptations (Funded by Department of Science and Technology, Govt. of India under WOS-A Scheme)

Survey and collection of ferns and fern-allies growing in fly ash (FA) contaminated areas of National Thermal Power Corporation (NTPC) units of Kanti, Muzaffarpur, Kahalgaon and Bhagalpur, Bihar were continued and done thrice in this year to know the seasonal variation among fern diversity. Various fern species like *Pteris vittata* L., *Thelypteris dentata* (Forssk.) E.P. St. John, *Diplazium esculentum* (Retz.) Sw, *Ampelopteris prolifera* (Retz.) Copel. and *Adiantum capillus-veneris* L. were found growing luxuriantly. The collected plant specimens were processed for herbarium. Spores were stored for raising the equal aged ferns in laboratory for further biochemical studies.

During this year, studies were also conducted to assess the feasibility of the fern, *Thelypteris dentata* for revegetation of FA landfills. In this context, pot experiments were designed with three FA amendments like 100% garden soil (GS) without FA, 50% FA+50% GS and 100% FA without GS. Three month old plants of *T. dentata* were introduced in these pots. After 30 days treatment, metal uptake by *T. dentata* was analyzed and found significantly higher in ferns growing at 100% FA (**Fig. 15A**). The impact of metal accumulation on biomass (**Fig. 15B**), photosynthetic pigments (**Fig. 15C**), melanoaldehyde (MDA) and superoxide dismutase (SOD) (**Fig. 15D**) were determined in *T. dentata* grown in different ratios of FA amended with GS after

30 days of treatment. The experimental results revealed tolerance of this fern against FA toxicity. Slight decrease in biomass and Chlorophyll (Chl. a and b) (**Fig.15 B & C**) at 100 % FA was recorded. This indicated an internal defense mechanism against the toxicity of heavy metals of FA. There was a significant increase in carotenoids, MDA and SOD content in the fronds of *T. dentata* at FA as compared to control on 100% GS. (**Fig. 15 C & D**). *T. dentata* has the potential to be used in the revegetation /ecorestoration of FA landfills.

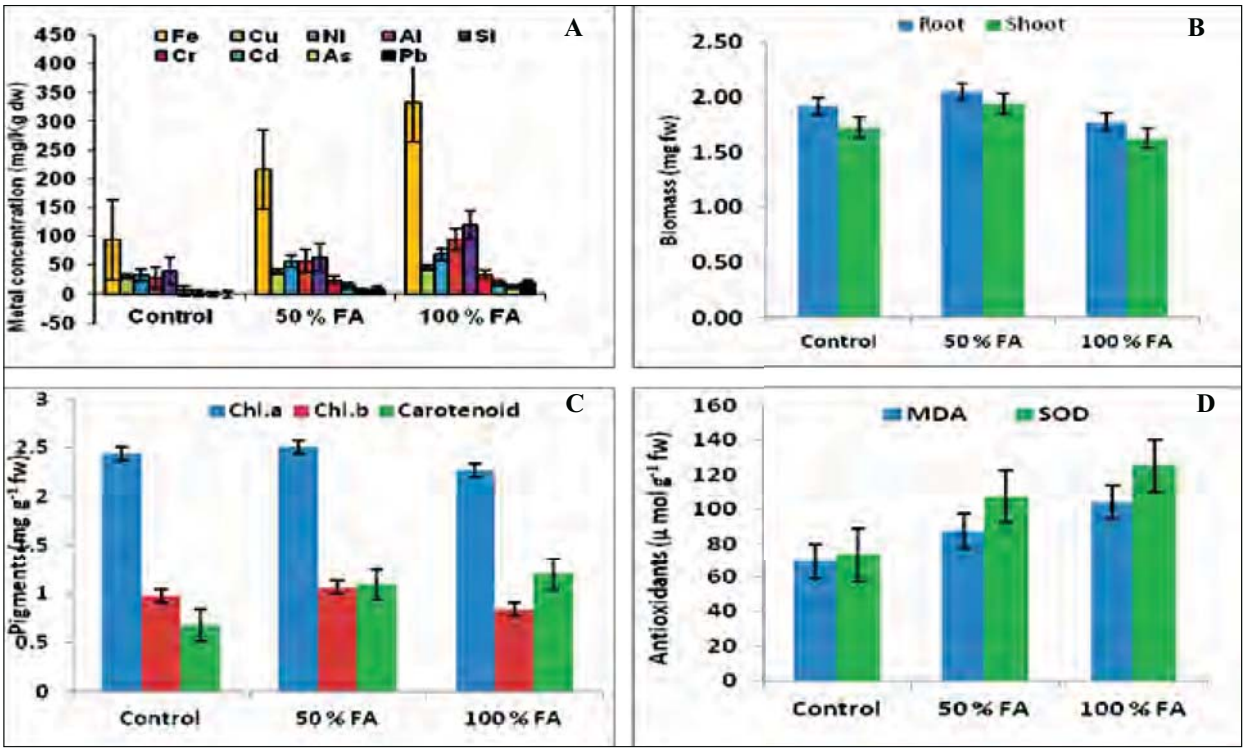


Fig. 15 (A) Metal accumulation in *Thelypteris dentata* at different FA amendments after 30 d (B) biomass, (C) photosynthetic pigments (D) antioxidants (MDA and SOD content)

Adsorbent for removal of heavy metals from water

The heavy metal contamination in groundwater is matter of global concern in developing countries. This heavy metal pollution is mainly due to various human activities and rapid industrialization. Numerous methods including precipitation, ion exchange, membrane process and different electrolytic methods are generally used for the removal and recovery of metals from water. Among these, the adsorption of metal ions onto insoluble compound as adsorbent is the most effective method. Although activated carbon, charcoal and resin are used as heavy metal adsorbents, they are expensive and produce large amounts of sludge leading to incomplete removal of metals. To overcome the drawback associated with commercial adsorbent, a low cost adsorbent material was developed using industrial waste i.e., apple pomace for removal of metals from water. The characterization of the adsorbent was carried out by FTIR, SEM, BET surface area (0.7129 m^2/g) and particle size (220 d.nm) analyzer (**Fig. 16**). Detail batch adsorption, kinetics, isotherm (q_{max}=16.39 mg/g) and thermodynamic studies were conducted to compute various adsorption parameters for this material. Regeneration protocol was also tested to reuse the saturated adsorbent by multiple recycles.

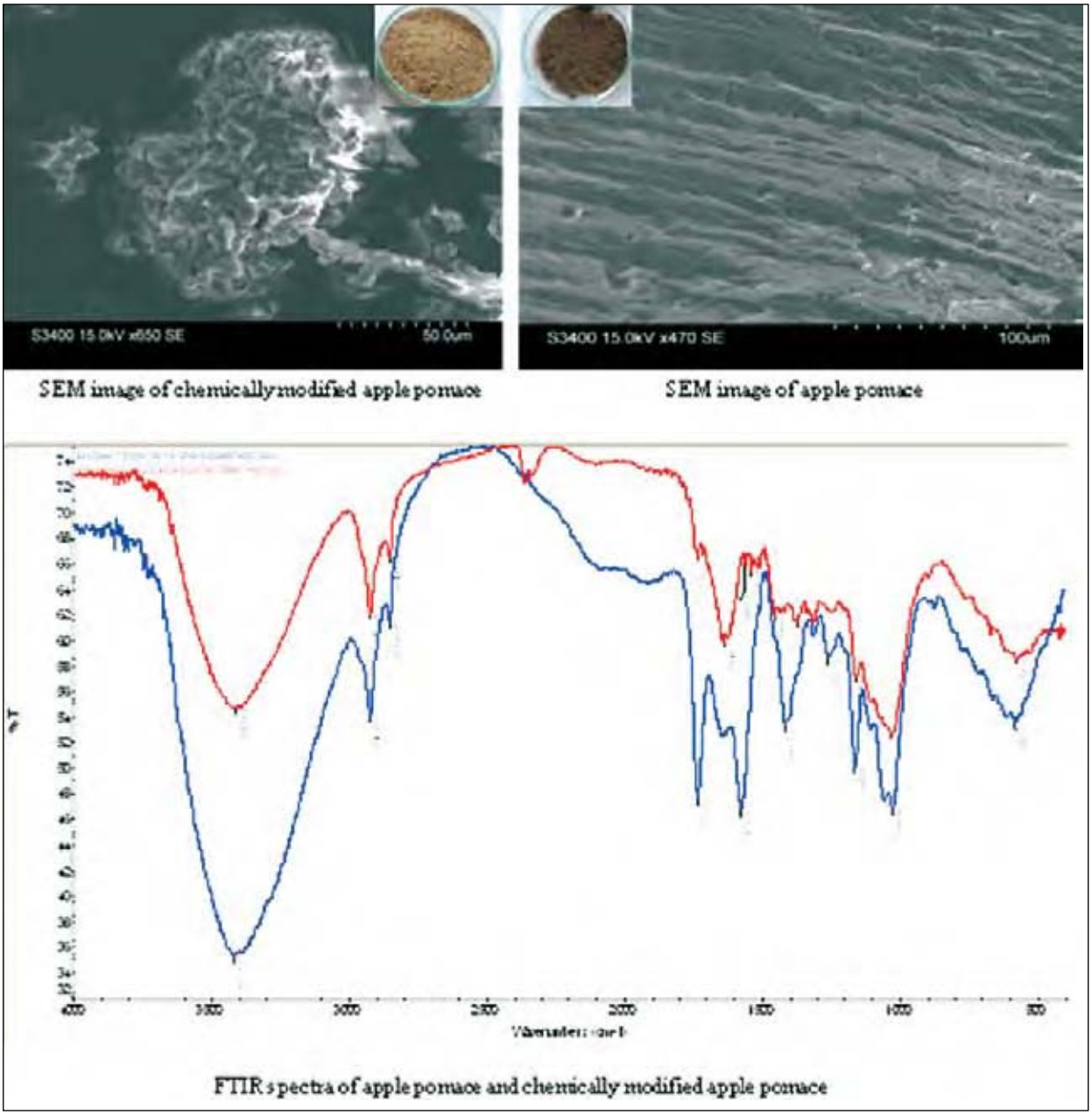


Fig. 16 Chemically modified apple pomace

MOLECULAR APPROACHES TO CROP IMPROVEMENT

Genome-wide expression profiling of NAC transcription factor family in potato (*Solanum tuberosum* L.)

NAC (NAM, ATAF1/2 and CUC2) proteins belong to one of the largest plant-specific transcription factor (TF) families. They play important roles in plant development processes, biotic and abiotic stress response and hormone signalling. On exploiting the available potato genome data and the genome-wide analysis, 110 *StNAC* genes encoding for 136 proteins were identified in potato. Phylogenetic analysis of StNACs and their *arabidopsis* and rice counterparts divided these proteins into 18 subgroups. Interestingly, 36 StNAC proteins clustered in NAC-q subgroup were potato-specific (**Fig. 17**). *In silico* expression analysis using Illumina RNA-seq transcriptome data revealed biotic and abiotic stress as well as hormone-responsive expression profile of *StNAC* genes. Quantitative real-time PCR analysis also confirmed the expression profile of *StNAC* genes revealed by RNA-seq data (**Fig. 18**). The data provides valuable leads towards putative functions of several StNAC TFs.

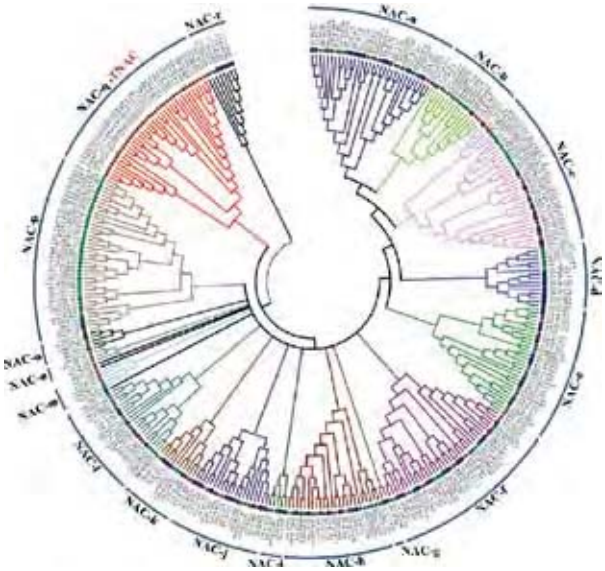


Fig. 17 Phylogenetic tree of NAC proteins of potato, *Arabidopsis* and rice

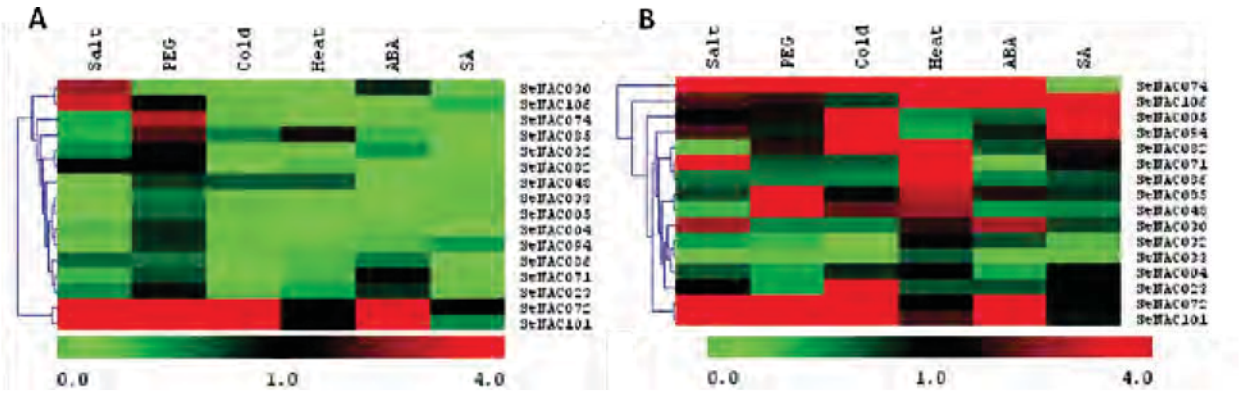


Fig. 18 Relative expression ratio of 16 representative *StNAC* genes analyzed by qRT-PCR under stress treatments for (A) 4 h (B) 24 h

Evaluation of transgenic potato lines for resistance against fungal diseases

Transgenic potato plants over-expressing *Camellia sinensis* thaumatin-like protein (*CsTLP*) gene were developed. Fungal resistance assays of transgenic potato elucidated the potential role of *CsTLP* in imparting tolerance to necrotrophic and hemi-biotrophic fungal pathogens i.e., *Macrophomina phaseolina* and *Phytophthora infestans*, respectively (**Fig. 19 A&B**). Transgenic tubers

with higher resistance to *M. phaseolina* showed significant increase in transcripts of *StPAL, StLOX* and *StTLP* genes involved in phenylpropanoid, lipoxygenase and general defense response pathway, respectively.

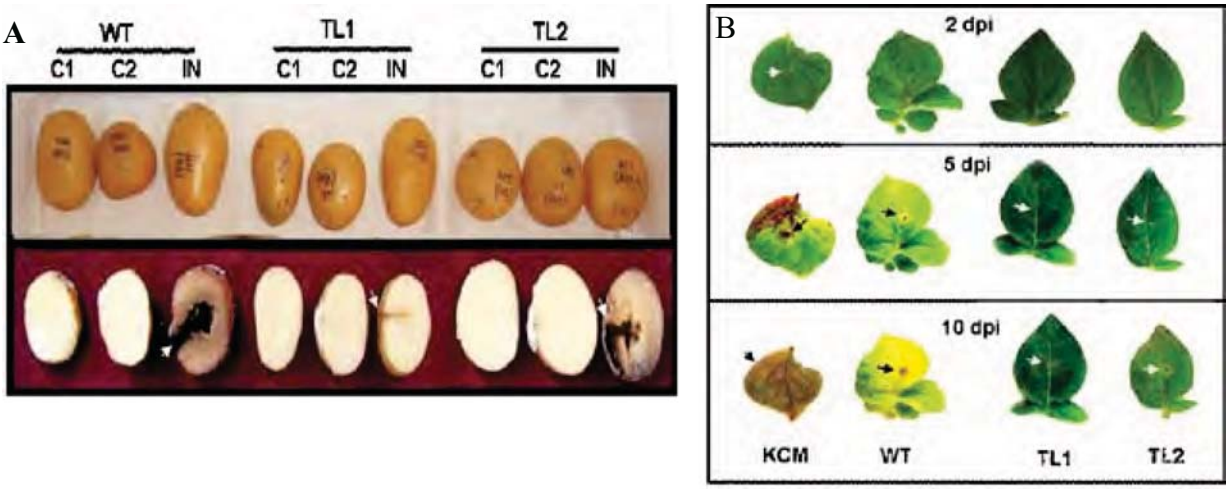


Fig. 19 Evaluation of transgenic potato for resistance against fungal diseases (A) tuber bioassay for resistance against *M. phaseolina* (B) inoculation of detached leaflets with *P. infestans;* C1, tuber skin control; C2, assay control; IN, tuber inoculated with *M. phaseolina*, WT, wild type, TL1 and TL2, *CsTLP* transgenic lines 1 and 2, KCM Kufri Chandramukhi (susceptible variety)

Over-expression of *PaSOD* in transgenic potato enhances photosynthetic performance under drought

Potato (*Solanum tuberosum*) is an important tuber crop, which is susceptible to drought stress. The present work was undertaken to improve the plant performance under drought stress by modulating super oxide radical ($O_2^{\cdot-}$) content in potato cv. Kufri Sutlej by over-expressing superoxide dismutase (SOD) (**Fig. 20**), the enzyme involved in the scavenging of $O_2^{\cdot-}$.

Over-expression of a cytosolic *copper-zinc SOD*, cloned from *Potentilla atrosanguinea* (*PaSOD*) resulted in enhanced net photosynthetic rates (P_N) and stomatal conductance (gs) compared to that in the wild type (WT) plants under control (irrigated) as well as drought stress conditions. Decline in leaf water potential, P_N, g_s, photosystem II activity and chlorophyll content, but increased proline and $O_2^{\cdot-}$ content was more in WT than transgenic potato plants (SS5). Significantly lower proline and $O_2^{\cdot-}$ content but enhanced SOD activity in SS5 compared to WT under drought stress probably generated lower stress signal for stomata to close. This was indicated by significantly higher g_s in SS5 as compared to the WT. Since g_s also regulates substomatal concentration of CO_2, SS5 plants exhibited significantly higher P_N. Manipulation of $O_2^{\cdot-}$ content could be a new way of modulating drought stress tolerance in plants.

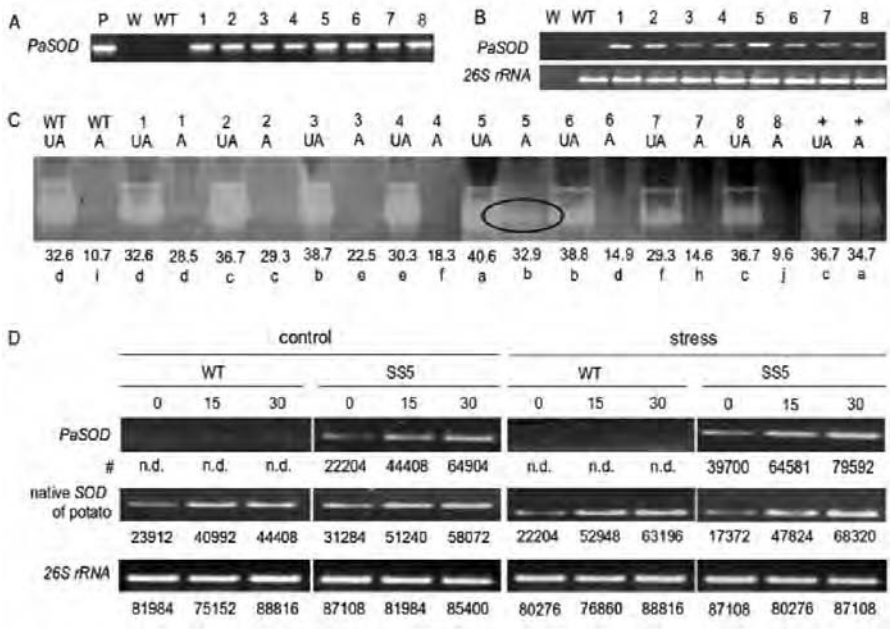


Fig. 20 Confirmation of *PaSOD* over-expressing transgenic potato lines and evaluation of gene expression by RT-PCR under different durations of drought stress. PCR (B) RT-PCR (C) - native activity gel staining for PaSOD in un-autoclaved (UA) and autoclaved (A) enzyme samples of WT, *PaSOD* transgenic lines and *Potentilla atrosanguinea*. Value below each lane denotes SOD activity and different letters indicate significant differences at $P \leq 0.05$ (D) RT-PCR analysis of *PaSOD* and native *SOD* of potato as compared to internal control *26S rRNA* in WT and SS5 under drought stress. #Value below each lane indicates the integrated density value (IDV) of the amplicons as recorded with *AD-1000* software. Background values of IDV were deducted from each lane. n.d.- not detected, control-irrigated regularly, stress-irrigation was withheld. P-positive control, W-negative control, WT-wild type, Lanes 1 to 8-*PaSOD* overexpressing transgenic lines SS1 to SS8

Identification of a cryptic bi-directional promoter

A unique insertion of the promoter-less *GFP* reporter gene at -461 bp of the At4g10596 gene led to the identification of a cryptic bidirectional promoter. This 461 bp fragment was cloned upstream to the *GUS* gene in two orientations to test for bi-directional promoter activity. Transgenic *arabidopsis* plants carrying either of these constructs showed GUS activity in anthers indicating that this fragment behaves as bi-directional promoter specific to anthers. The results were also supported by the presence of *cis*-acting motifs such as TATA box and POLLEN1LELAT52 (AGAAA) within the 461 bp sequence in both orientations. However, transcripts corresponding to the upstream sequences beyond -461 nucleotides were not detected in the wild type suggesting that this 461 bp fragment is a cryptic promoter (**Fig. 21**). The study reveals the importance of promoter trap approach to identify novel regulatory sequences. This novel bidirectional promoter would be especially useful for the simultaneous expression of pairs of genes in anthers.

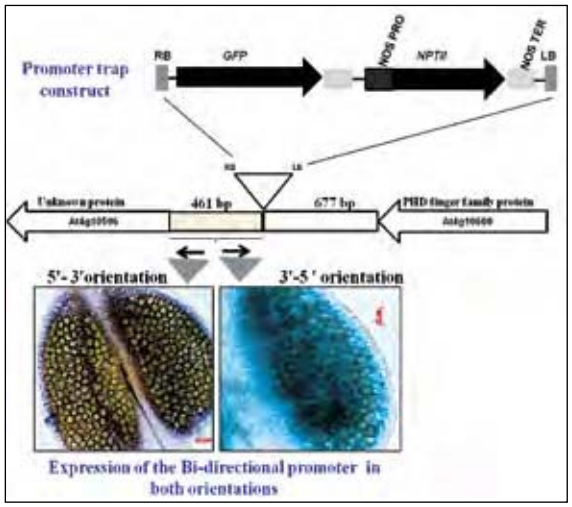


Fig. 21 Cloning and characterization of cryptic bi-directional promoter

Transcriptome and small RNA analysis in response to drought stress in horsegram

(Funded by CSIR under YSA scheme)

In continuation to previous study, transcripts, small RNA and DNA methylation epigenetic marks responsive to drought stress were identified and characterized. Variation in CpG methylation behavior was studied in drought-sensitive (HPKC2) and drought-tolerant (HPK4) genotypes of horse gram (*Macrotyloma uniflorum*). The methylation pattern studied through methylation-sensitive amplified polymorphism revealed higher methylation in HPKC2 (10.1%) than in HPK4 (8.6%). Sequence homology demonstrated that the DRE binding factor (cbf1), the POZ/BTB protein and the Ty1-copia retrotransposons were some of the polymorphic fragments showing alteration in methylation behaviour (**Fig. 22**).

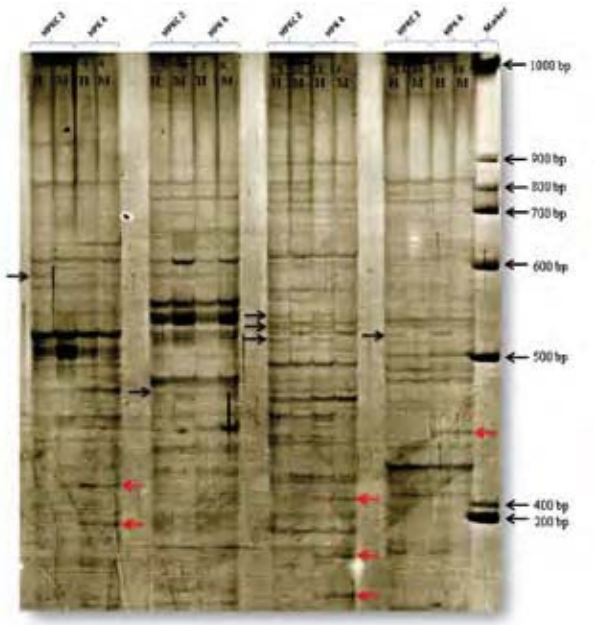


Fig. 22 Methylation pattern in HPKC2 and HPK4 genotypes of horsegram

Biochemical and proteomic evaluation of horse gram (*Macrotyloma uniflorum* (Lam.) verdc.)

(Funded by Department of Science and Technology, Govt. of India)

In continuation to the work carried out earlier, the phenol method for protein extraction was applied to some legume and non-legume plants. Different salts were used for depleting the abundant proteins from horse gram seeds and $MnCl_2$ was found to be the best (**Fig. 23**).

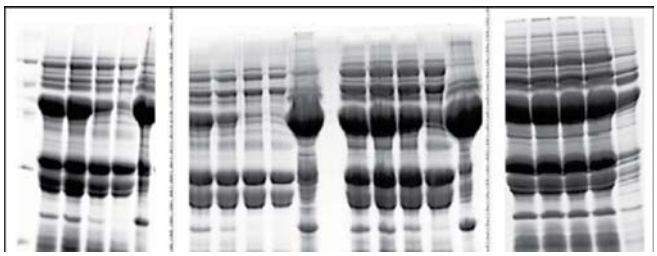


Fig. 23 SDS PAGE showing the effect of different salts ($CaCl_2$, $MnCl_2$, $MgCl_2$, NaCl) on the depletion of abundant proteins from horse gram seeds

Over-expression of *CsANR* in transgenic tobacco for increased flavan-3-ols

Anthocyanin reductase (ANR) represents a branching-point enzyme of the pathway that converts anthocyanidins to flavan-3-ols. When *CsANR* from *Camellia sinensis* was over-expressed in tobacco, leaf tissue of transgenic lines showed higher contents of flavan-3-ols (epicatechin and epigallocatechin) (**Fig. 24 A & B**). The transgenic flowers were light pink/white in colour as opposed to dark pink colour of wild type flowers (**Fig. 24 C**). The decrease in anthocyanin content was also lower in the transgenic lines (**Fig. 24 D & E**).

FLS-silenced-tobacco for engineering of flavonoid pathway

The gene encoding flavonol synthase (FLS) was silenced in tobacco in order to direct the flow of metabolites towards the production of flavan-3-ols. When antioxidant enzyme activities were

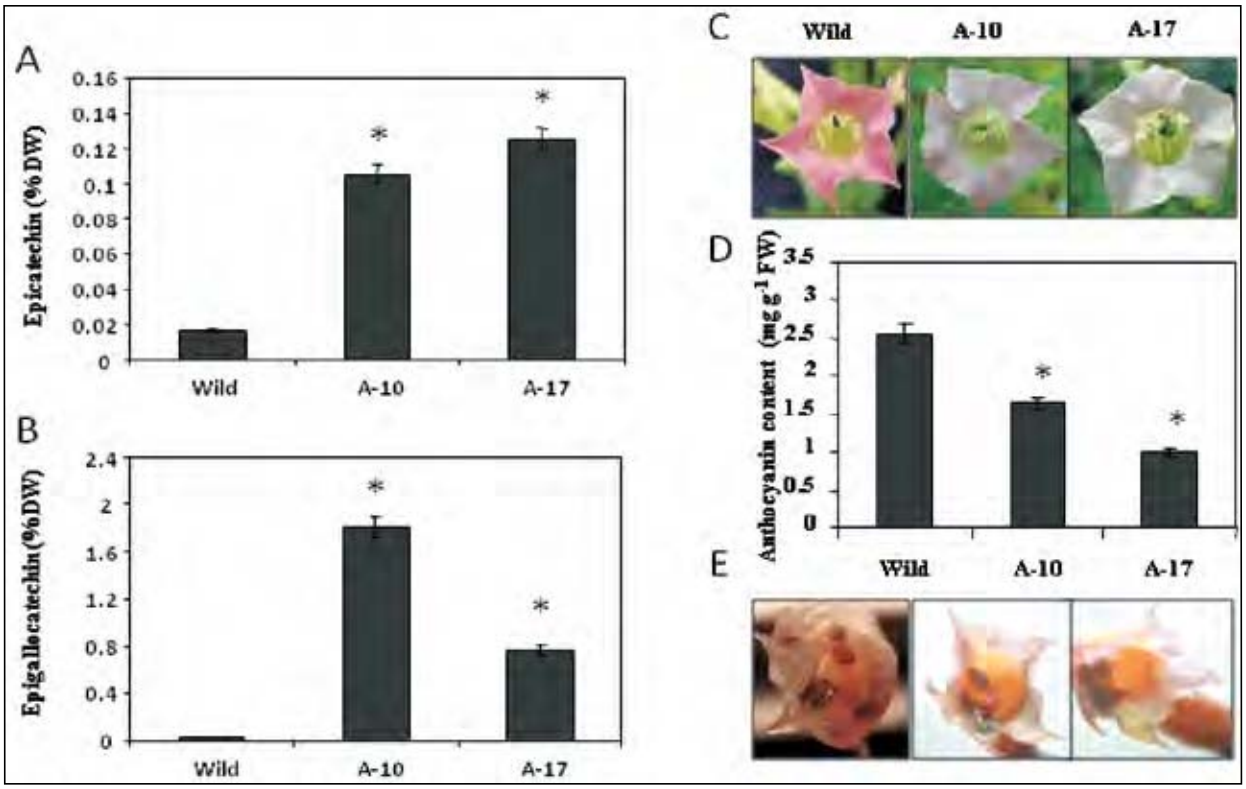


Fig. 24 Effect of over-expression of *CsANR* on flavan-3-ols in tobacco (A) epicatechins (B) epigallocatechins (C) flowers (D) anthocyanin content (E) DMACA staining confirmed more accumulation of flavan-3-ols content

assayed in the FLS-silenced-lines, an increase in transcript levels and activities of GR, APX and CAT, whereas, decrease in GST was observed (**Fig. 25**). In a separate study, tobacco seedlings were also exposed to 10 µM and 50 µM catechins *in vitro* for two days to validate the effect of flavan-3-ols on antioxidant system.

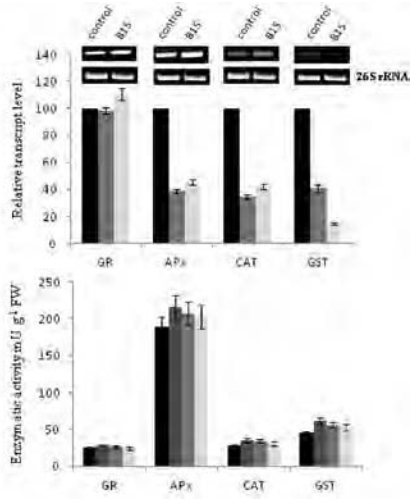


Fig. 25 Changes in the transcript level and antioxidant enzyme activities in control and *FLS* silenced transgenic lines

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)? (Funded by CSIR under EMPOWER scheme)

In continuation to earlier studies, the role of different regions of Initiator tRNA (tRNAi) was analyzed. The tRNAi gene from *Arabidopsis thaliana* was cloned into pGEM-T easy vector and further sub-cloned into pCAMBIA1300 *Lac*Z MCS. The pCAMBIA1300 vector harboring the cloned wild type tRNAi and mutated tRNAi genes (site-directed mutagnesis) was transferred to *Agrobacterium tumefaciens* with pCAMBIA1300 (**Fig. 26**).

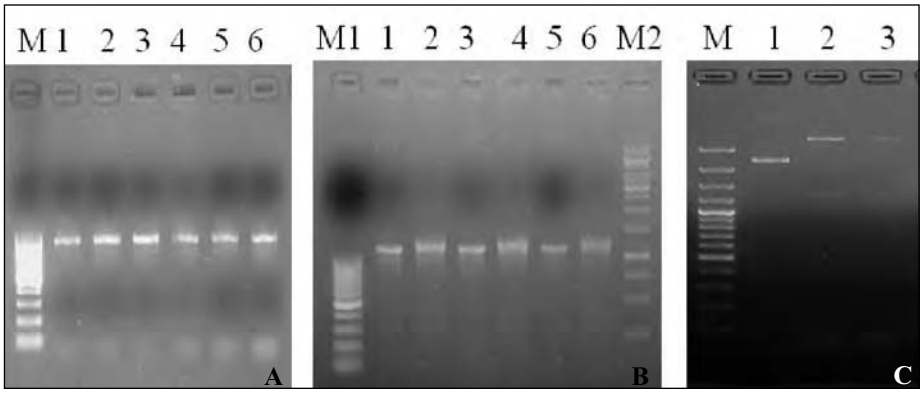


Fig. 26 Amplification of tRNAi gene from *Arabidopsis thaliana* and its transfer to *Agrobacterium tumefaciens* (A) PCR amplification of tRNAi (B) confirmation of tRNAi insert in pGEM-T easy vector by colony PCR (C) PCR transformed colonies with pCAMBIA1300

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

In continuation to previous study, various morphological, physiological and biochemical changes were recorded in *arabidopsis* (ecotype Col-0) after different treatments. Decrease in all the measured biochemical parameters (leaf biomass, root biomass, shoot length, root length, number of leaves, chlorophyll content) was recorded after dark treatment (**Fig. 27**). After heat-shock treatment, the number of leaves increased under light but was not affected under dark conditions. However, alteration in chlorophyll metabolism was observed when the plants were inoculated with fungi. As compared to control plants, the inoculated plants performed better under dark conditions. External application of 10 μM NADPH also resulted in 26.7% increase in leaf and shoot biomass under dark conditions as compared to control plants.

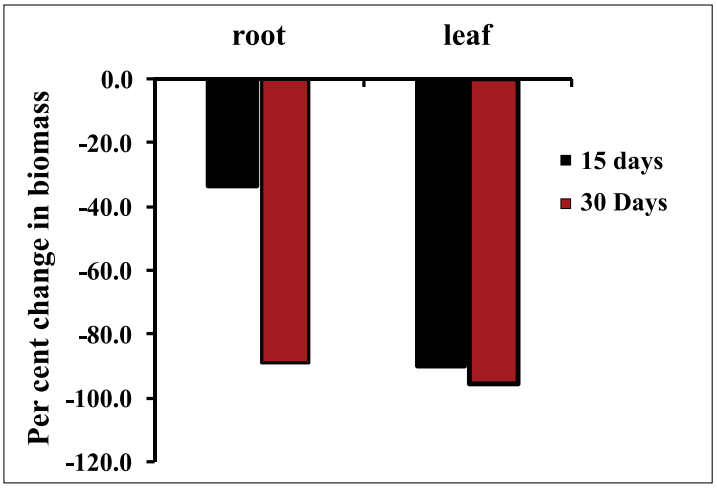


Fig. 27 Effect of dark treatment on root and leaf biomass of *arabidopsis*

COMPUTATIONAL BIOLOGY AND BIOINFORMATICS

Integrative network biology approach for therapeutic studies

In continuation to previous study, an Asthma Protein Interactome (API) underlying the intricate and complex molecular mechanism of the disease was constructed. A strategy based on network analysis of the interactome was used to identify a set of potential drug targets. Topologically and dynamically, v-src sarcoma (Schmidt-Ruppin A-2) viral oncogene homolog (SRC) emerged as the most central target in API (**Fig. 28**). SRC is known to play an important role in promoting the growth of the airway smooth muscle cells and also in facilitating migration in airway remodeling. Thus, SRC emerged as a promising drug target for asthma from interactome analysis and its reported role in respiratory mechanisms.

Fig. 28 A topological view of the Asthma Protein Interactome (API)

Prospecting novel plant-derived molecules as potent drug targets for complex diseases

Aldose Reductase (AR) is implicated in the development of secondary complications in diabetes and is an interesting target for therapeutic intervention. Extracts of *Rauvolfia serpentina,* a medicinal plant endemic to Himalaya is known to alleviate diabetes and its complications. Therefore, an extensive library of *R. serpentina* molecules was compiled and computationally screened for inhibitory action against AR. The stability of the complexes with docked leads was verified using molecular dynamics simulations. Indobine and indobinine are two structurally distinct plant-derived molecules that were identified as inhibitors. These were used as templates to identify 16 more leads from plant-derived indole alkaloids and their structural analogs from a manually curated dataset (**Fig. 29**).

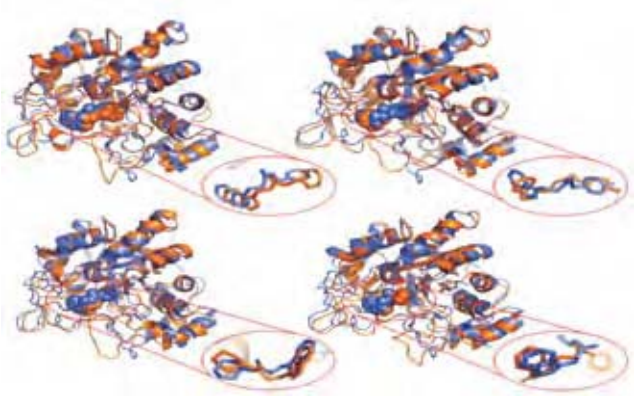


Fig. 29 Comparison of conformations of lead complexes before (blue) and after (orange) molecular dynamics simulations

Identification of key nodes of type 2 diabetes mellitus (T2DM) protein interactome

Protein-protein interaction network associated with T2DM was constructed using candidate genes and available data on systems-level interactions. The relevance of the constructed network was verified using gene ontology, node deletion and biological essentiality studies. MAPK1, EP300, and SMAD2 were identified as the most central proteins of potential therapeutic value. Studies were conducted to structurally understand the potential interaction of the anti-diabetic agent, phlorizin with proteins central to T2DM mechanisms. The molecular docking results suggested that phlorizin was potentially involved in critical interactions with MAPK1.

Development of an accurate miR-BAG tool to identify de novo microRNAs across the genomic sequences

Non-coding elements such as miRNAs play key regulatory roles in living systems. These ultra-short, ~21 bp long, RNA molecules are derived from their hairpin precursors and usually participate in negative gene regulation by binding the target mRNAs. Discovering miRNA candidate regions across the genome has been a challenging problem. Most of the existing tools work reliably only for limited datasets. Thus, a novel reliable miR-BAG approach was developed to identify miRNA candidate regions in genomes. The miR-BAG utilizes a bootstrap aggregation based machine learning approach and successfully creates an ensemble of complementary learners to attain > 90% accuracy, sensitivity and specificity. The miR-BAG was developed for wide range of species and tested extensively for performance over a wide range of experimentally validated data. In a detailed comparative analysis, miR-BAG performed better than six existing tools. Using miR-BAG NGS module, a total of 22 novel miRNA candidate regions were identified in cow genome in addition to a total of 42 cow specific miRNA regions. In practice, discovery of miRNA regions in a genome demands high-throughput data analysis, requiring large amount of processing. Considering this, miR-BAG was developed in multi-threaded parallel architecture as a web server as well as a user friendly GUI stand alone version.

NANOBIOLOGY

Major research initiative were taken during the year. These included: (a) Improvement of solubility/bioavailability of active biomolecules as nanotherapeutics, (b) Green synthesis of biodegradable nanoparticles using Himalayan bioresource for slow and sustained release of bioactive molecules for safer cellular uptake and biodistribution, (c) Developing hybrid nanocomposite materials for multimodal imaging system for simultaneous diagnosis of disease sites as well as for therapy and (d) Efficacy/toxicity evaluation of the developed nanomaterials at *in vitro* and *in vivo* level.

Several medicinally significant plant extracts were used for the synthesis of metallic as well as polymeric nanoparticles. Encapsulation, controlled and sustained release of few active components such as quercetin was also achieved (**Fig. 30**).

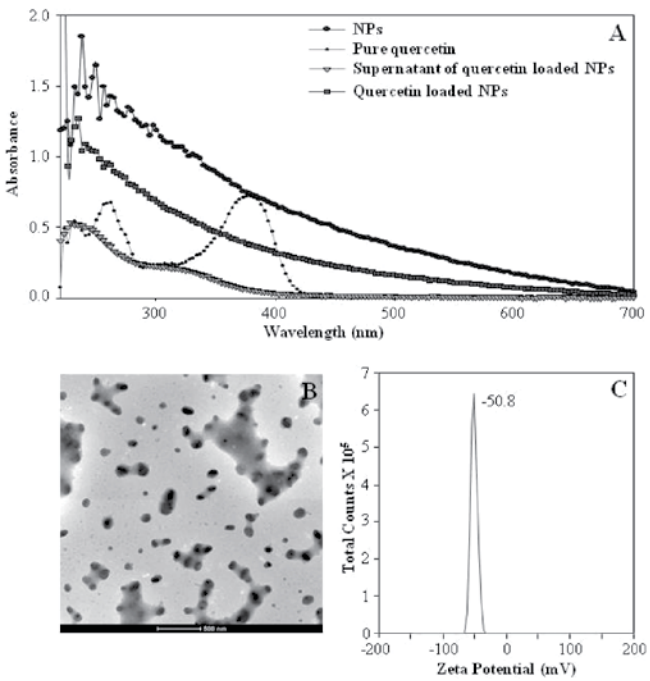


Fig. 30 Characterization of quercetin loaded *Lonicera japonica* plant extract (PE) synthesized polylactic acid nanoparticles (PLA NPs) (A) UV-VIS spectra (B) TEM image of quercetin loaded PE synthesized PLA NPs (C) zeta potential of quercetin loaded PE synthesized PLA NPs.

In another activity, the synthesized inorganic nanohybrid composites modified with biologically relevant molecules were found to selectively recognize targeted cancer cell lines. The initial cell uptake and cytotoxicity studies suggested that these materials can be used as targeting agents towards folic acid receptor over-expressing cell lines (**Fig. 31**).

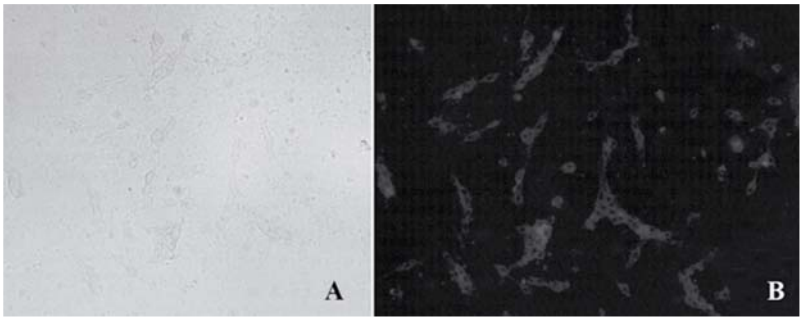
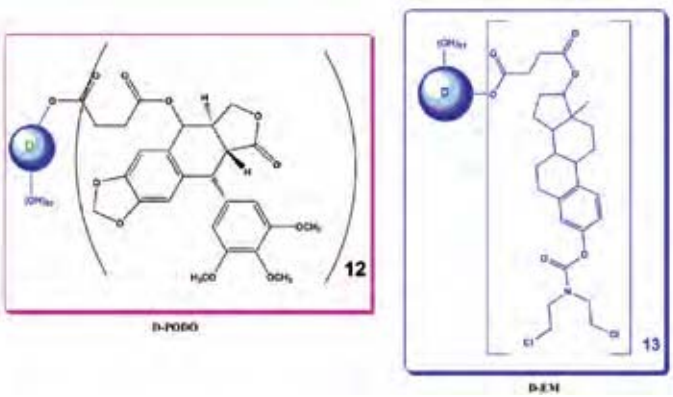


Fig. 31 Images of C6 cells treated with nanohybrid composites (A) bright field (B) fluorescence microscope

Synthesis and characterization of dendrimer-drug conjugated nanodevice for drug delivery and its efficacy

The synthetic estramustine (EM) and natural podophyllotoxin (PODO) are anti-mitotic agents that inhibit tubulin polymerization and are known as anti-cancer agents. However, low bioavailability of these compounds limit their anti-cancer properties. Thus their conjugation with PAMAM dendrimer (D) for enhanced activity of D-EM and D-PODO was investigated by altering

their release pattern. Physico-chemical characterization using NMR, MALDI-TOF-MS, TEM, DLS, Zeta potential and HPLC suggested covalent attachment of both EM and PODO to the dendrimer and indicated the conjugates to be of high purity. The nano-particles were uniformly distributed. Release kinetics indicated the conjugates to be stable against hydrolytic cleavage. While both conjugates showed sustained release, the release of D-EM was slow as compared to D-PODO both in PBS and DMEM. Comparison of the anti-tumor effect of these two dendrimer conjugates on glioma cell revealed (i) increased cell death and cell cycle arrest (ii) decreased migration and (iii) increased tubulin depolymerization in cells treated with D-EM and D-PODO as compared to free drug. Importantly, the effects of PAMAM conjugated natural PODO on glioma cell survival and migration was more pronounced than D-EM.

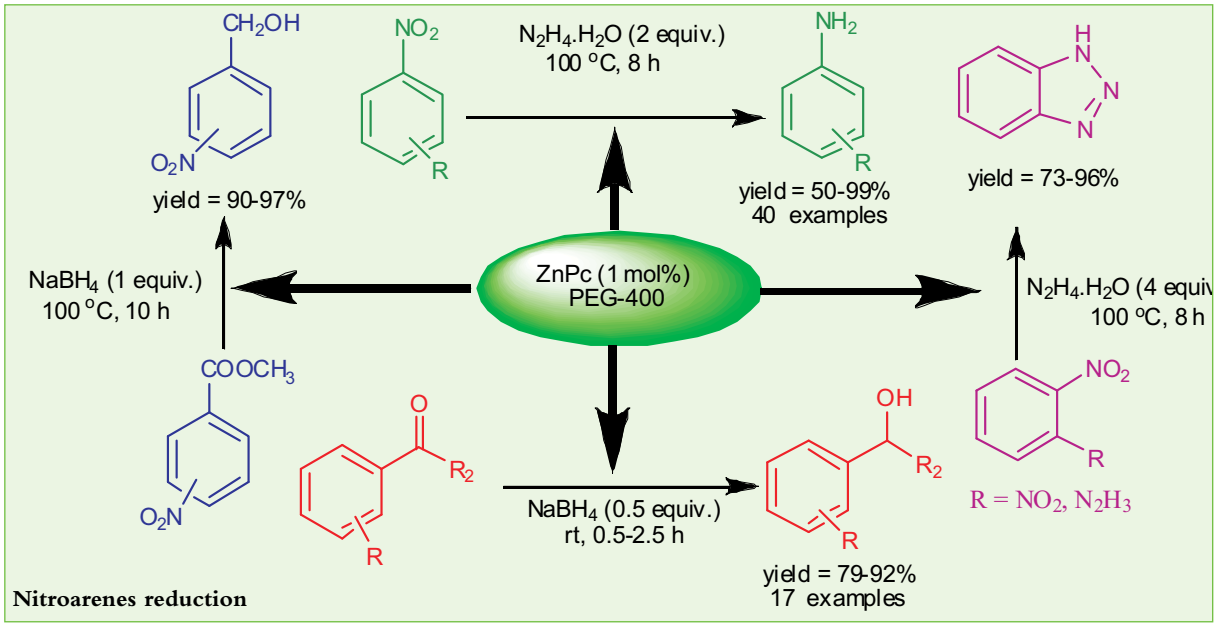


Dendrimer-drug conjugated nanodevice

SYNTHETIC CHEMISTRY

Zinc phthalocyanine catalyzed selective reduction of aromatic nitro compounds

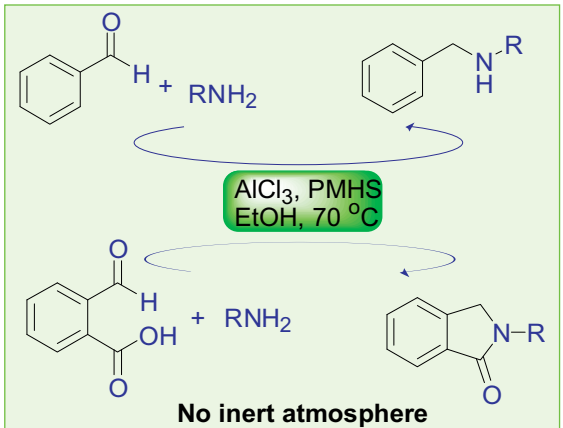
Highly selective reduction of nitroarenes was achieved with zinc phthalocyanine in PEG-400 when hydrazine hydrate was used as a reducing agent. A wide spectrum of reducible functionalities remained inert under the reaction conditions. The catalytic system was successfully employed for (i) the reduction of carbonyl and ester compounds to their corresponding alcohols and also for (ii) reductive amination of benzaldehydes with primary amines into corresponding secondary amines. Direct synthesis of benzotriazole from *o*-dinitrobenzene was achieved for the first time. The catalyst was reused up to four times without any significant loss in activity.



Nitroarenes reduction

Synthesis of substituted amines and isoindolinones: $AlCl_3$/PMHS catalyzed reductive amination

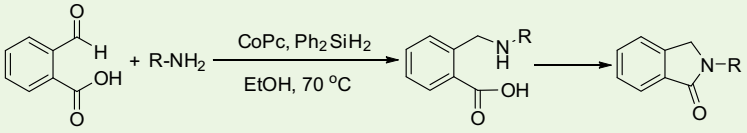
Novel sustainable catalytic system ($AlCl_3$/PMHS) was established for highly chemoselective reductive amination of carbonyl compounds with high contents of primary as well as secondary amines. Synthesis of *N*-substituted isoindolinones by tandem amination-amidation of 2-carboxybenzaldehyde with different amines was also described. The use of abundantly available eco-friendly reagents under ambient reaction conditions made the method suitable for industrial applications. The catalyst can be reused upto three times without loss in activity.



Substituted amines and isoindolinones

Cobalt phthalocyanine catalyzed synthesis of isoindolinones

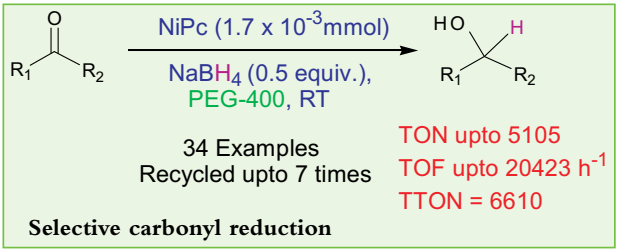
Synthesis of *N*-substituted isoindolinones by one pot amination-amidation of 2-carboxybenzaldehyde with different amines was carried out. Cobalt phthalocyanine (CoPc) was employed as catalyst with high chemoselectivity and excellent yield. The method utilized diphenylsilane as reducing agent in ethanol. Other remarkable advantages of this method are high isolated yields, clean reactions and easy work-up procedure.



Synthesis of isoindolinones

Nickel phthalocyanine assisted selective carbonyl reduction

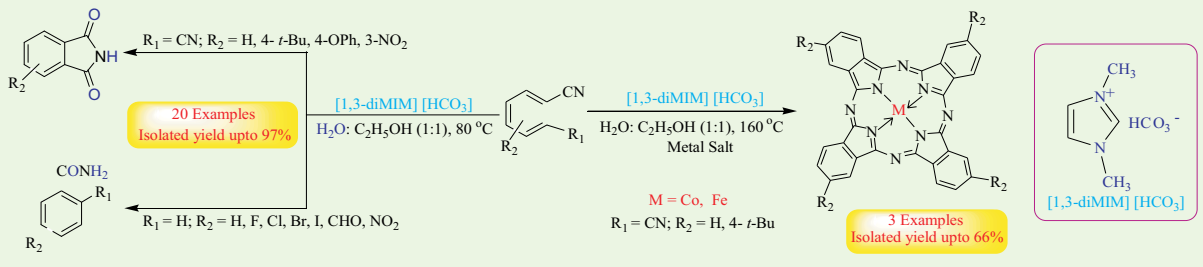
Nickel phthalocyanine with polyethylene glycol-400 was developed as a highly efficient, reusable and green method for the high chemo- and regioselective reduction of carbonyl compounds to corresponding alcohols using $NaBH_4$ as hydrogen source. The method showed very wide substrate scope with high TON and TOF tolerating and highly sensitive functional groups such as hydroxyl, carboxyl and olefin. Regioselective reduction of aldehyde group in case of benzenedicarbaldehydes was also reported for the first time. The catalyst was reused up to seven times without any significance loss in activity. Rapid reaction, easy work up procedure and high efficiency make the present method most suitable for carbonyl group reduction.



Selective carbonyl reduction

Transition metal-free hydration of organonitriles to amides

Transition metal free chemoselective hydration of organonitriles to corresponding amides was developed using1,3-dimethylimidazolium hydrogen carbonate as efficient organocatalyst. Various aromatic, heteroaromatic and aliphatic organonitriles were hydrated to corresponding amides with excellent chemoselectivity and yields. The developed catalytic method was also applicable for the synthesis of metal phthalocyanines.

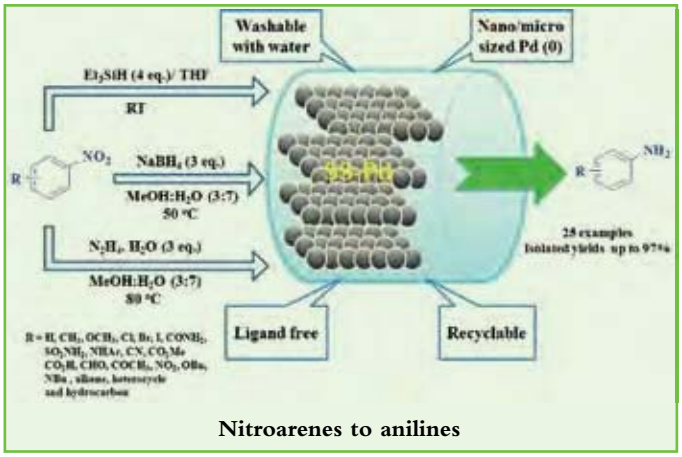


Hydration of organonitriles to amides

Solid supported palladium(0) catalyzed chemoselective reduction of nitroarenes

(Funded by Department of Science and Technology, Govt. of India)

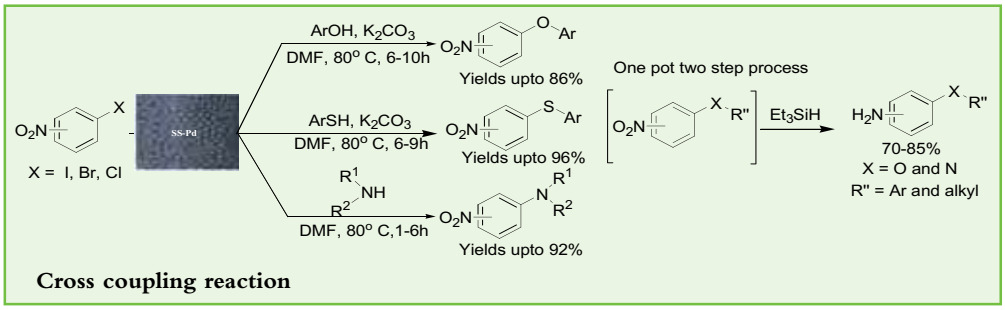
Solid supported palladium(0) (SS-Pd) catalyzed highly chemoselective reduction of nitroarenes to corresponding anilines was accomplished under milder reaction condition. This catalyst showed high compatibility with various reducing agents ($NaBH_4$, Et_3SiH and $NH_2NH_2.H_2O$). A large number of reducible functional groups such as sulfonamide, amides, carboxylic acid, ester, alcohol, halide, hetero-cycle, nitrile, alkene, carbonyl, O-benzyl and N-benzyl were tolerated. Most of the reactions were clean and high yielding. The SS-Pd catalyst could be recycled up to seven runs without significant loss of activity.



Nitroarenes to anilines

Solid supported palladium(0) catalyzed C-O, C-S and C-N cross-coupling reaction

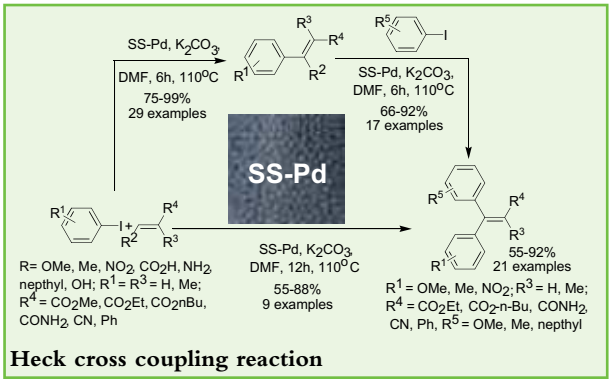
Ligand free solid-supported nano and microparticles of Pd(0) (SS-Pd) were used as heterogeneous catalyst in carbon-heteroatom bond formation reactions. Nitro substituted aryl halides reacted with oxygen, sulphur and nitrogen nucleophiles to afford corresponding products in good yields. A one pot sequential cross-coupling and nitro-reduction were performed using the same SS-Pd catalyst to access amine substituted carbon-heteroatomic molecules. In addition, SS-Pd could be recycled up to seventh runs without significant loss of catalytic activity.



Cross coupling reaction

Solid supported palladium(0) catalyzed mono and multifold Heck cross coupling reaction

Solid supported palladium (0) nano/ microparticles were found to be active catalyst in performing mono and multifold Heck reactions. Different β-unsubstituted and substituted alkenes including acrylates, methaacrylates,crotonates,styrene,acrylonitrile,

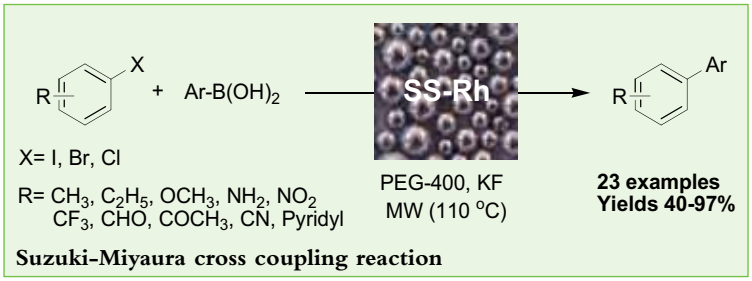


Heck cross coupling reaction

and acrylamide were investigated successfully for mono and multifold Heck reactions with aryl iodide under milder reaction condition. One-pot multifold Heck reaction of aryl iodides with α,β-unsaturated ester, amide, nitrile, and styrene derivatives were also performed under standard reaction conditions. Wide functional groups tolerance, easy catalyst recovery and recyclability up to twelve times without significant loss of catalytic activity added extra importance to the present process.

Solid supported rhodium (0) catalyzed Suzuki-Miyaura cross coupling reaction

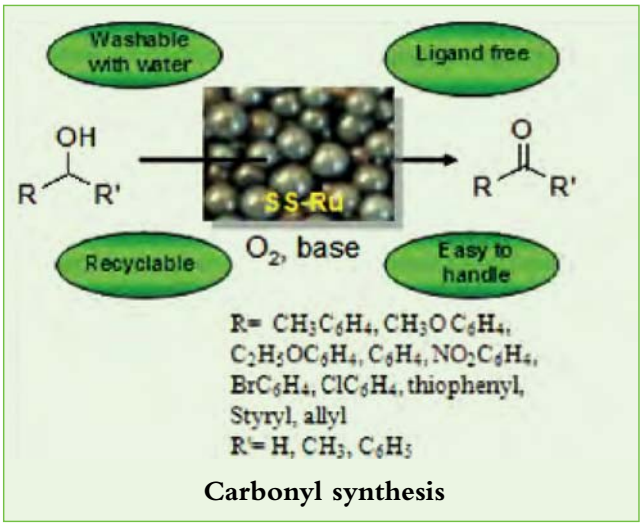
Solid supported nano and microparticles of rhodium (0) (SS-Rh) were prepared. These were applied as ligand free heterogeneous catalyst for Suzuki-Miyaura cross-coupling reaction with wide range of substrate scope. Hitherto unknown Rh-catalysed Suzuki cross coupling reaction of aldehyde and cyano haloarenes was observed rather than usual nucleophilic arylation. The catalyst was removed by simple filtration and recycled upto twelve runs without any deterioration of activity.



Suzuki-Miyaura cross coupling reaction

Solid supported ruthenium (0) catalyzed aerobic oxidation of benzylic and allylic alcohol

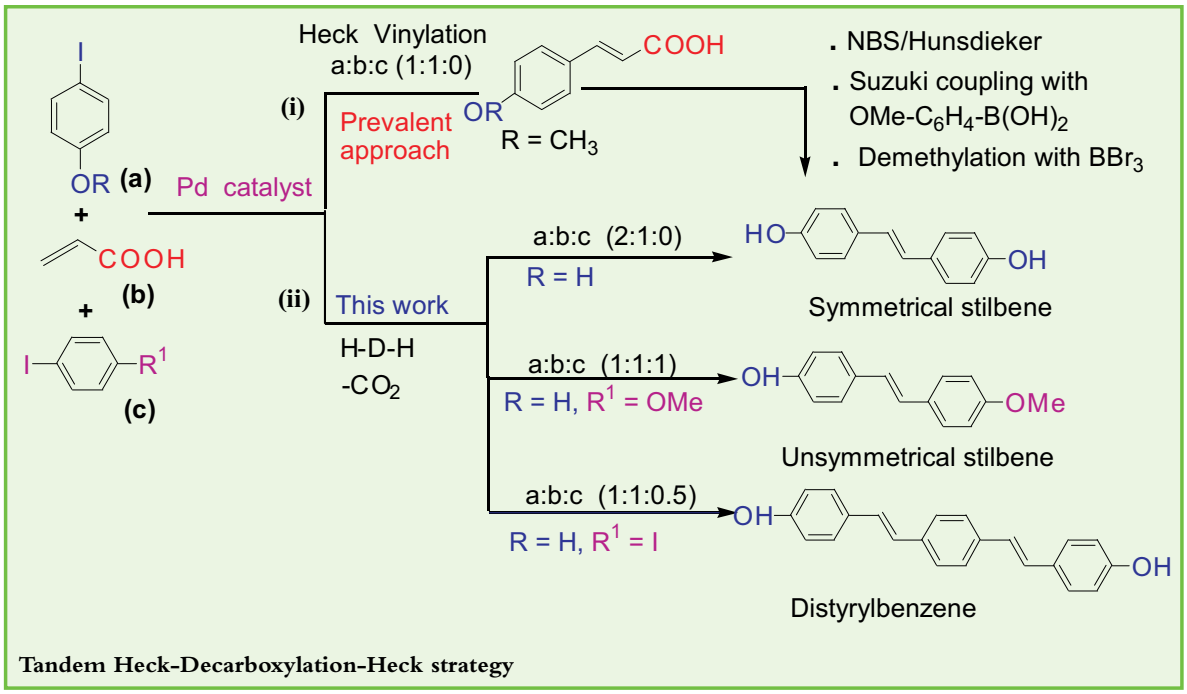
Polymer immobilized, stable and spherical ruthenium nanoparticles were prepared and characterized. These acted as a heterogeneous catalyst for the selective benzylic and allylic alcohol oxidation into corresponding carbonyls using molecular oxygen. The solid supported Ru(0) (SS-Ru) was used as a heterogeneous catalyst, it exhibited good reusability and easy separation from reaction mixture by filtration.



Carbonyl synthesis

Tandem Heck-Decarboxylation-Heck strategy: protecting-group-free synthesis of symmetric and unsymmetric hydroxylated stilbenoids

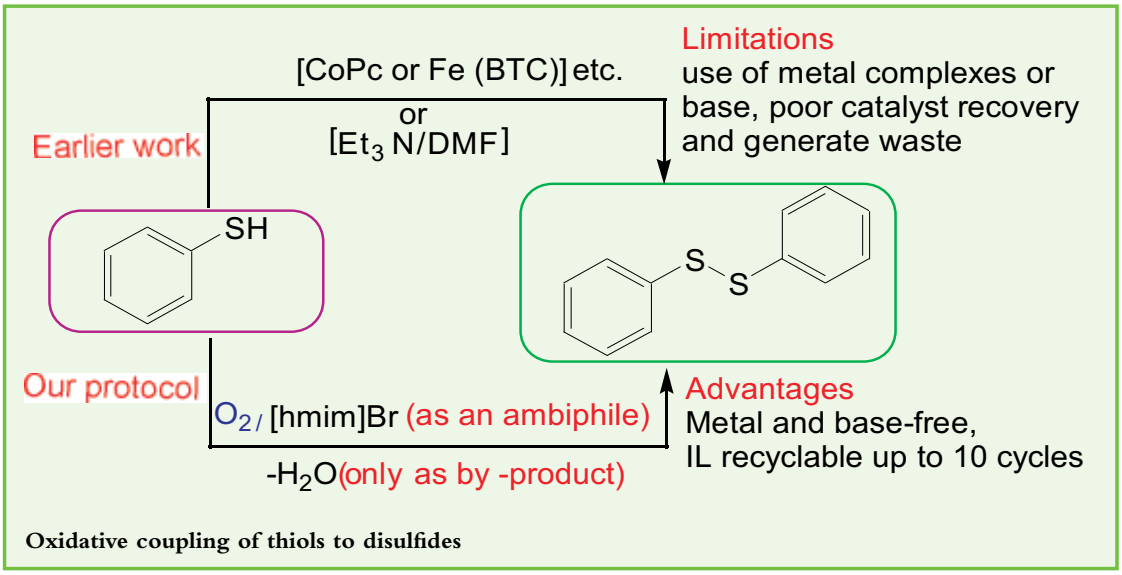
A tandem/sequential Heck-Decarboxylation-Heck (H-D-H) strategy was developed for the synthesis of hydroxylated symmetrical or unsymmetrical stilbenoids utilizing 4-halophenols and acrylic acid as coupling partners. The developed protocol was successfully applied to the formal sequential synthesis of antineoplastic agent pterostilbene and a distyrylbenzene with fluorinated analogs having potent β-amyloid binding affinity.



Tandem Heck-Decarboxylation-Heck strategy

Metal and base-free selective oxidative coupling of thiols to disulfides in ionic liquids

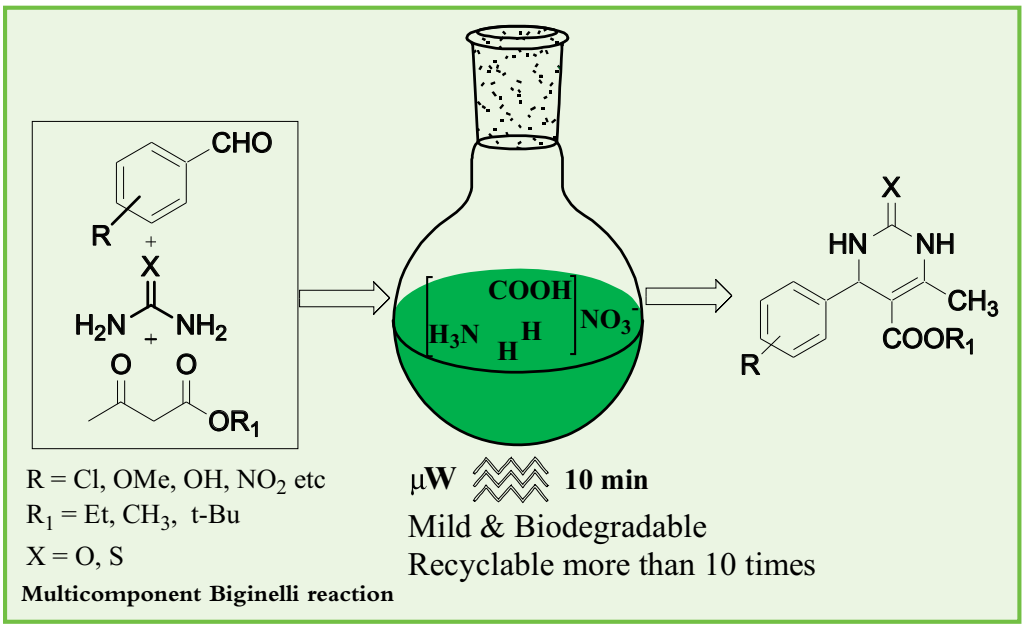
Selective aerobic oxidation of thiols into disulfides in [hmim]Br was developed without relying on any base/metal catalyst. The ^{1}H NMR based mechanistic study proved a cooperative role of imidazolium cation and halide anion of neutral IL as an ambiphile.



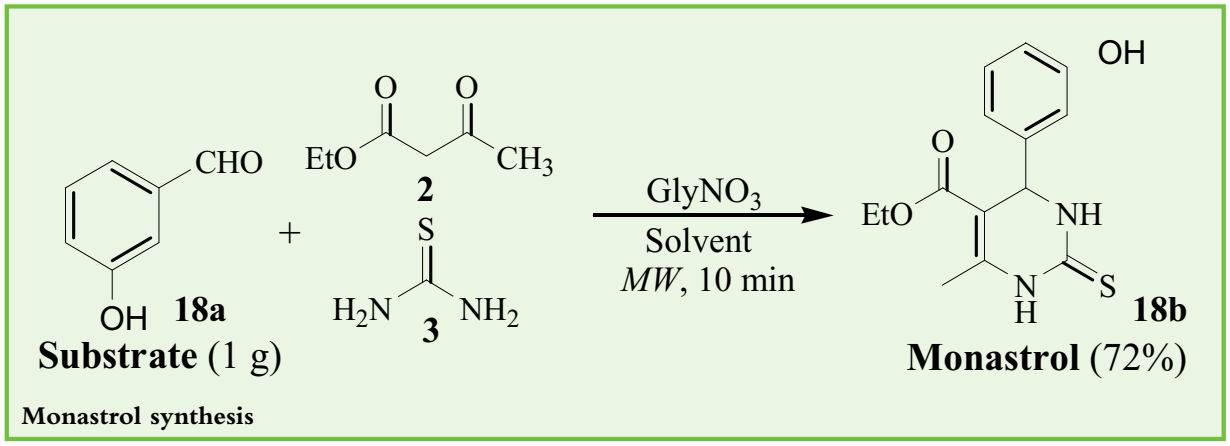
Oxidative coupling of thiols to disulfides

Green and recyclable glycine nitrate ($GlyNO_3$) ionic liquid triggered multicomponent Biginelli reaction for dihydropyrimidinones synthesis

Amino acid ionic liquid was employed as a green catalyst for the multicomponent synthesis of 3,4-dihydropyrimidin-2(1*H*)-ones for excellent yields in short reaction time. The ionic liquid is inexpensive, biodegradable and can be reused for more than ten consecutive reactions.



Multicomponent Biginelli reaction



Monastrol synthesis

Synthesis and SAR investigation of natural phenylpropene-derived methoxylated cinnamaldehydes and their novel Schiff bases as potent antimicrobial and antioxidant agents

A series of cinnamyl compounds **(Fig. 32)** were synthesized from abundantly available methoxylated phenylpropenes. These were also evaluated for their antimicrobial activity against fourteen opportunistic bacterial and fungal human-pathogens. Structure-activity relationship studies indicated that methylenedioxy cinnamaldehyde exhibited promising broad spectrum activity against the tested microorganisms. Hence, it was used as a lead structure during the synthesis of novel Schiff bases/heterocyclic compounds (**23-33**) under microwave irradiation. Out of these, thiazole based Schiff bases showed promising antibacterial activity against *B.subtilis* (26; MIC 0.12 mM), *M. luteus* (27; MIC 0.20 mM) and *S. aureus* (27; MIC 0.20 mM) (**Tables 8-10**).

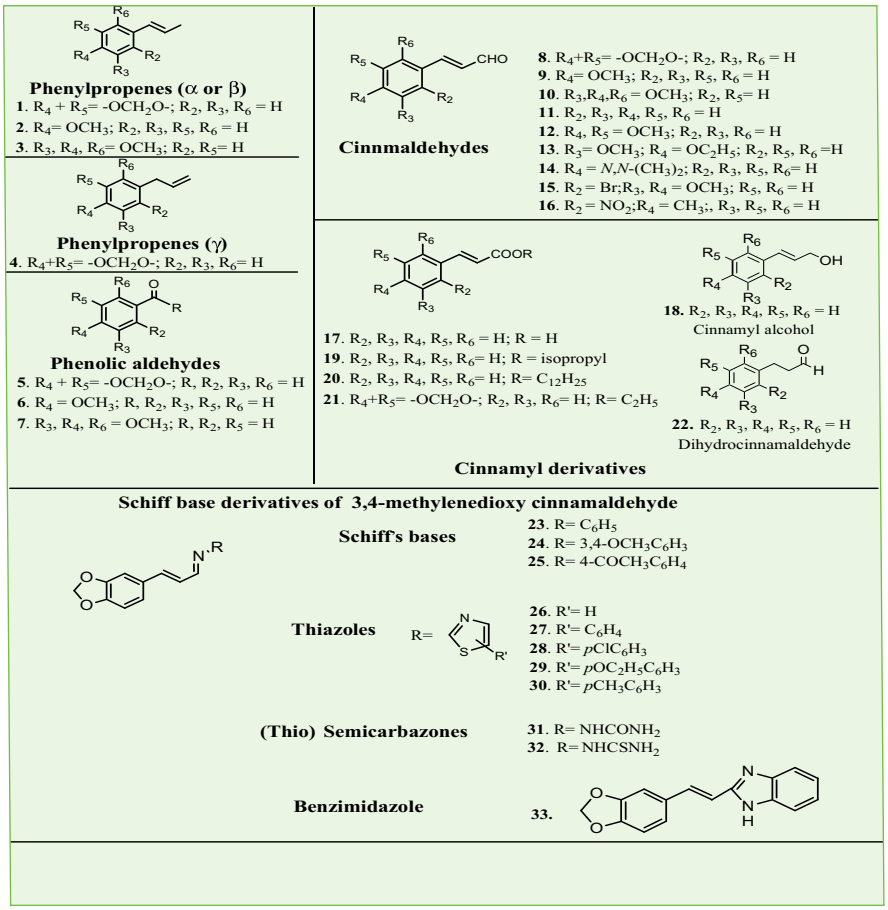


Fig. 32 Chemical structures of phenylpropenes and cinnamyl derivatives

Table 8. Screening of methoxylated phenylpropenes (1-4) and their benzaldehyde derivatives (5-7) for antimicrobial activity

Test Compound/ Entry	Antimicrobial activity against standard microbial cultures (mM)													
	Bacteria								Fungi					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N
1	R	R	R	R	R	R	R	R	R	R	R	3.08	R	R
2	R	R	R	R	R	R	R	R	R	R	R	R	6.74	6.74
3	R	9.60	R	R	R	R	R	R	4.80	2.40	1.20	0.60	0.60	1.20
4	R	R	R	R	R	R	R	R	R	R	R	6.16	6.16	6.16
5	3.33	3.33	6.66	R	3.33	3.33	0.83	3.33	3.33	3.33	3.33	0.83	0.83	0.83
6	14.69	14.69	14.69	14.69	R	1.83	R	14.69	7.34	1.83	1.83	0.92	3.67	3.67
7	10.19	10.19	5.10	5.10	2.55	5.10	2.55	10.19	5.10	5.10	2.55	0.16	2.55	2.55
Standard	0.08	5.7	0.01	5.7	0.01	0.01	2.8	5.7	0.03	0.04	0.06	0.03	0.008	0.03

A= *E. coli*; **B=** *E. cloacae*; **C=** *B. subtilis*; **D=** *B. cepacea*; **E=** *M. luteus*; **F=** *S. aureus*; **G=** *P. aeruginosa*; **H=** *K. pneumoniae*; **I=** *A. niger*; **J=** *A. sydowii*; **K=** *A. parasiticus*; **L=** *T. rubrum*; **M=** *C. albicans* **and N=** *I. orientalis*; **R= resistant; Ampicillin and nystatin were standard controls for anti-bacterial and anti-fungal, respectively.**

Table 9. Screening of cinnamyl derivatives (8-22) for antimicrobial activity

Test Compound/ Entry	Antimicrobial activity against standard microbial cultures (mM)													
	Bacteria								Fungi					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N
8	2.84	1.42	2.84	0.71	2.84	2.84	0.35	1.42	1.42	0.35	0.71	0.04	0.35	0.35
9	3.08	3.08	6.16	R	3.08	3.08	0.77	3.08	3.08	3.08	3.08	0.77	0.77	0.77
10	R	R	R	R	2.25	R	R	R	R	4.50	R	0.28	8.99	8.99
11	1.89	1.89	1.89	1.89	3.78	1.89	1.89	3.78	1.89	3.78	3.78	0.47	0.47	0.47
12	10.40	10.40	5.20	5.20	2.60	5.20	2.60	10.40	5.20	5.20	2.60	0.16	2.60	2.60
13	9.70	9.70	4.85	4.85	4.85	2.42	4.85	9.70	4.85	4.85	2.42	0.60	2.42	4.85
14	R	11.41	R	R	11.41	R	R	R	R	R	R	0.18	R	R
15	R	R	R	R	R	R	R	R	R	R	R	0.46	R	R
16	2.61	10.46	2.61	2.61	2.61	10.46	2.61	10.46	R	R	R	0.16	R	R
17	13.50	6.75	6.75	6.75	6.75	3.37	13.50	6.75	1.68	1.68	3.37	0.84	0.42	0.84
18	7.45	7.45	7.45	1.86	7.45	14.90	3.72	3.72	3.72	3.72	3.72	0.93	1.86	3.72
19	R	R	R	R	R	R	R	R	R	R	R	5.25	R	R
20	R	R	R	R	R	R	R	3.16	R	R	R	6.32	0.79	0.39
21	R	R	R	R	R	R	0.56	R	0.56	0.14	0.14	0.56	R	R
22	7.45	7.45	7.45	14.90	7.45	14.90	7.45	7.45	7.45	3.72	14.90	0.93	3.72	3.72
Stan ar	0.08	5.7	0.01	5.7	0.01	0.01	2.8	5.7	0.03	0.004	0.06	0.03	0.008	0.03

A= *E. coli*; **B=** *E. cloacae*; **C=** *B. subtilis*; **D=** *B. cepacea*; **E=** *M. luteus*; **F=** *S. aureus*; **G=** *P. aeruginosa*; **H=** *K. pneumoniae*; **I=** *A. niger*; **J=** *A. sydowii*; **K=** *A. parasiticus*; **L=** *T. rubrum*; **M=** *C. albicans* **and N=** *I. orientalis*; **R= resistant; Ampicillin and nystatin were standard controls for anti-bacterial and anti-fungal, respectively.**

Table 10. MIC of various Schiff base derivatives (23-33) prepared from 3,4-methylenedioxy cinnamaldehyde

Test Compounds/ Entry	Antimicrobial activity against standard microbial cultures (mM)													
	Bacteria								Fungi					
	A	B	C	D	E	F	G	H	I	J	K	L	M	N
23	1.99	0.99	1.99	0.49	0.99	1.99	0.25	0.99	0.99	1.99	1.99	0.99	0.99	0.49
24	R	R	R	R	R	R	R	R	R	3.21	1.60	0.40	R	R
25	R	R	0.85	1.70	0.85	0.85	R	R	1.70	0.85	1.70	0.21	1.70	1.70
26	0.97	0.48	0.12	1.93	0.97	0.48	R	0.97	3.87	1.93	3.87	0.24	0.97	0.97
27	0.81	0.81	0.40	0.81	0.20	0.20	0.81	0.81	R	R	R	0.40	0.81	1.62
28	R	R	0.73	0.73	0.73	0.73	R	R	R	R	R	0.18	0.73	0.73
29	R	R	1.42	1.42	0.71	0.71	R	R	R	0.71	0.71	0.17	1.42	1.42
30	R	0.77	0.77	0.77	0.77	0.38	R	R	R	R	R	0.19	0.77	0.77
31	R	R	R	R	R	R	R	R	R	R	R	R	8.57	8.57
32	R	R	R	R	R	R	R	R	R	R	R	R	R	R
33	1.90	0.95	3.78	0.47	1.90	1.90	0.01	1.90	0.95	1.90	1.90	0.47	0.47	0.47
Standard	0.08	5.7	0.01	5.7	0.01	0.01	2.8	5.7	0.03	0.004	0.06	0.03	0.008	0.03

A= *E. coli*; **B=** *E. cloacae*; **C=***B. subtilis*; **D=** *B. cepacea*; **E=** *M. luteus*; **F=** *S. aureus*; **G=** *P. aeruginosa*; **H=** *K. pneumoniae*; **I=** *A. niger*; **J=** *A. sydowii*; **K=** *A. parasiticus*; **L=** *T. rubrum*; **M=** *C. albicans* **and N=** *I. orientalis*; **R= resistant; Ampicillin and nystatin were standard control for anti-bacterial and anti-fungal, respectively.**

Naturally occurring limonene to cinnamyl-type γ-butyrolactone substituted aldol condensation derivatives

Method was developed for the synthesis of γ-butyrolactone substituted aldol condensation derivatives under milder basic conditions to serve as antioxidant compounds. Proline and triethylamine were used as base for the preparation of different substituted hydroxyl and methoxy derivatives. The antioxidant activity of all the synthesized compounds (**Fig. 33**) was assessed using DPPH (1,1-diphenyl-2-picrylhydrazyl) radical scavenging, ABTS [2,2′-azino-bis(3-ethylbenzothiazoline-6-sulfonic acid) diammonium salt] cation radical and FRAP (ferric reducing ability of plasma) bioassays. Among these, **5** and **6** with IC_{50}: 0.26±0.39 and 0.29±0.26 mM displayed higher activity than the standard antioxidants (**Table 11**).

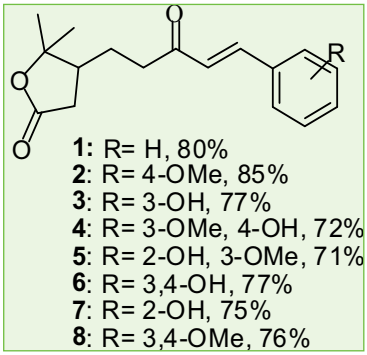


Fig. 33 Chemical structures of cinnamyl-type γ-butyrolactone derivatives

Table 11. Antioxidant activities of compounds

Compound	DPPH radical scavenging activity (IC_{50}, mM)	ABTS cation radical scavenging activity (IC_{50}, mM)	Reducing power (IC_{50}, mM)
1	NA	NA	NA
2	NA	NA	NA
3	>3.0	>3.0	>3.0
4	>3.0	0.30±0.28	>3.0
5	>3.0	0.26±0.39	>3.0
6	0.37±0.24	0.29±0.26	0.11±0.27
7	>3.0	0.84±.18	>3.0
8	NA	NA	NA
AA[a]	0.87±0.16	1.37±0.23	0.18±0.34
BHT[b]	2.28±0.29	0.73±0.31	2.88±0.29
BHA[c]	0.31±0.12	0.31±0.20	1.28±0.37

[a]AA- ascorbic acid; [b]BHT- butylated hydroxyl toluene; [c]BHA-butylated hydroxyl anisole

NATURAL PRODUCT CHEMISTRY

SHATAVARI (*Asparagus racemosus*)

The plant is rich in compounds having galactogogue, anti-inflammatory and immunomodulatory properties. Thus, a new furostane steroidal saponin, shatavaroside C and a diphenylpentendiol, shatavarol, were isolated from its roots along with five known compound such as shatavarin IV, racemoside A, β-sitosterol, stigmasterol and ursolic acid. Racemoside A was also reported from its roots for the first time (**Fig. 34**).

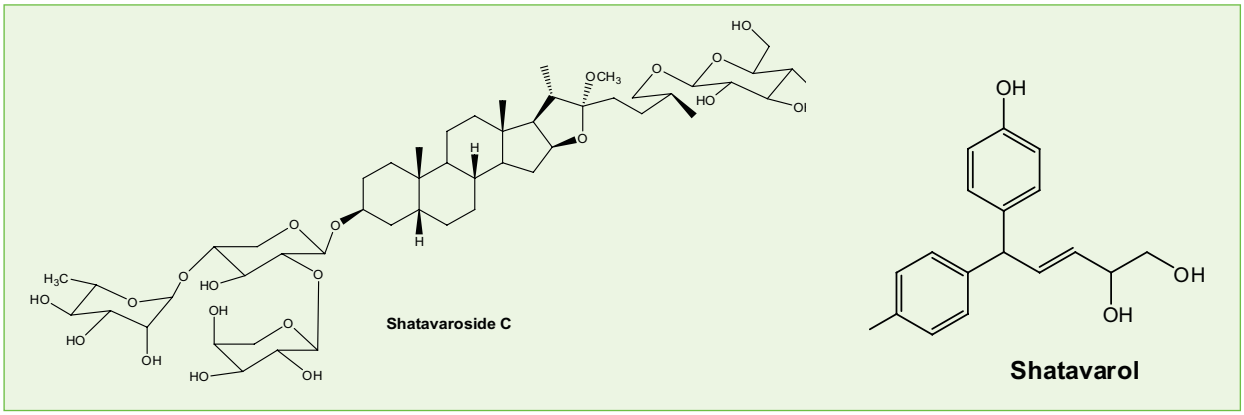


Fig. 34 Chemical structures of new compounds isolated from *A. racemosus*

GUDUCHI (*Tinospora cordifolia*)

The plant is known for its immunomodulatory activity. Hence, different polysaccharide enriched fractions were prepared and evaluated for immunomodulatory activity by the polymorphonuclear leukocyte function test. The GC-MS analysis of derivatized active fractions showed the presence of glucose, fructose and arabinose as major components (**Fig. 35**).

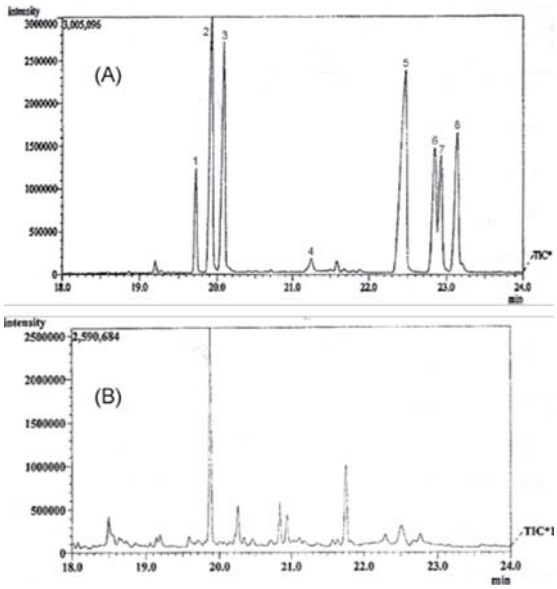


Fig. 35 GC-MS chromatogram of (A) standard sugar mixture where 1: rhamnose, 2: arabinose, 3: xylose, 4: galactose, 5: inositol, 6: mannose, 7: glucose and 8: fructose; (B) active fraction

PINK RAIN LILY *(Zephyranthes grandiflora)*

The different species of *Zephyranthes* are widely used as folk medicines in many countries for the treatment of *Diabetes mellitus*, tumor, breast cancer, viral infections, and ear and chest ailments. The amaryllidaceae alkaloids (AAs) of this genus are responsible for various pharmacological activities. Galanthamine alkaloid is the most important acetylcholinesterase inhibitor used for the treatment of Alzheimer disease. Thus, a new betaine type amaryllidaceae alkaloid, Zephgrabetaine (**Fig. 36**) was isolated from the bulbs of this plant along with seven known alkaloids namely, lycorine, galanthine, lycoramine, hamayne, haemanthamine, tortuosine and ungeremine. The isolated alkaloids were also tested for *in vitro* cytotoxic activities against two cell lines, C-6 (rat glioma cells) and CHO-K1 (Chinese hamster ovary cells). All the alkaloids exhibited a dose dependent cytotoxic effect, against two cancer cell lines with prominent activity of lycorine and haemanthamine.

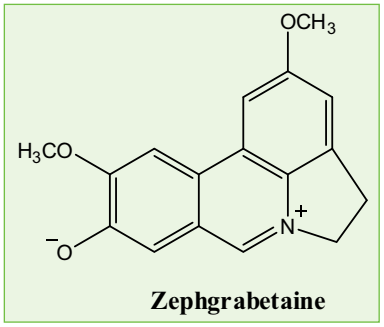
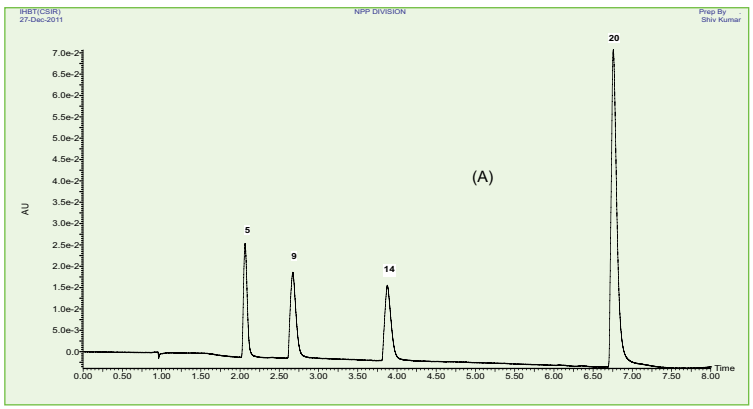


Fig. 36 Chemical structures of new alkaloid isolated from *Z. grandiflora*

A simple, rapid and reliable ultra performance liquid chromatography method was developed and validated for simultaneous quantification of bioactive AAs *viz*. lycoramine, hamayne, haemanthamine and tortuosine. The analytes were separated using a BEH C_{18} column (1.7 µm, 100 mm x 2.1 mm) and a linear gradient elution with acetonitrile and water (0.05% formic acid) was used as the mobile phase at a flow rate of 0.3 mL/min and at λ_{max} 280 nm. The method was validated for specificity, linearity (R^2=0.9999, linear range: 0.005 ~ 0.5 mg/mL), precision (intra-day RSDs<1.33% and inter-day RSDs<2.67%) and recovery (97.8–105.3%). The method was also applied for identification of AAs in the plant. In total, seventeen AAs of different structural types *viz*. lycorine-type, haemanthamine-type, galanthamine-type, narciclasine-type were characterized (**Fig. 37** & **38**). The concentration of the alkaloids was highest during rainy season.



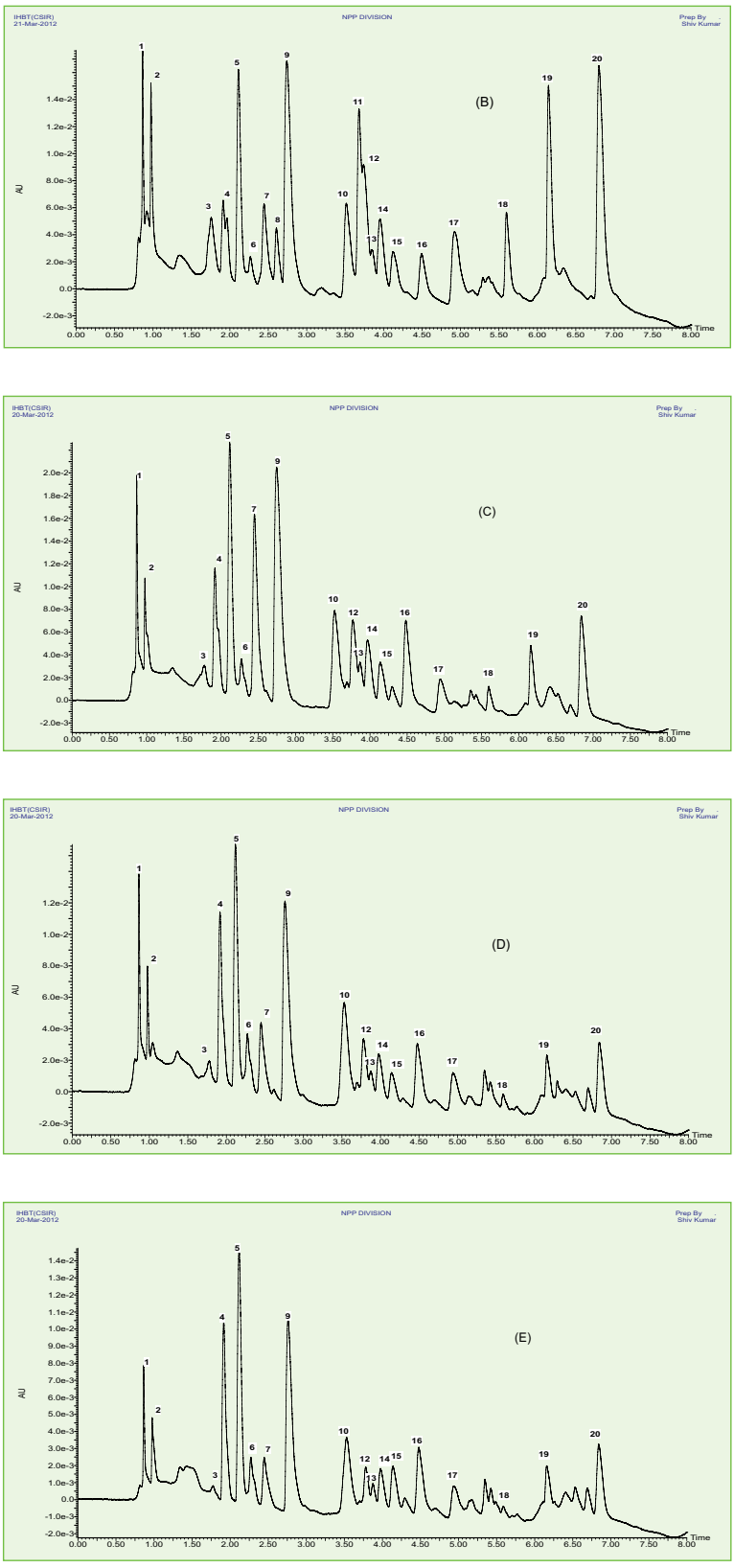


Fig. 37 UPLC Chromatograms of (A) mixture (B) sample of spring season (C) sample of rainy season (D) sample of autumn (E) sample of winter

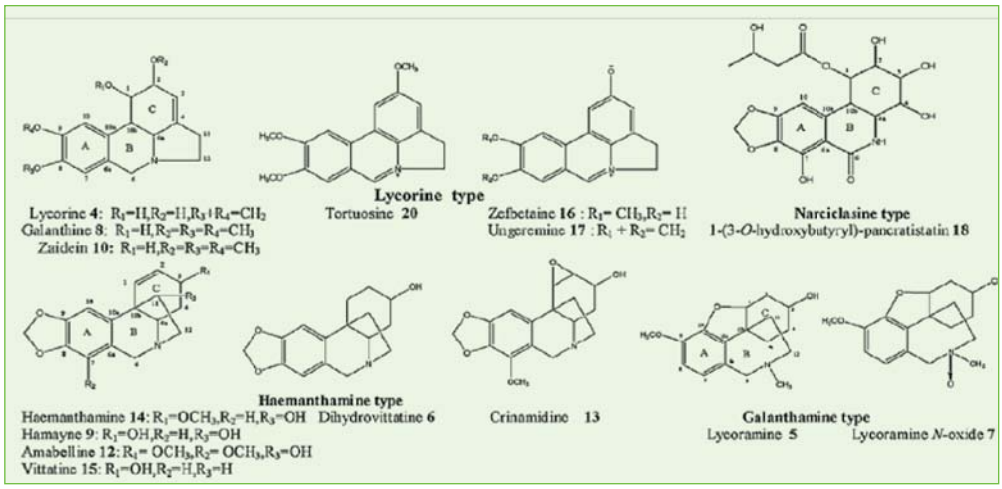


Fig. 38 Chemical structures of the AAs identified in *Z. grandiflora*

SKIMMIA (*Skimmia laureola*)

This evergreen, glabrous shrub of Himalaya is used for the treatment of cold, fever and headache. GC-MS analysis of the hydrodistillate revealed the presence of 20 constituents representing 94.6% of the total oil. The major constituents of oil were linalyl acetate (33.0%), linalool (25.0%), limonene (8.1%), α-terpineol (5.9%) and geranyl acetate (5.9%).

PICRORHIZA (*Picrorhiza kurrooa*)

Traditionally, the plant is known for hepatoprotective effects. Two known compounds, luteolin-5-O-glucoside and picein were isolated from the n-butanol extract of aerial parts. The extract, fractions and isolated molecules showed very good antioxidant activity.

Population assessment and identification of superior genetic stock of *Picrorhiza kurrooa* Royle ex Benth and *Valeriana jatamansi* Jones by screening different populations from North-Western Himalayas (HP and Uttarakhand) (Funded by National Medicinal Plant Board)

Thirty eight samples of *V. jatamansi* were analyzed for valepoteriate contents by HPLC. The content ranged between 0.5-2.1%. The sample HFRI\VJ\04\KLK\201 was observed to have highest content of valepoteriate (2.1%).

Fifty six samples of *P. kurroa* were analyzed for picrosides (picroside-I and picroside-II) content by HPLC. The picroside content ranged between 0.15-6.7%. Three samples showed more than 5% of total picroside (P-I and P-II) content. The sample HFRI\PK\03\KKF showed the highest picroside content (P-I=2.3% and P-II=3.4%).

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

In continuation to previous work, the extracted fraction of a few plants (*Funaria hygrometrica, Helianthus annuus, Brassica juncea, Musa acuminata*) showed highest uptake of radionuclide. When it

was subjected to column chromatographic purification, three molecules were isolated. Of these, only one showed 100% uranium uptake.

SEABUCKTHORN (*Hippophae rhamnoides*)

Preparation and phytochemical characterization of extracts from berries of *Hippophae rhamnoides* (seabuckthorn) for onward evaluation of radioprotective efficacy (Funded by INMAS (DRDO), Govt. of India)

Various extracts/fractions were prepared and screened for their radioprotective effect. One of the fractions (AKMB-11-01) showed radioprotection to mice population in terms of survival. However, it caused some toxicity and the number of micronuclei in the peripheral blood increased.

EUCALYPTUS (*Eucalyptus youmanni*)

The plant is a good source of rutin (quercetin-3-O-rutinoside) (**Fig. 39**) which is used for various therapeutic purposes. However, there is a lack of commercially established process nationally for its production from this plant. Therefore, a lab scale water based process was developed for isolation of rutin from leaves. Studies on process variables like leaves, extraction solvent ratio and extraction time were optimized. The upscaling of the process is under progress.

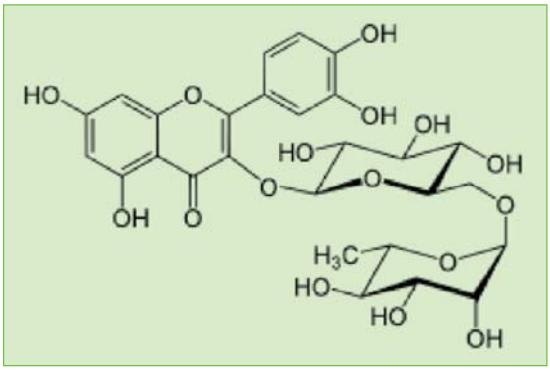


Fig. 39 Chemical structure of rutin

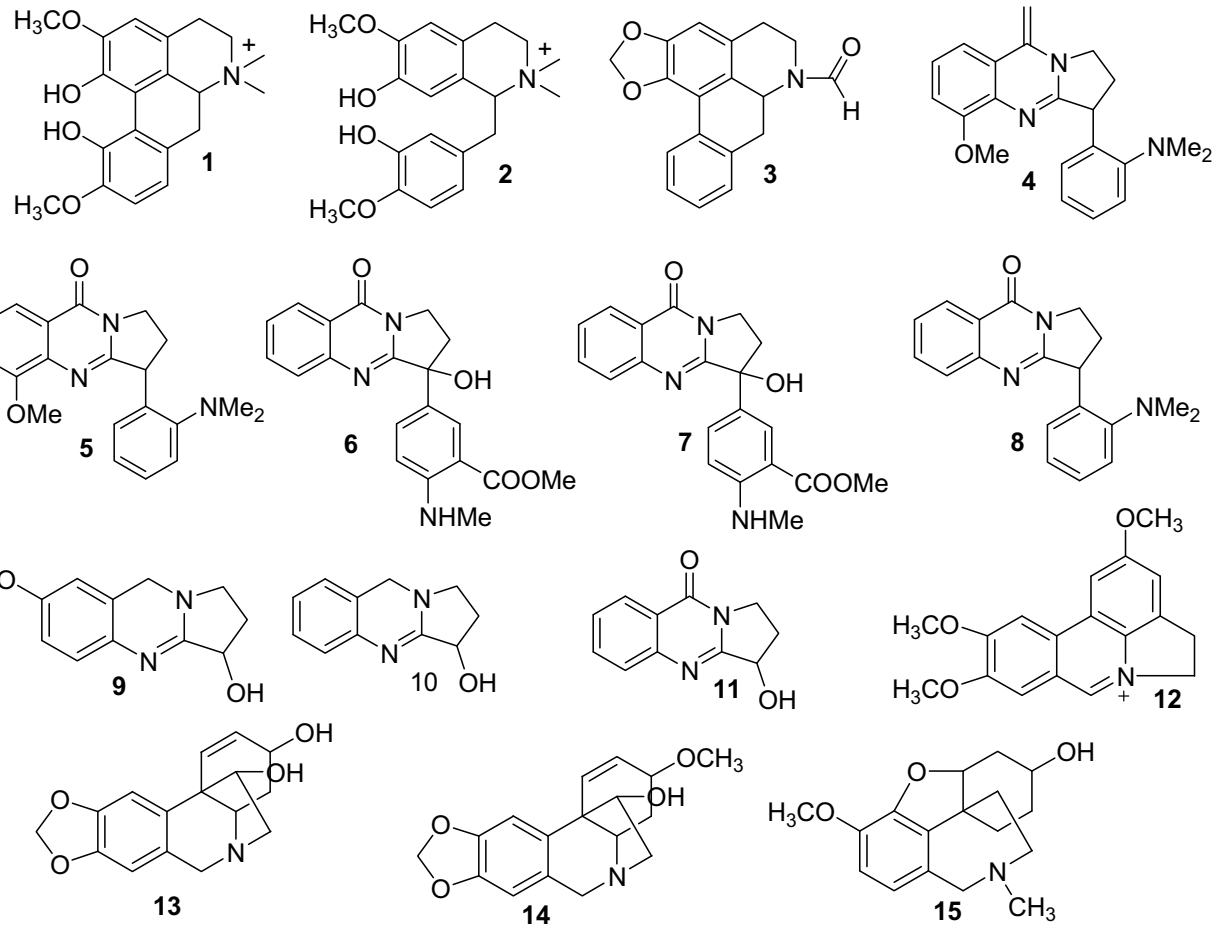
INDIAN HORSE CHESTNUT (*Aesculus indica*)

The plant is widely distributed in the temperate Himalaya. Its anti-inflammatory, vasoconstrictor and vasoprotective properties are attributed to a mixture of saponins commonly known as aescin. Lab scale experiments were conducted on optimization of liquid-liquid extraction (LLE) unit operation, a key step in the isolation of β-aescin. Optimization of solvent to seed ratio, dilution factor of feed prior to LLE and solvent to feed in the LLE step were also carried out.

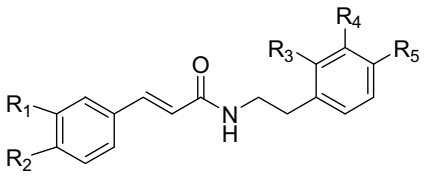
LIBRARY OF NATURAL, SEMISYNTHETIC AND SYNTHETIC COMPOUNDS

Natural Compounds

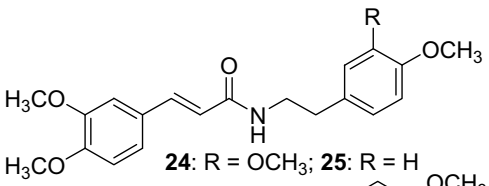
Alkaloids



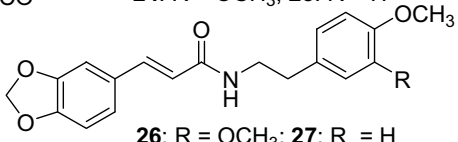
Amides



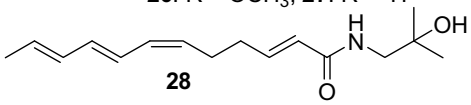
16: $R_1 = R_2 = R_3 = R_4 = R^5 = H$
17: $R_1 = R_2 = R_3 = R^4 = H$, $R_5 = OCH_3$
18: $R_1 = R_2 = R_4 = R_5 = H$, $R_3 = OCH_3$
19: $R_1 = R_2 = R_4 = R_5 = H$, $R_3 = Br$
20: $R_1 = R_2 = R_3 = R_4 = H$, $R_5 = Br$
21: $R_1 = R_2 = R_3 = R_5 = H$, $R_4 = Br$
22: $R_1 = R_2 = R_3 = H$, $R_4 = Br$, $R_5 = OCH_3$
23: $R_1 = R_5 = OCH_3$, $R_2 = OH$, $R_3 = R_4 = H$



24: R = OCH_3; **25**: R = H



26: R = OCH_3; **27**: R = H



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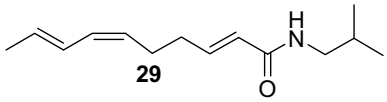

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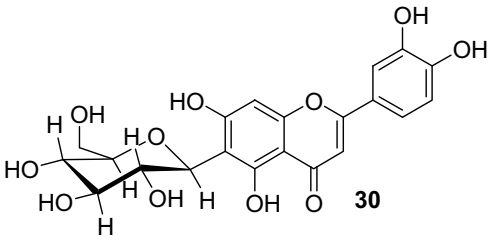
Polyphenols, lignans and flavonoids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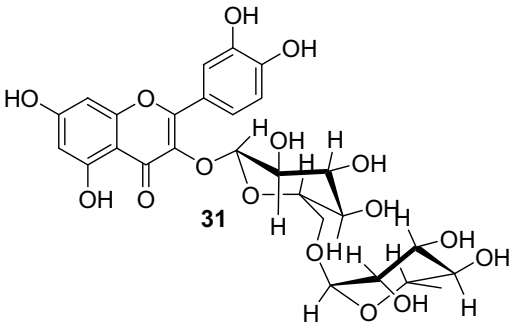
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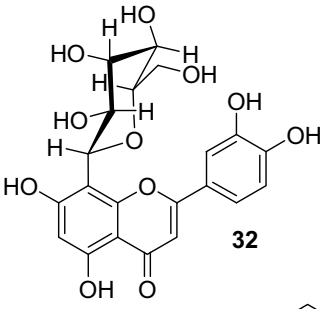
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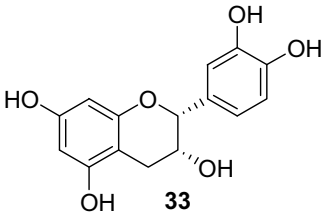
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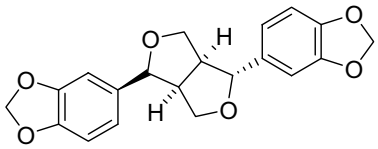
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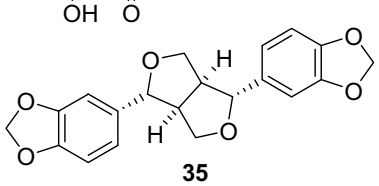
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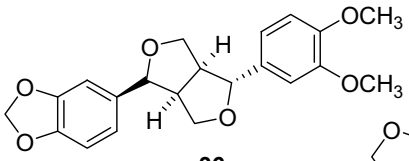
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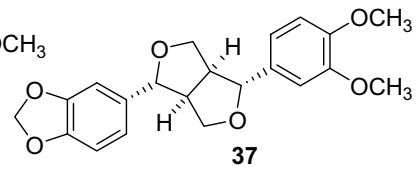
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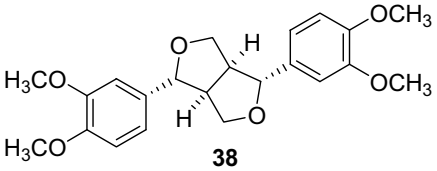
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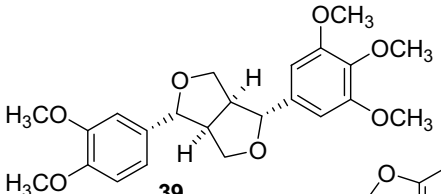
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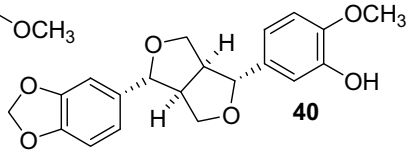
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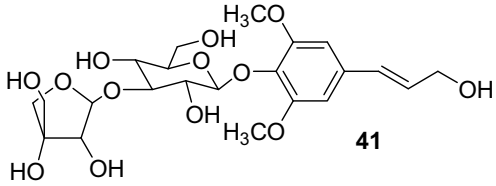
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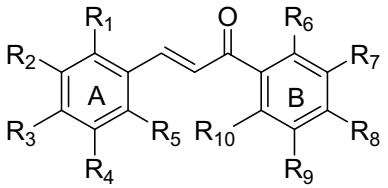
Chalcones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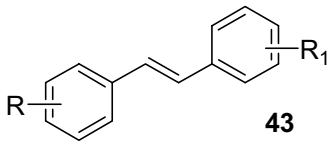
R_1, R_2, R_3, R_4, R_5, R_6, R_7, R_8, R_9, R_{10}, = H, Cl , OCH_3, Br, NO_2, OH etc.

Stilbenes



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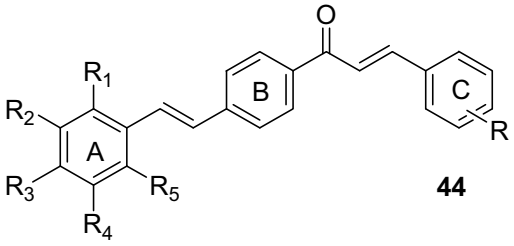
R, R1 = OCH_3, OH, Cl, NO_2, CF_3, C_6H_5 etc.

Hybrids of stilbene-Chalcone



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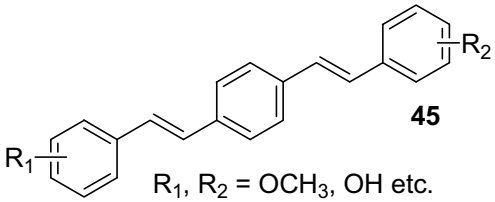
R, R_1, R_2, R_3, R_4, R_5 = H, OCH_3, OH, $COCH_3$ etc.

Distyrylbenzene



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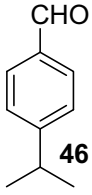
R_1, R_2 = OCH_3, OH etc.

Monoterpene and sesquiterpenes



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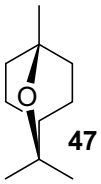

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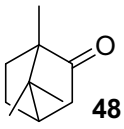

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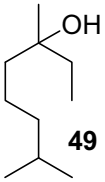

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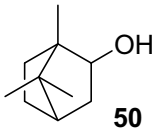

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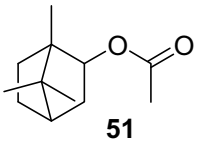

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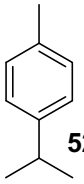

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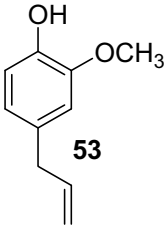

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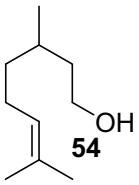

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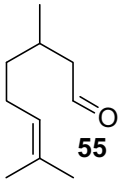

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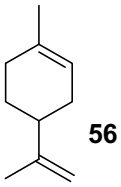

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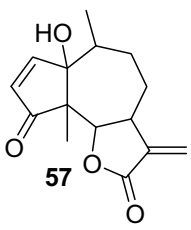
Sesquiterpene Lactones



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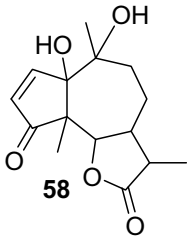

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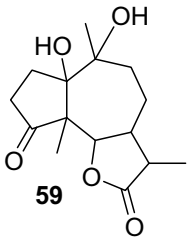

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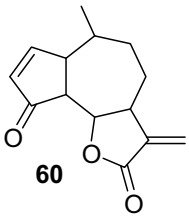

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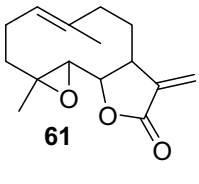

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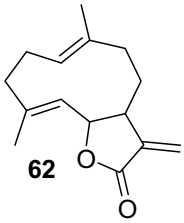

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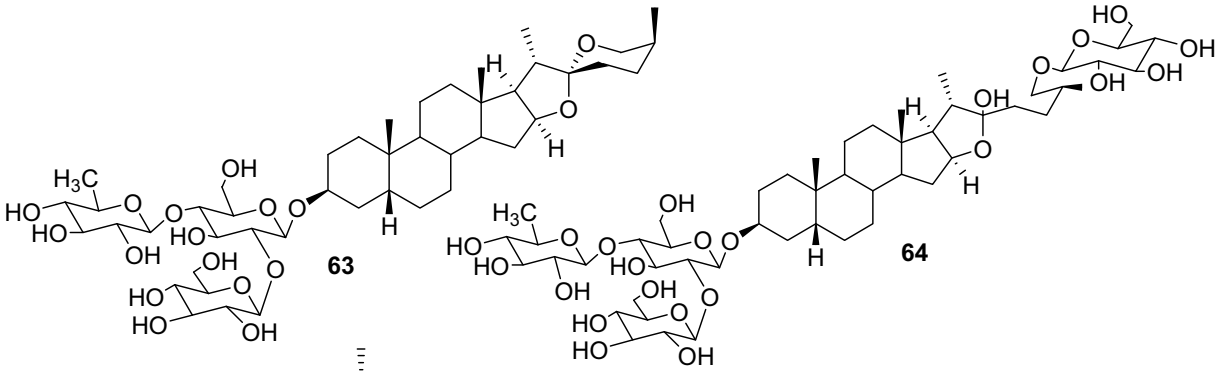
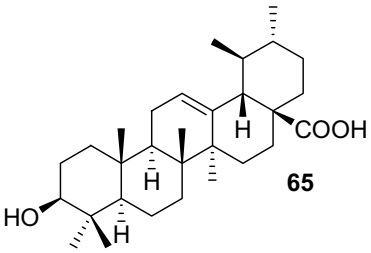
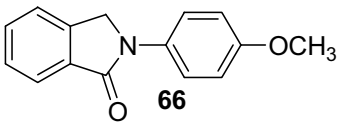
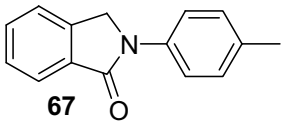
Triterpenes & Saponins

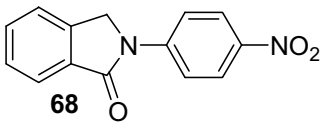


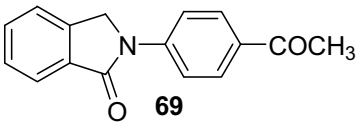


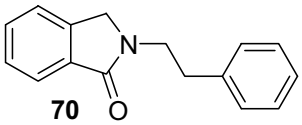
Synthetic Molecules

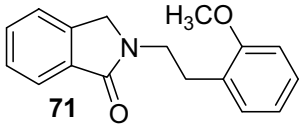


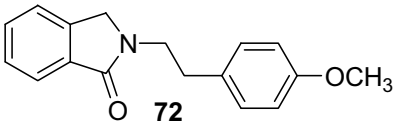


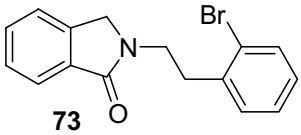


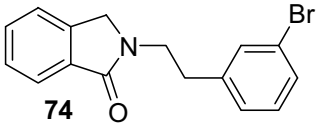


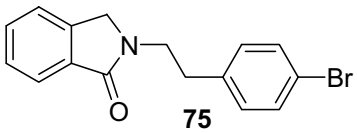


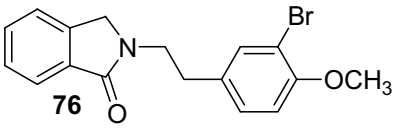


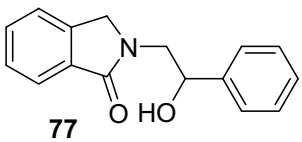


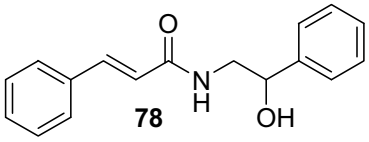


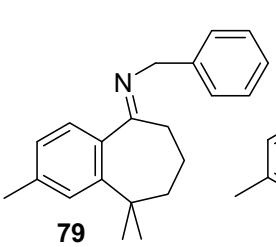


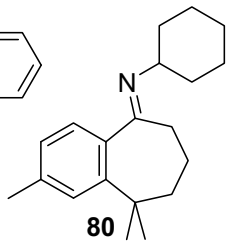


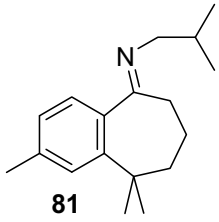


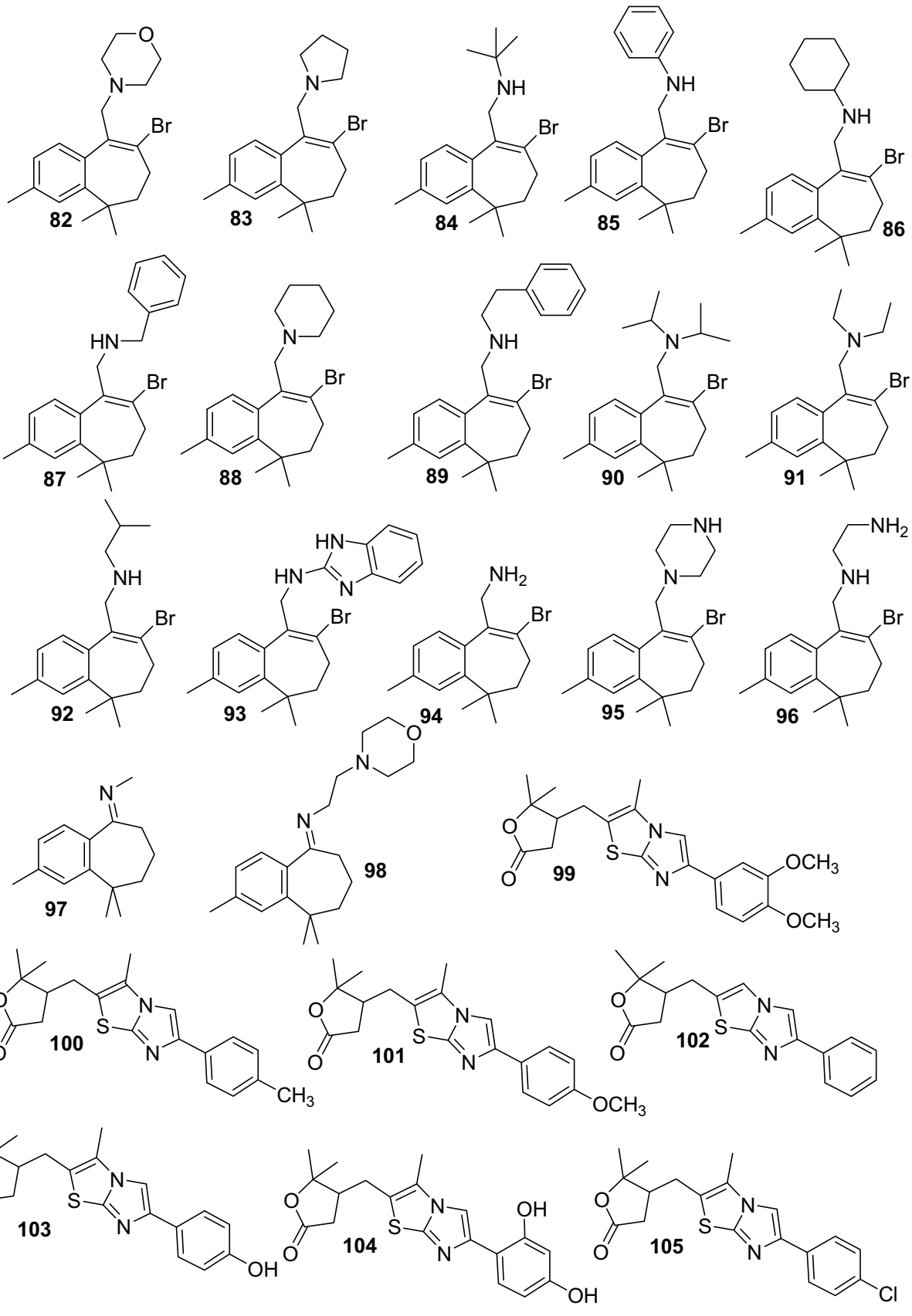








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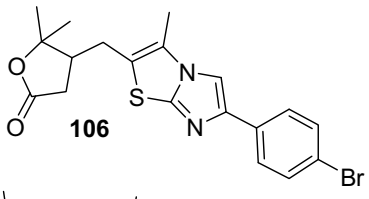

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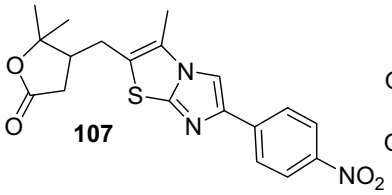

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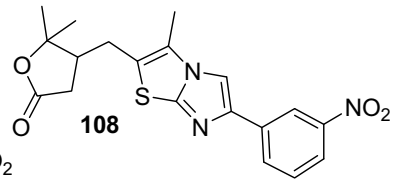

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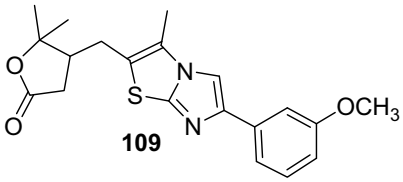

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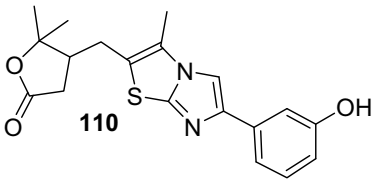

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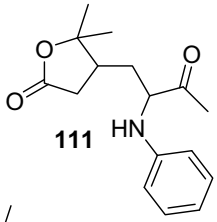

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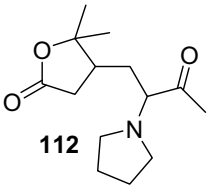

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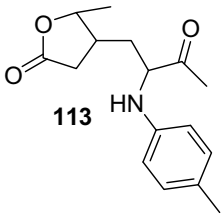

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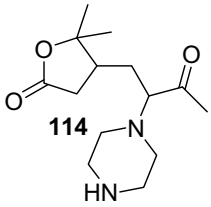

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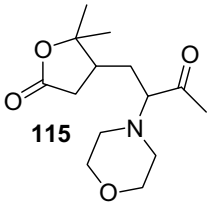

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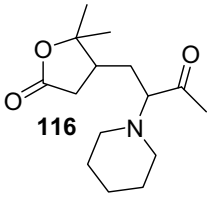

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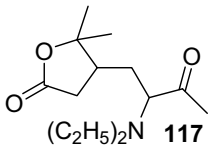

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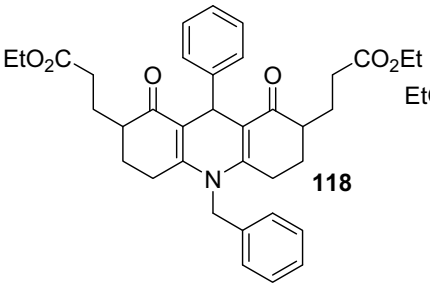

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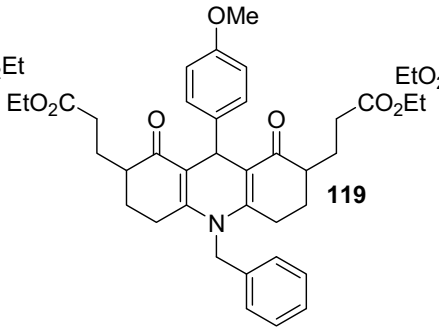

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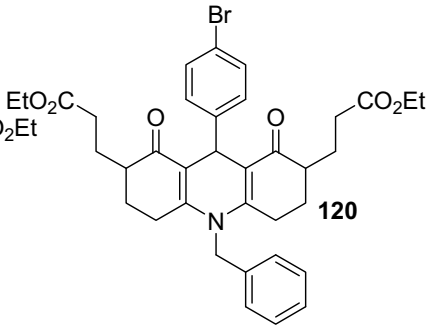

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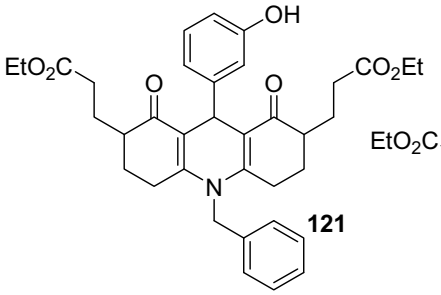

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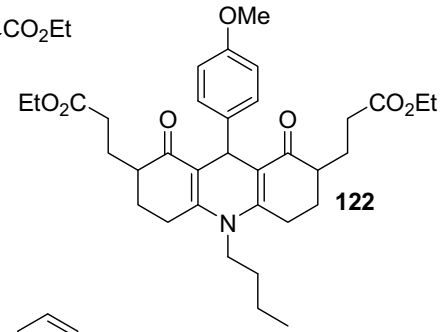

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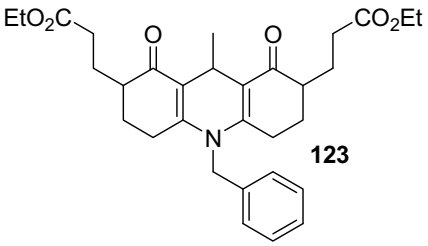

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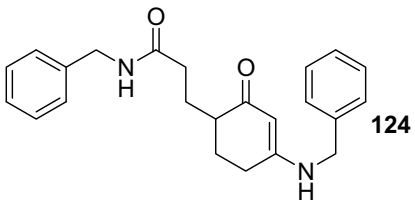

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REGULATORY RESEARCH

Screening of high value compounds from western Himalayan bioresource

Regulatory Research Center (RRC) is involved in *in vitro* and *in vivo* screening of molecules from western Himalayan bioresource for their anti-cancer, anti-diabetic, anti-inflammatory, nephro and hepatoprotective activities. Toxicological safety evaluation of novel food constituents, cosmetic products and pharmaceuticals of natural origin is another important activity of RRC. Several plant products, plant derived natural compounds and their chemical analogues were screened *in vitro* as well as *in vivo* for their potential anti-diabetic and anti-cancer activities.

In vivo studies

Acute dermal toxicity of aescin extracted from *Aesculus indica* was determined by Limit test on 14 wistar rats for its intended use in cosmetic products. The test formulation was applied to the dorsolateral area of the shaved skin as a single dermal patch to the rats (**Fig. 40**).

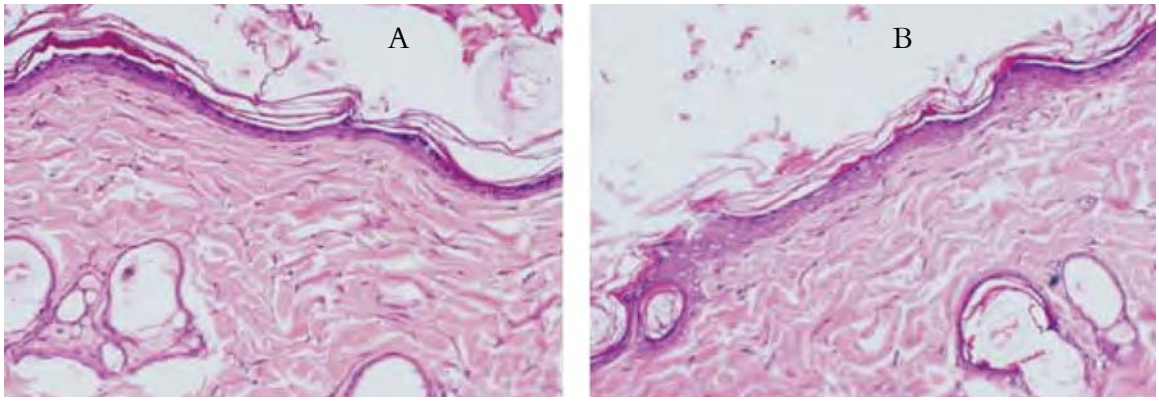


Fig. 40 Dermal toxicity evaluation of aescin. Skin section of (A) normal control (B) treated rats

In vitro studies

Based on their cytotoxic potential, different tissue representative human cancer cell lines were effectively utilized to screen various molecules and formulations for their anticancer activities. In a separate study C-6, A-549, CHOK1 and THP-1 cells were treated with different concentrations of essential oil of *Malus domestica* for the evaluation of its cytotoxic potential (**Table 12**). Among the different concentrations 1000 µg/ml was found to be effective with more than 50% cytotoxicity (**Fig. 41**).

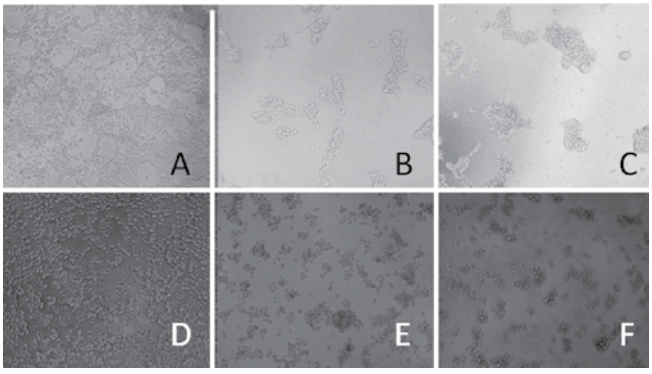


Fig. 41 Microscopic images of C-6 (A-C) and THP-1 (D-F) cells treated with essential oil of leaves of *Malus domestica*. (A) control (B-C) treatment with 1000 µg/mL test compound for 24 hrs (B) 48 hrs (C) (D) control (E-F) treatment with 1000 µg/mL test compound after 24 hrs (E) and 48 hrs (F)

Table 12 *In vitro* cytotoxicity against different cancer cell lines by SRB assay

Sample Conc. (μg/mL)	Growth inhibition percentage			
	C-6	A-549	CHOK1	THP-1
100	5.5	11.5	0	0
300	18.8	1.5	13.5	19.9
Essential oil of leaves of *M. domestica*				
1000	58.5	60.7	68.3	65.7
1500	68.0	74.5	70.8	na
2000	98.2	76.7	69.5	na
Mitomycin C				
(1 μM)	65.7	76.4	75.4	na
Vinblastin				
(1 μM)	na	na	na	73.1

na: The activity not observed

MULTIDISCIPLINARY APPROACHES TO CROP IMPROVEMENT

BAN KAKDI (*Podophyllum hexandrum*)

P. hexandrum Royle (syn, *Sinopodophyllum hexandrum*; Berberidaceae) is an endangered species, commonly known as Himalayan mayapple. It is confined to alpine regions of the Himalayas from Ladakh to Sikkim at altitudes of 3000–4200 m. Its rhizomes are known for podophyllotoxin having anticancer properties.

Identification and characterization of novel UniGene-derived microsatellite markers in *Podophyllum hexandrum*

The level and distribution of genetic diversity was estimated for its effective conservation. In total 1084 FASTA formatted EST sequences were retrieved from NCBI for subsequent data mining. A non-redundant (NR) expressed sequence data set of 26.94 kb was created by clustering random ESTs into 655 unigenes (195 contigs and 460 singletons). The clustering of ESTs with DNAstar resulted in 41 unigenes containing 47 SSRs. Non-redundant data represented 33 trirepeats, 9 tetrarepeats, 4 pentarepeats and 1 direpeat. Among the trirepeats, (TTC)*n*, and (GAT)*n* were most abundant followed by (GGA)*n*, (GAA)*n* and (CTT)*n*. In amplification-based validation of the 47 UniGene MicroSatellite (PHUGMS) primer pairs, expected amplicons were observed in the target DNA with 36 primer pairs. Of these, 20 PHUGMS markers were polymorphic among the tested populations. The identified PHUGMS markers were moderately to highly polymorphic having a total of 91 alleles. The number of alleles ranged between 2 to 9 with an average 4.55 alleles per locus. The expected and observed heterozygosity obtained by Popgene software package ranged from 0.239 to 0.869 (av. 0.687) and 0.067 to 1.000 (av. 0.703), respectively. A representative profile generated with primer PHUGMS 21 is given in **Fig. 42**.

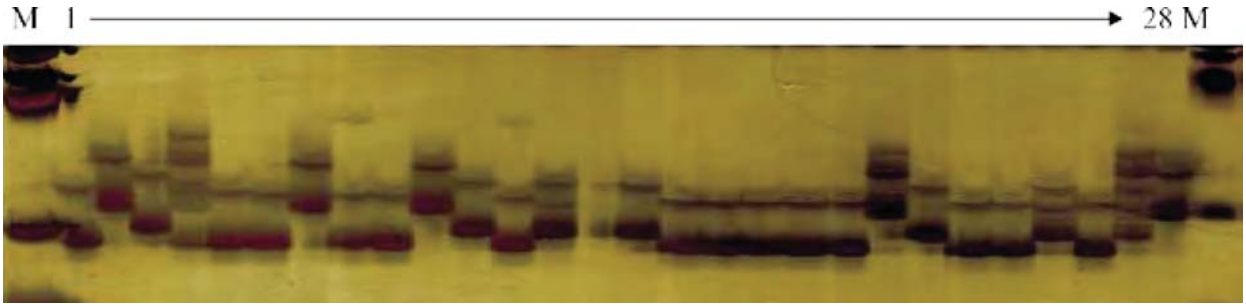


Fig. 42 Representative picture of amplification validation generated with PHUGMS 21. M: 50 bp ladder standard, lanes 1-28: selected *P. hexandrum* accessions

Seed germination protein profiles

In continuation to previous studies on 2-DE and Peptide Mass Fingerprint (PMF) analyses, of seed germination protein profiles, several proteins of dormant and germinating seeds were identified. Twenty of these were involved in carbohydrate and amino acid metabolism, 17 in ABA/GA signalling, 15 in stress and 7 were with unknown functions. Two-DE and MS/MS analysis in conjunction with semi-quantitative RT-PCR data of cell wall hydrolyzing genes revealed the up-accumulation of cell wall hydrolases such as β-1, 3-glucanase and XET

(**Fig. 43)**.These probably weakened the thick walled endosperm at the micropylar end and facilitated radicle protrusion.

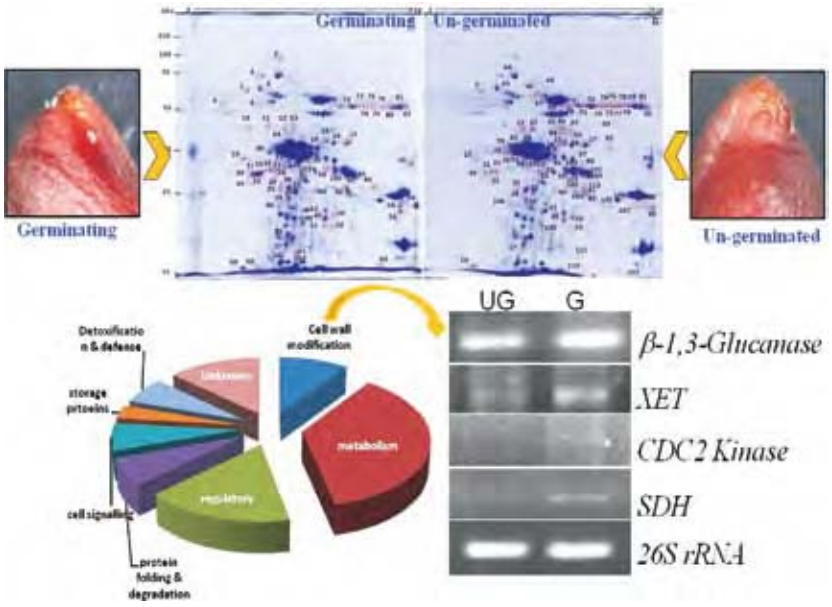


Fig. 43 2-DE analysis of seed germination proteins in *P. hexandrum*

ATISH (*Aconitum heterophyllum*)

In continuation to earlier studies on comparative 2-DE analysis of protein profiles of ethanol treated and untreated germinating seeds, 40 differentially expressed proteins were recorded at Phase II. Twenty seven out of 40 proteins were induced, 5 were increased and 8 were repressed. Mass spectrometry and subsequent identification confirmed that these proteins were involved in metabolism, DNA regulation, stress tolerance and plasma membrane/cell wall biosynthesis/ extension processes (**Fig. 44**). These protein changes might be responsible for physiological and physical changes and subsequent increase in germination percentage.

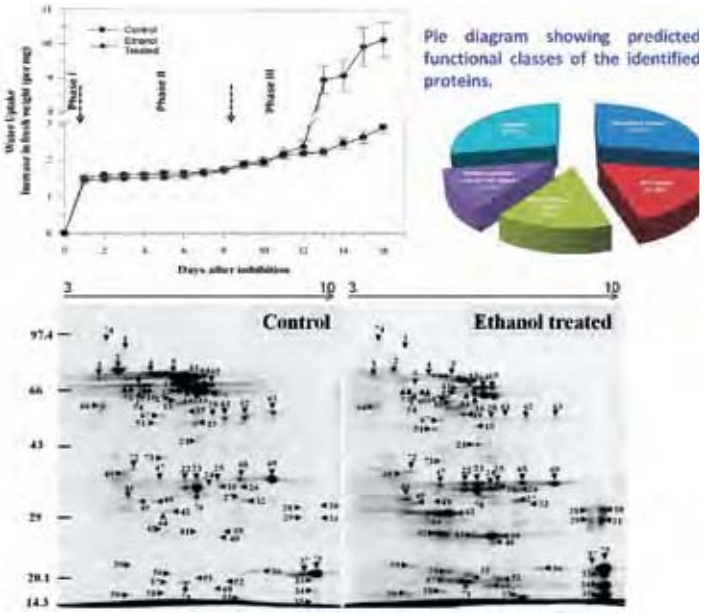


Fig. 44 2-DE analysis of protein changes during ethanol induced seed germination in *A. heterophyllum*

KUTKI (*Picrorhiza kurrooa*)

Transcriptome analysis of *Picrorhiza kurrooa* for picrosides biosynthesis pathway

Previous studies on transcriptome analysis of *P. kurrooa* for molecular regulation of monoterpenoids, picroside I and II was continued. High throughput *de novo* transcriptome sequencing was carried out at temperatures known to modulate the biosynthesis of picrosides (15 and 25 °C). Using pair end Illumina sequencing technology, a total of 20,593,412 and 44,229,272 paired end reads were obtained (**Table 13**). Annotation of the transcriptome followed by expression profiling through read per exon kilobase per million (RPKM) revealed a total of 74,336 assembled transcript sequences with an average coverage of 76.6 and length of 439.5. Intense transcriptome changes at the two temperatures were also observed (**Fig. 45)**. When genes/transcription factors involved in mevalonate, 2-C-methyl-D-erithritol

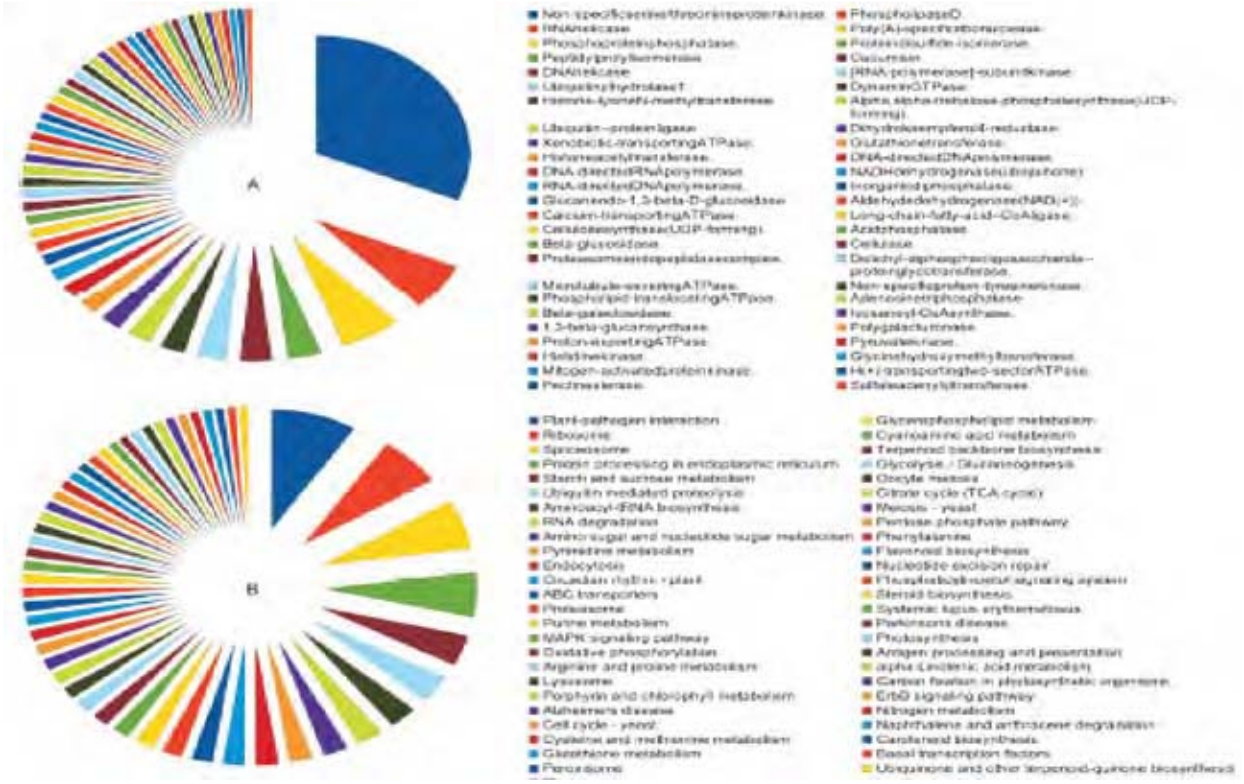


Fig. 45 Functional characterization of *P. kurrooa* transcriptome classified into top 50 abundant enzyme classes. Values in percent are represented as pie diagram

Table 13 Summary of transcriptome data generated on Illumina Genome Analyzer IIx for leaf tissue of *P. kurrooa* at 15 and 25 °C

Generated data	15 °C	25 °C	Total/Pooled
Total number of paired end reads	27,562,496	49,274,224	76,836,720
No. of reads obtained after quality filtering	20,593,412	44,229,272	64,822,684
No. of assembled transcripts	31,338	63,718	74,336
Average length of transcripts (in base pair)	403.87	434.39	439.5
Average coverage	64.68	71.26	76.6

4-phosphate of phenyl propanoid pathways were subjected to RT-PCR, 19 out of 21 genes were validated. The genes were found to be up-regulated at 15 °C. Based on the obtained data, the KEGG pathways were validated (**Fig. 46**).

In vitro shoot cultures were raised from *ex vitro* leaves. The *in vitro* leaves were then used to develop direct as well as indirect regeneration protocols. The middle portion of leaf explants resulted in maximum shoot number (42.0) after thidiazuron (TØ) treatment for 15 days. The abaxial surface that was in touch with the medium was more responsive (**Fig 47 AB**). Increase in cell layers from 6-7 to 8-9 and cell size from 0.28 µm to 0.50 µm coupled with small pockets of dividing cells or meristemoids prior to callusing or organogenesis were also observed (**Fig. 48**). Scanning electron micrographs showed direct emergence of shoot buds or indirect emergence of shoot bud primordia from callus (**Fig. 49**). While optimum shoot multiplication occurred on medium containing 2.32µM Kn, well developed rooting of microshoots was observed on basal MS medium after 4 weeks. The survival percent of the plants under green house conditions was enhanced by treatment at 15°C for 10 days. In flow cytometric analysis, no significant differences in the 2C DNA (~2.20 pg) contents of the *in vitro* raised and source plants (**Fig. 50**) indicated genetic stability.

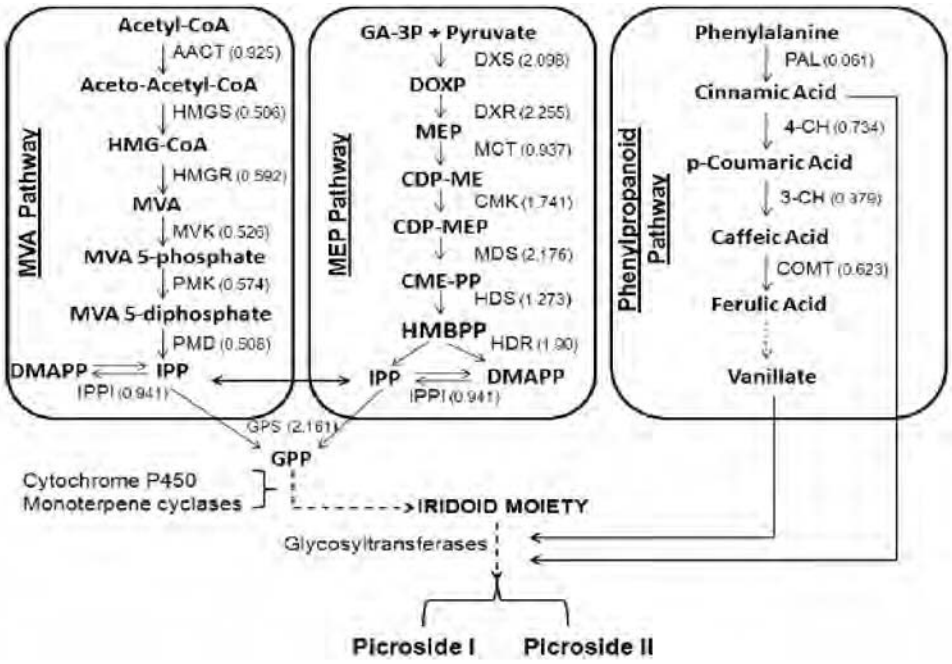


Fig. 46 Transcriptome data on the effect of temperature on picrosides biosynthesis genes of *P. kurrooa* in KEGG pathways. Numerals in parenthesis indicate fold change in gene expression at 15 and 25 °C based on RPKM values. (Source: *BMC Genomics*: 13: 126. doi:10.1186/1471-2164-13-126)

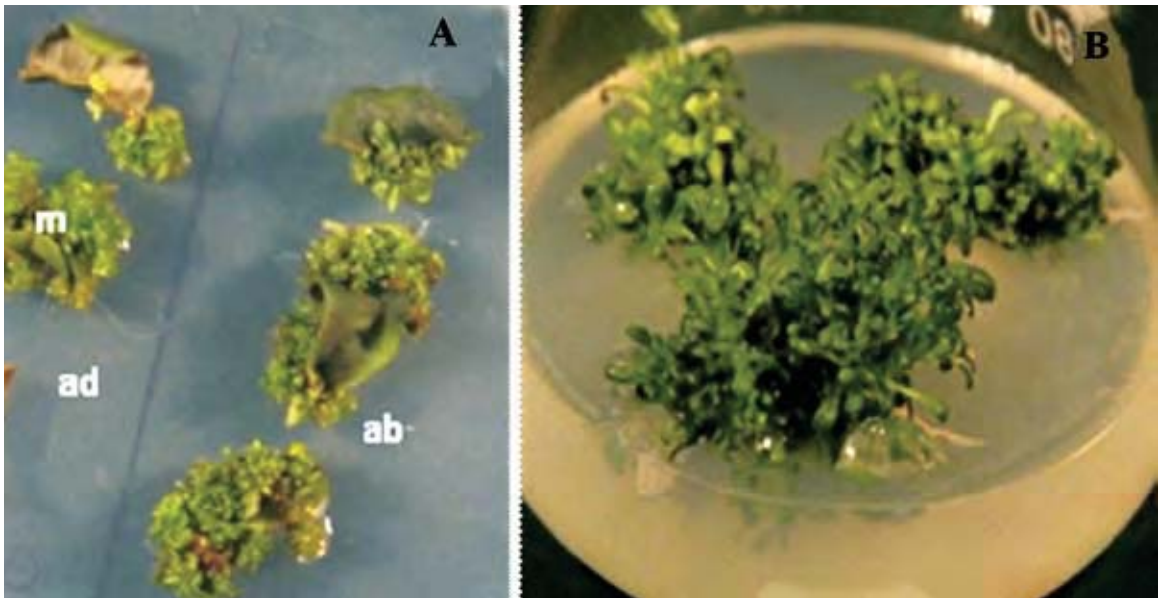


Fig. 47 ***In vitro*** **regeneration of** ***P. kurrooa*** **(A) Comparative response of adaxial (ad) and abaxial (ab) surface of leaf explant with middle portion showing maximum response (Bar line 1 cm) (m) (B)** ***In vitro*** **raised shoot cultures**

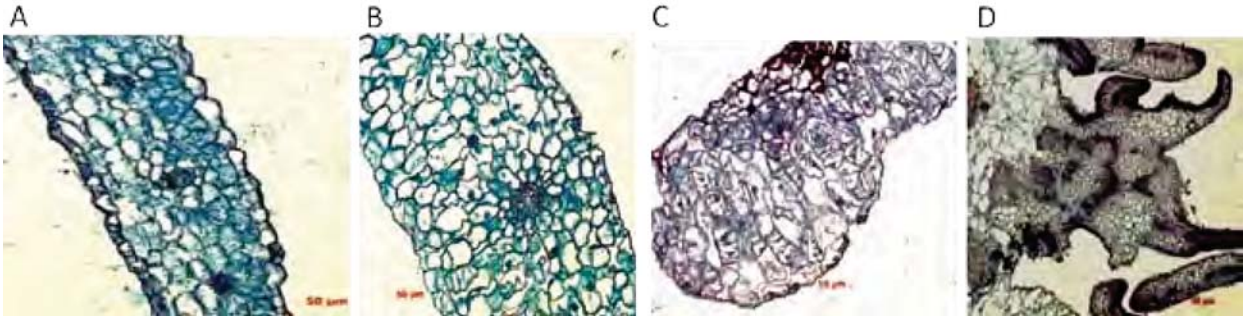


Fig. 48 Light microscopic studies of transverse section of leaf on medium containing 0.5 µM TDZ (A) at day 0 (B) at day 15; Note increase in cell size and number of cell layers (C) meristemoids in leaf tissue (D) shoot buds emerging from mid-rib

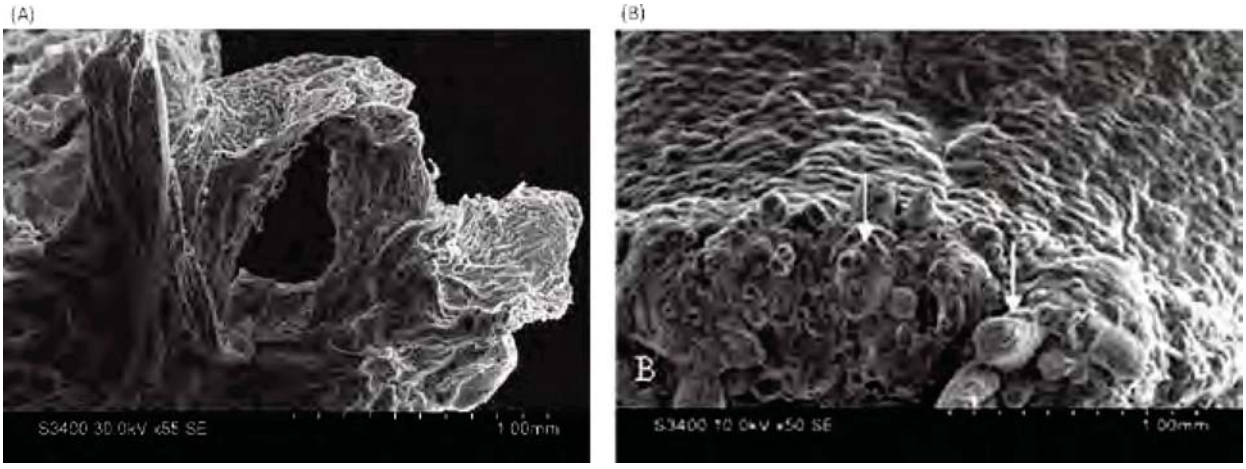


Fig. 49 Scanning electron microscopic studies (A) direct emergence of shoot buds from leaf (B) emergence of shoot bud primordia (arrow) from callus at cut ends

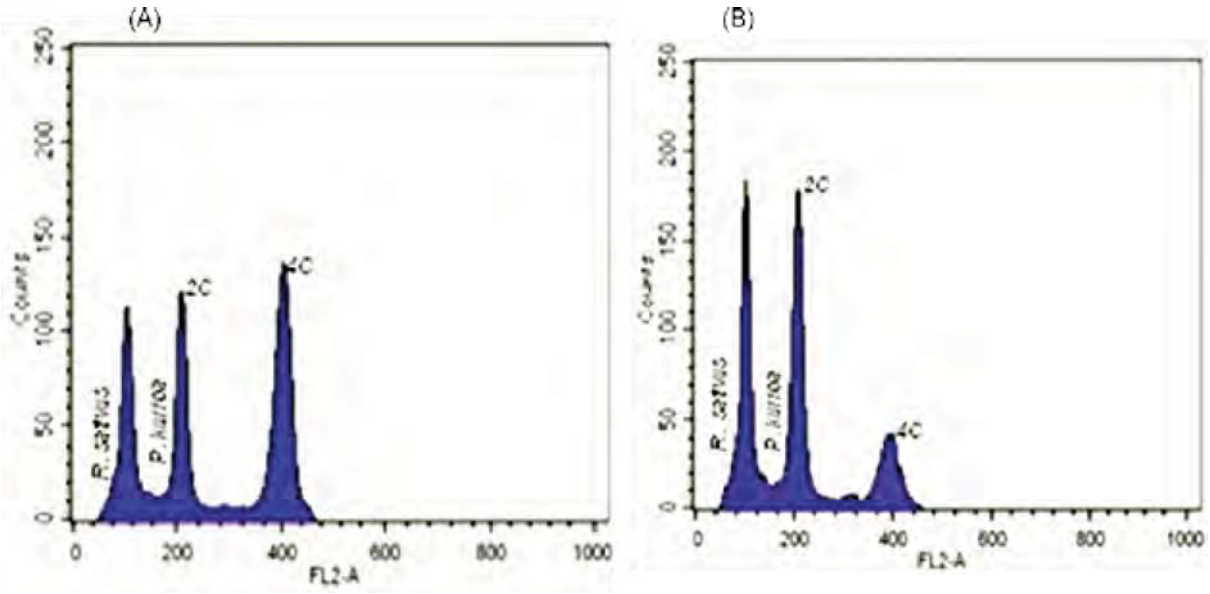


Fig. 50 Histogram of relative DNA content of *P. kurrooa* (A) source plant (B) *in vitro* raised plants where *R. sativus* was internal reference standard (2C=2.2 pg)

COLOUR AND DYES

Arnebia species

Comparative evaluation of *Arnebia* species with specific reference to metabolome related to shikonin synthesis *in situ* (Funded by Department of Biotechnology, Govt. of India)

Three *Arnebia* species were collected from the high altitude areas of HP (**Fig. 51**) for metabolome studies on shikonin biosynthesis. *A. euchroma* was collected from Kaza (4190 m) and *A. gutata* from Tabo area (3280 m) of district Lahaul & Spiti (HP), whereas, *A. benthamii* was collected from Yada area (3455 m) of district Chamba (HP).

Fig. 51 Collections of *Arnebia* species (A) *A. euchroma* (B) *A. benthamii* (C) *A. guttata* from different altitudes of western Himalaya, HP

Sixty samples of secondary metabolites including various aromatic acids were analyzed by RP-HPLC method. The analysis revealed significant differences in the formation of shikonin. Comparative evaluation of the different parts of *Arnebia* spp. showed decreasing antioxidant activity in stem nodes, roots and leaves.

PLANTATION CROPS

Tea (*Camellia sinensis*)

Identification and charaterization of sequence based markers for genetic improvement applications in tea (Funded by Department of Biotechnology, Govt. of India)

Microsatellite marker development

In continuation to previous work, the trancriptome of tea was sequenced for the identification of microsatellite markers. Of the 973 microsatellite markers identified and designated as 'tea transcriptome derived microsatellite' (TTMS), 30 were validated in selected accessions and related species of *Camellia*. The markers were validated by amplification. Repeat motifs were categorized in class I (≥ 20 bp) and class II (>12 bp to≤ 20 bp) with respect to EST-SSR length and di- (549), tri- (313) and tri-(111) class I repeats were detected (**Fig. 52).**

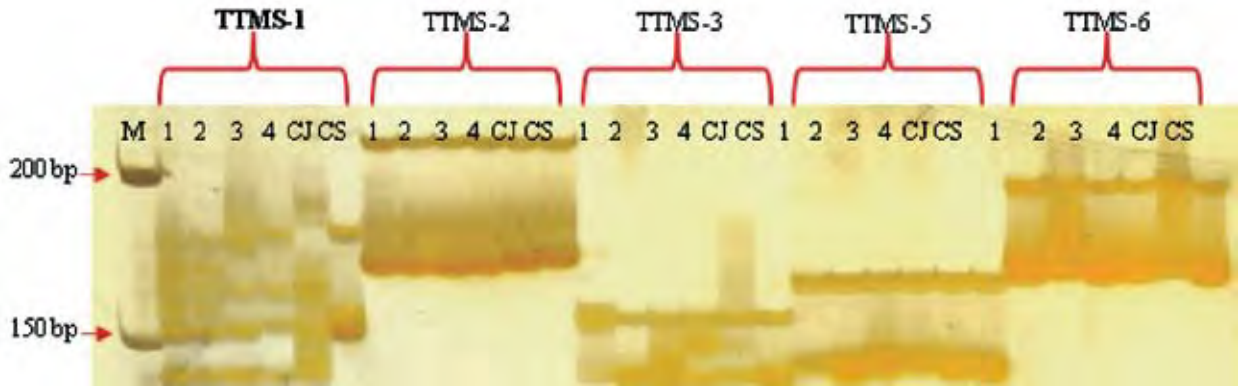


Fig. 52 Representative picture of amplification validation and cross species transferability of newly developed TTMS primer. M: 20 bp ladder, lanes 1-4: selected tea accessions, lane CJ: *C. japonica*, CS: *C. sananqua*

Genetic mapping

The existing pseudo test cross progeny comprising of 213 individuals from a cross of SA6(R) x Asha(S) were utilized for constructing a genetic map. Additional 83 SSR markers were utilized for parental polymorphism. Among these, 53 were informative in distinguishing both the parental lines.

Organization of tea germplasm

The germplasm resources of western Himalayan region include selections from the commercial estates, abandoned tea gardens of Kangra valley and elite clones of CSIR-IHBT, Palampur. Data were recorded for different morphological traits contributing to yield. Multivariate clustering of the data differentiated the germplasm resources into distinct groups based on comparisons among the clusters for leaf size and biochemical parameters. Leaf size differentiated the tea accessions into six phenotypic groups (**Fig. 53**), while shoot density, an important yield parameter was independent of leaf size. Accessions were differentiated into nine groups based on total catechin

and caffeine contents (**Fig. 54**). Of these, Group I recorded the highest total catechin content, moderate to high caffeine level and high astringency factor (AF). Epicatechin gallate (ECG) had a significantly high correlation with AF implying that high levels of ECG and epigallocatechin gallate (EGCG) are critical for the production of Theaflavin 3,3' Digallate (TFDG), an important quality constituent providing astringency and briskness to black tea liquor.

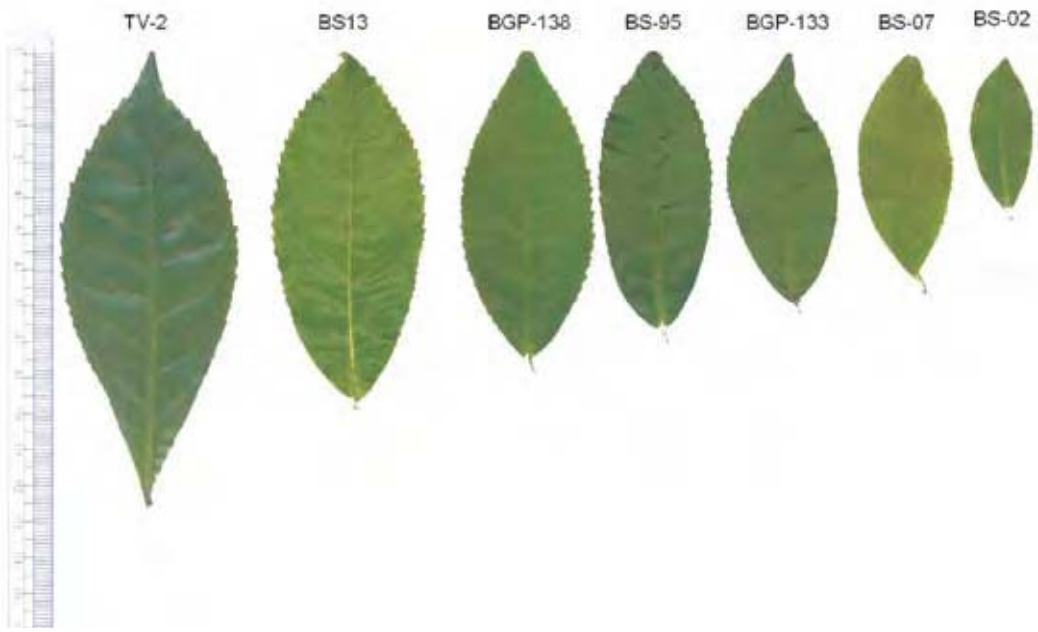


Fig. 53 Variations in leaf size representing different phenotypic groups of western Himalayan germplasm resources as compared to Assam type TV-2

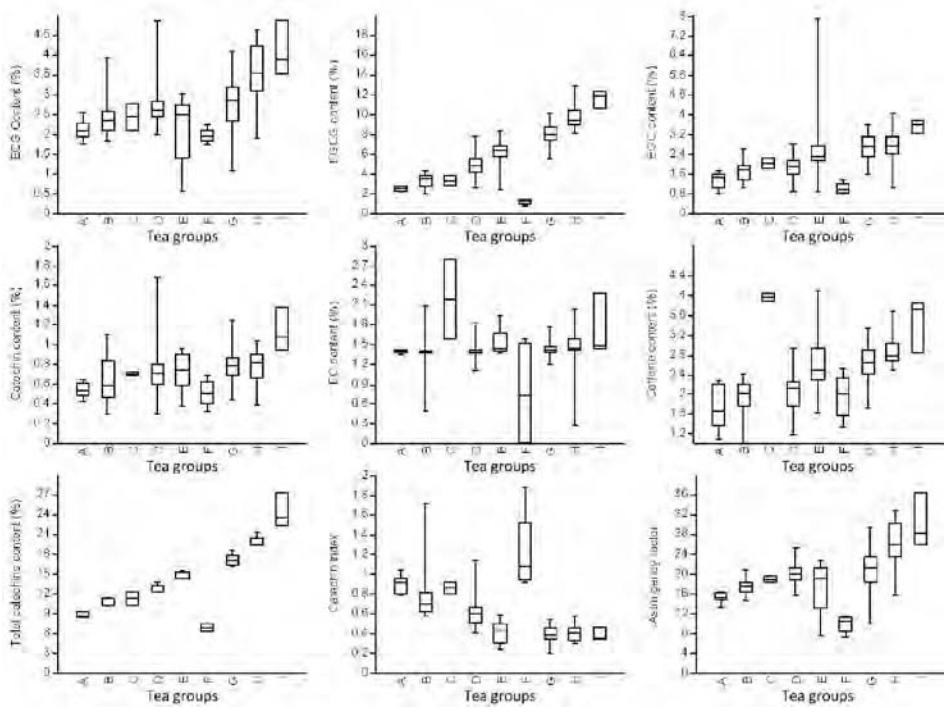


Fig. 54 Graphical depiction of biochemical parameters among nine groups (A-I) of western Himalayan tea germplasm resources

Hyperspectral data analysis for discriminating spectral behavior of tea plantations

The quality and yield of plantation depends upon factors like type, age of plantation, growth stage, pruning status, light conditions, and disease incidence. Hyperspectral data has the ability to detect minute spectral variations in vegetation. Therefore, a study was conducted to understand the spectral behaviour of tea plantations. Hyperspectral data were recorded from randomly selected bushes representing the test parameters in Banuri Tea Experimental Farm, Kangra, HP. A handheld spectroradiometer was used with a range of 325-1075 nm. It was observed that the green region followed by NIR region was the most appropriate band for discriminating different types of plants under sunlight and shade conditions (**Fig. 55**). For discriminating the age of plantation, growth stage, and diseased and healthy bushes, blue region was the most appropriate. The red and NIR regions were the best bands for distinguishing pruned and unpruned bushes.

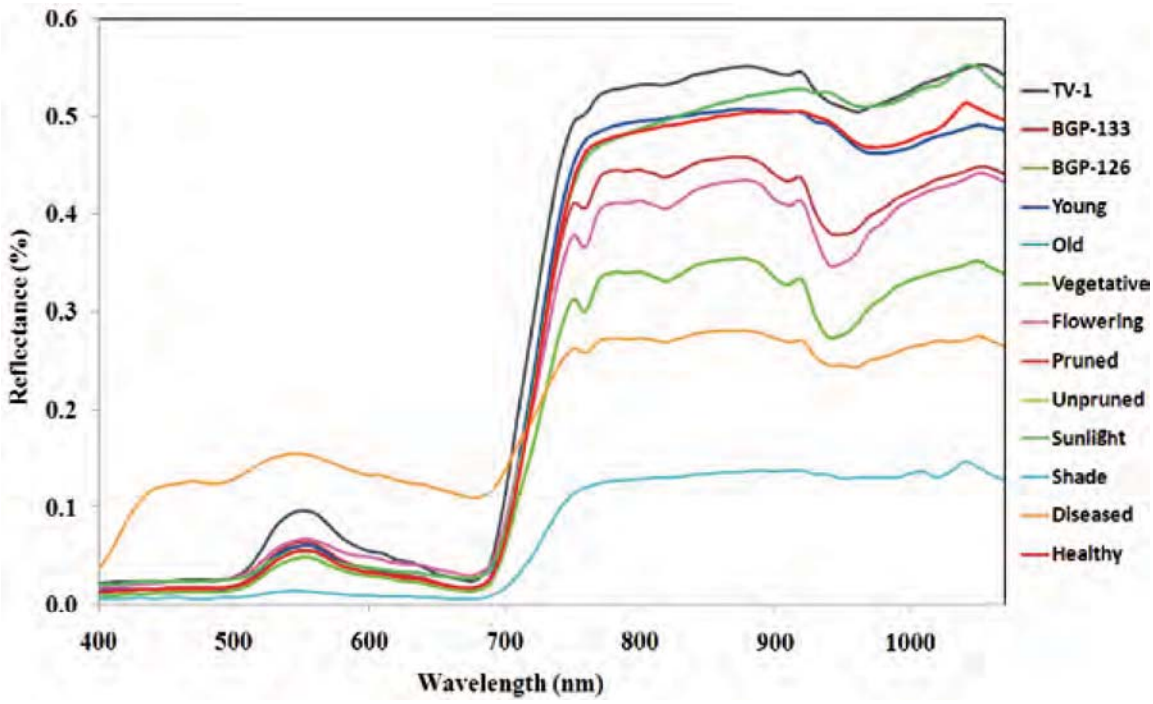


Fig. 55 Spectral reflectance of various management parameters of *Camellia sinensis*
Source: International Journal of Applied Earth Observation and Geoinformation DOI. 10.1016/j.jag.2012.10.006.

Selection of elite planting material

Evaluation of clonal plants from selected mother bushes of Kangra Jat and biclonal seed stocks was continued. The accessions showed productivity over 1,500 KMTH (Made Tea kg/ha) during the past three years (**Table 14**). Based on varietal performance trial, the accession CEF-02 was released as a variety named "Him Sphurti" for commercial cultivation in Kangra. It recorded consistently higher yield (an average 37 per cent higher than the high yielding clone UPASI-09). Based on the yield trend of biclonal seed stock populations in the last 3 years, the accessions CEF-01 and BGP-146 were chosen among china hybrid tea selections and SST-09 and SST-02 from the assam type tea selections.

Table 14 Performance evaluation of elite planting material

Accession	Number of bushes/ plot	Yield (KMTH)		
		2010	2011	2012
Germplasm Block - F				
BGP-017	13	1572	1786	2144
BGP-063	30	1584	1680	1353
BGP-066	27	1558	1367	1613
BGP-072	30	1882	1425	1452
BGP-118	28	1531	1392	1116
BGP-119	30	1647	1458	1200
BGP-122	29	1635	1406	1119
BGP-123	30	1538	1663	1253
BGP-144	19	1870	1514	1452
BGP-146	19	1728	2057	1984
BGP-156	9	1653	1852	1554
CEF-02	22	2282	2534	2205
UPASI-9*	25	1980	1655	1540
Germplasm Block-G				
BGP-146	22	1605	1195	1121
BGP-151	17	1605	1074	1500
CEF-01	12	1968	2059	2059
CEF-03	18	1604	1642	1703
SST-01	19	2010	1483	1718
SST-02	10	1736	2321	1984
SST-09	9	3924	3351	4112
UPASI-9*	23	1803	1561	1712

*** High yielding clone (Control)**

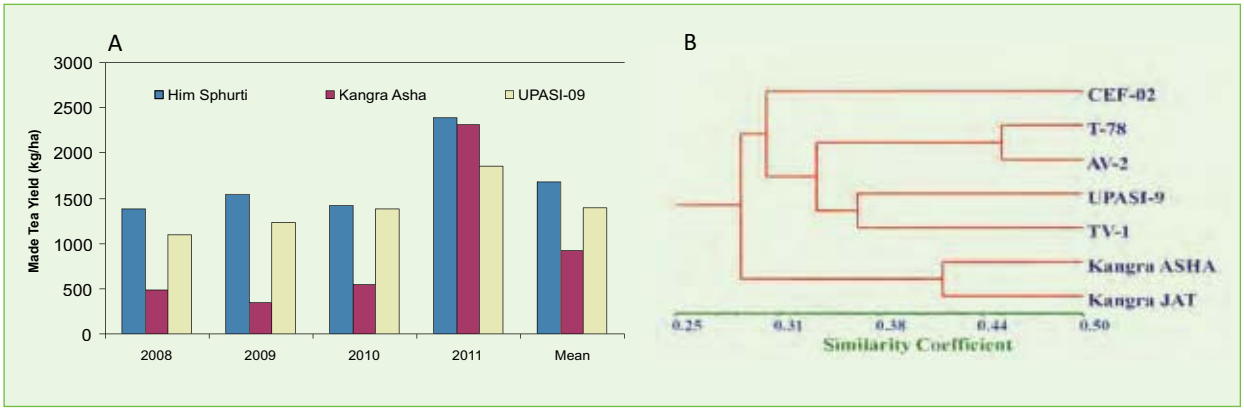
Tea cultivar (HIM SPHURTI)

The Institute released an improved cultivar of China hybrid tea named as "Him Sphurti" (**Fig. 56**) having following features (**Fig. 57**):

- Developed through selection approach from the century old Kangra tea plantations
- Excellent nursery performance
- Recorded over 1500 KMTH (first 4-year cycle average) >50% recommended cultivars for the region
- It has a potential of 2500 KMTH in the second cycle, >25% of counterparts
- Its aroma profile is better than Kangra Jat, Kangra Asha and UPASI 09
- Moderately resistant to blister blight (10-20% disease severity)

Fig. 56 Him Sphurti

- It has captured moderate to high level of genetic diversity



C

Quality parameter	Component	Remarks
Aroma	Aroma GC- profile	Better than Kangra Asha, Kangra Jat and UPASI-9
Astringency	TF, TR, Caffeine	At par with Kangra Asha, UPASI-9 and better than Kangra Jat
Brightness	TF	At par with Kangra Jat, Kangra Asha and lower than UPASI-9
Briskness	TF, TR, Caffeine	At par with Kangra Asha, UPASI-9 and better than Kangra Jat

Fig. 57 Characteristics of "Him Sphurti"- (A) Productivity (B) Quality and (C) Similarity coefficient

Standardization of E-Vision system for rapid detection of quality parameters of Kangra orthodox black tea infusion (Collaboration with C-DAC, Kolkata)

Theaflavins (TF) and thearubigins (TR) are the important chemical compounds that contribute to colour and brightness of tea infusion. An E-Vision system based on image processing was developed by C-DAC. The system was tested for the estimation of the quality of orthodox black tea infusions. The data were analyzed using Principal Component Analysis and Multiple Linear Regression (MLR). A correlation was established between colour of tea liquor images and TC (tea color), TB (tea brightness), TR and TF/TR ratio. The results showed good correlation (75-88%) between the data recorded on E-Vision system and the results estimated by spectrophotometer (**Fig. 58**).

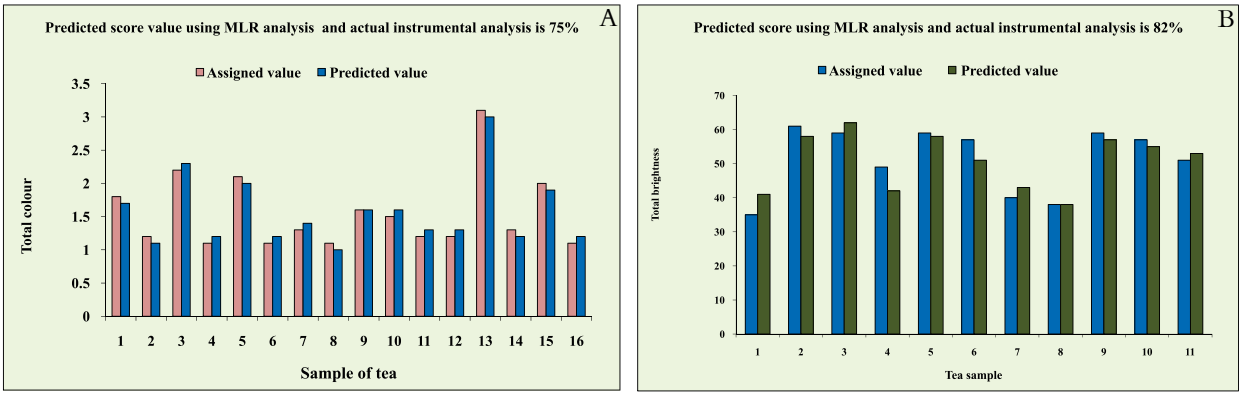


Fig. 58 Predicted score value using MLR analysis and actual instrumental analysis (A) 75% (B) 82%

Effect of tannase application on quality of CTC and Kangra orthodox black tea infusions (Collaboration with Delhi University)

CTC and Kangra orthodox black tea infusions were treated with different concentration (0.05–0.2%) of tannase extracted from *Penicillium charlesii*. The tannase treated CTC and Kangra orthodox tea infusions showed better infusion quality compared to untreated infusions w.r.t. cream formation, extractable theaflavins, polyphenols, antioxidant activity and volatile flavour components. Tannase treated infusions recorded higher brightness, total liquor colour, theaflavins and caffeine. Black tea infusion treated with tannase showed hydrolysis of both epigallocatechin gallate and epicatechin gallate to epigallocatechin and epiecatechin, respectively. This was accompanied by 11 (CTC tea) and 10-fold (Kangra orthodox tea) increase in gallic acid concentration. The tannase treated tea infusion showed reduction in tea cream formation and an increase in antioxidant activity to 1.73- and 1.61-fold, respectively. However, there was no change in the content and concentration of volatile compounds.

Isolation and characterization of microbes from tea roots

A total of 55 endophytes including 29 bacteria, 5 actinomycetes and 21 fungi were isolated and characterized from tea roots. The phylogenetic relatedness of bacterial and actinomycetes isolates based on 16s rRNA gene sequencing showed their affiliations to *Bacillus, Brevibacillus, Lysinibacillus, Burkholderia, Pantoea, Dyella, Streptomyces, Rhodococcus, Terracoccus* and *Nocardia*. The fungal isolates showed relatedness to *Fusarium, Aspergillus, Alternaria, Pestalotiopsis, Xylaria, Thanatephorus, Eurotium, Penicillium, Cadophora, Sordariomycetes, Coprinellus, Coprinellus, Cryptosporiopsis* and *Bjerkandera*. In this regard, bacterial-isolates cultured from *Juniperus communis*, the common juniper, showed maximum identity with *Staphylococcus*, *Streptomyces*, *Bacillus*, *Paenibacillus*, *Rhizobium* and *Novosphingobium* **(Fig. 59).** The fungal isolates showed relatedness with *Penicillium*, *Rhexocercosporidium*, *Cochliobolus*, *Neonectria* and *Fusarium* **(Fig. 60).**

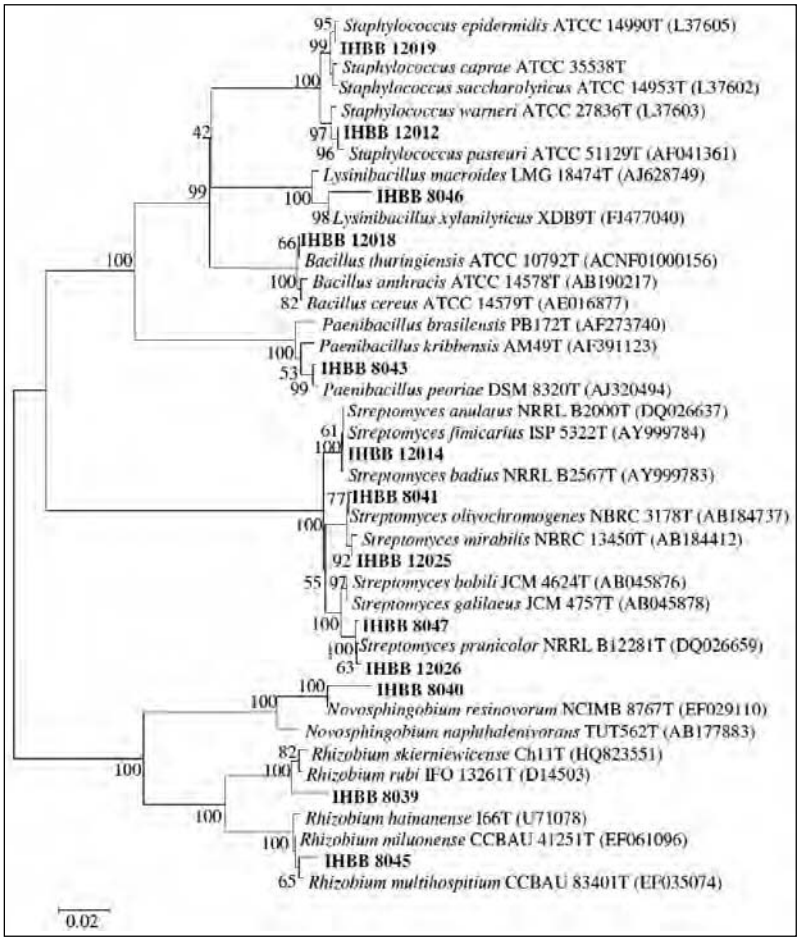


Fig. 59 Evolutionary relationship of fungal-endophytes from *Juniperus communis* and its related taxa constructed using the neighbour-joining method. The percentage of replicated trees in which the associated taxa clustered together

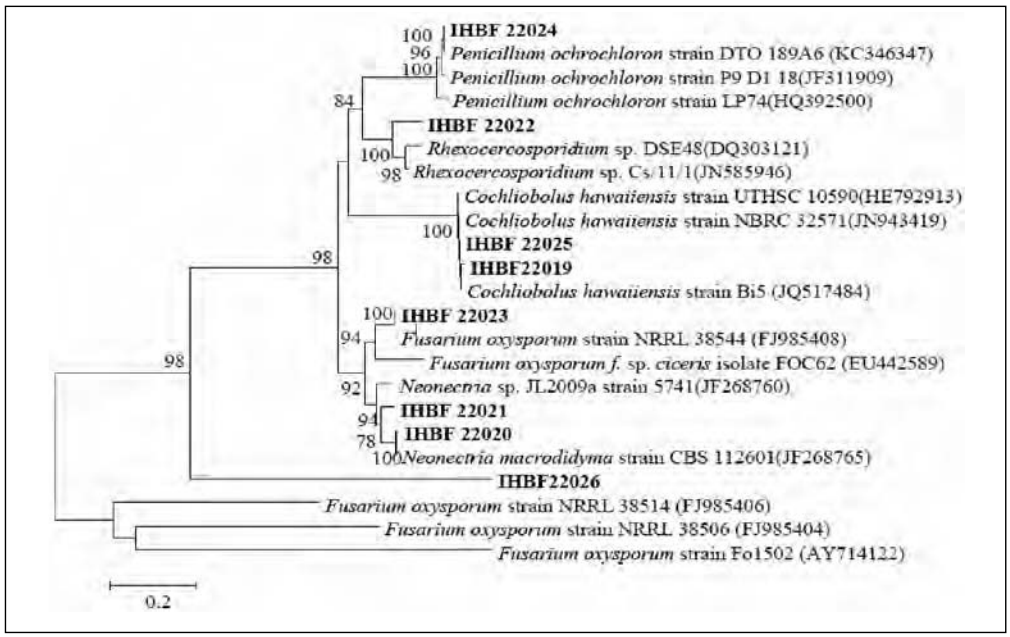


Fig. 60 Evolutionary relationship of fungal-endophytes from *Juniperus communis* and its related taxa constructed using the neighbor-joining method. The percentage of replicated trees in which the associated taxa were clustered together in the bootstrap test (1000 replicates) and evolutionary distances were computed using the Kimura 2-parameter method in the bootstrap test (1000 replicates) and evolutionary distances were computed using the Kimura 2-parameter method.

Profiling of essential and toxic metals of tea garden soil and its transversal pattern in tea brew

The level of essential and toxic metals in soil and leaves are known to affect the quality of tea. Hence, the level of uptake of essential and toxic metals from soil and its translocation to leaves and infusion were assessed. Fe was one of the predominant heavy metal in soil (5494-5627 mg/kg) followed by Mn (245-435 mg/kg), Zn (30-111 mg/kg) and Cu (22 - 51 mg/kg). The level of essential metal in tea leaves showed a decrease in the order of Mn>Fe>Zn>Cu. The level of most abundant essential metal in infusion was Zn followed by Mn (**Fig. 61**).

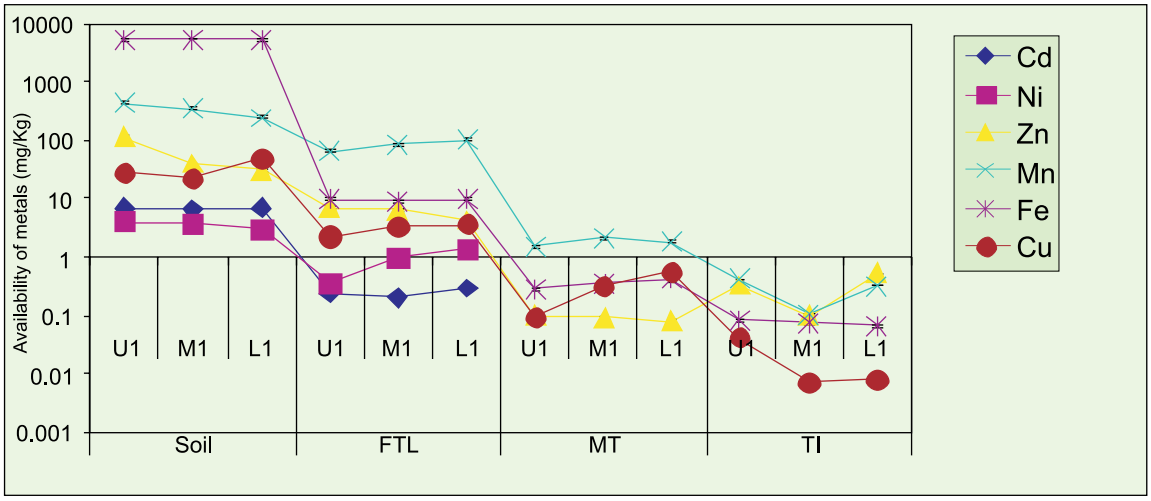


Fig. 61 Transversal pattern of metal ions from soil to tea infusion (U1: Upper location; M1: Middle location; L1: Lower location; FTL: Fresh tea leaves; MT: Made tea; TI: Tea infusion).

Survey of insect pests of tea

Surveys were conducted in different tea gardens of Palampur area for identifying the insect and mite pests of tea. The collected insects were preserved in 70% alcohol for their identification. Scale insects, aphids and thrips were the major pests. Both adults and crawlers of scales insects were congregated on the tender stem/shoots, leaves, buds for sucking of the sap, thereby resulting in yellowing, drying and dropping of leaves. However, leaf folder, leaf minors, grasshoppers and mites were also recorded as minor pests.

Improved micropropagation using betaine

Betaine, a quaternary ammonium compound was used to improve the micropropagation of two commercially important cultivars (UPASI-9 and UPASI-10). At 1,000 mg l^{-1} betaine increased the uptake of water and nutrients, and facilitated faster assimilation of carbon and nitrogen. This led to earlier differentiation of vascular elements and hence enhanced growth and multiplication. Amongst the two cultivars, growth was significantly higher in UPASI-10 as compared to UPASI-9 shoots (**Fig. 62** & **63**).

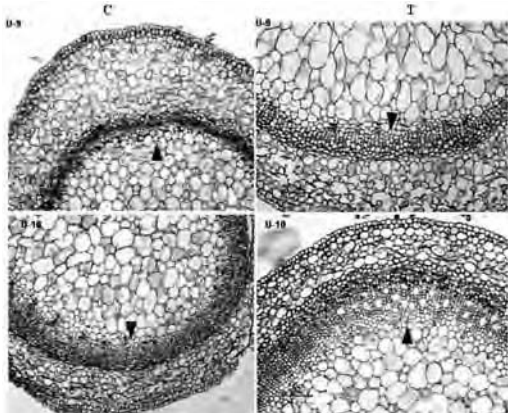


Fig. 62 Transverse sections of 60 days old *in vitro* shoots of UPASI-9 and UPASI-10, where T is betaine treated shoots and C is control shoots

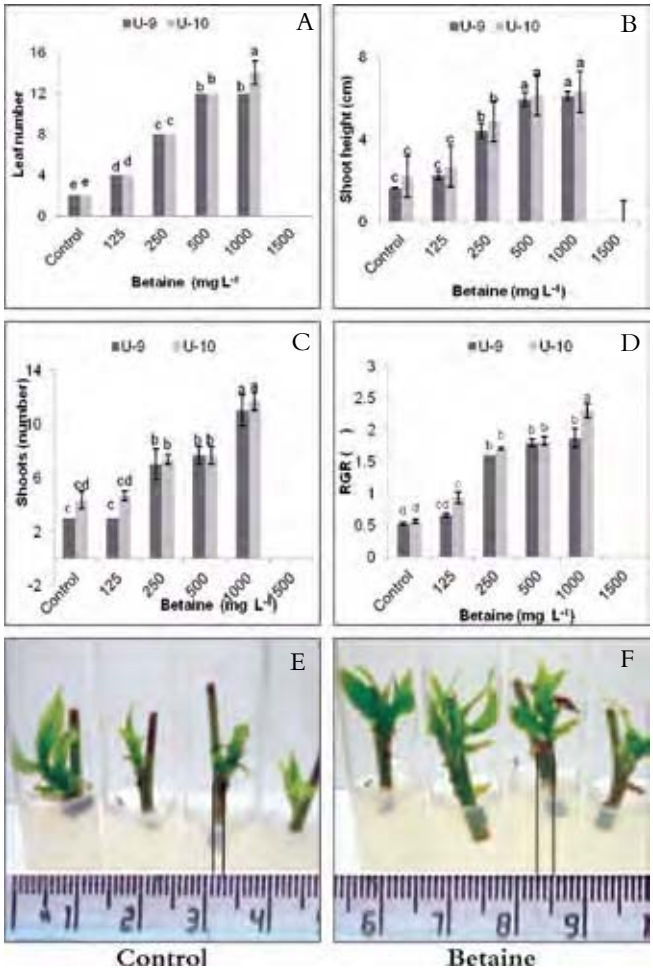


Fig. 63 Effect of betaine on the *in vitro* shoot growth of UPASI-9 and UPASI-10 cultivars of tea (A) leaf number (B) plant height (C) shoot number (D) RGR (E-F) stem thickness of UPASI 10 shoots after 15 days of growth

Gene networks modulated during winter dormancy

In continuation to previous work on modulation of winter dormancy (WD), a suppression subtracted library showed the down-regulation of genes involved in cell cycle and cell division. Up-regulation of stress-inducible genes including those encoding chaperons was also observed

(**Fig. 64**). When these genes were cloned and subjected to expression analysis, they could be grouped into functional classes based on the MIPS classification system. The genes involved in cell cycle/cell division included the ones encoding the histone proteins (*CsH2A*, *CsH2A.1*, *CsH2B*, *CsH2B.1*, *CsH3*, *CsH4*), *Cyclin A* (*CycA*), *Cyclin B* (*CycB*), *β-tubulin* and DNA cytosine 5-methyltransferase (*CsCM*). The stress responsive genes comprised of *CsLEA4*, *CsLEA5*, *CsDeh1* (dehydrin), *CsDeh2*, *CsCOR413* (cold responsive), *CsGST* (glutathione S-transferase), *CsELP* (early light induced protein), *CsMLP* (major latex protein) and *CsDIP* (drought induced protein). Up-regulation of genes involved in cryoprotection and energy metabolism (i.e., *β*-amylase and lipase) was observed during WD and dormancy release (DR) (**Fig. 65**). The effect of low temperature, ABA and GA_3 treatment on the mature leaves (ML) and the 'two leaves and a bud' (TAB) harvested from field-grown bushes was also studied. The responses were found to vary between the ML and TAB, and also between the period of active growth (PAG) and WD. Stress-responsive genes/chaperons and tissue preparedness were found to be critical for ABA and GA_3 mediated responses.

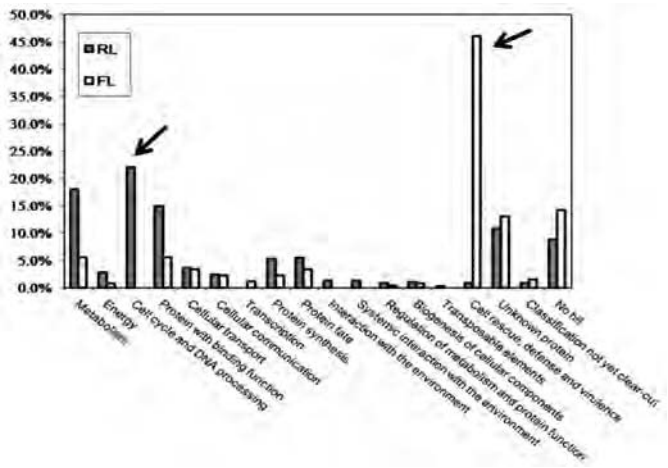


Fig. 64 Functional classification of clones obtained in forward (FL) and reverse (RL) subtracted libraries showing the over-expression of FL and RL genes during winter dormancy and period of active growth, respectively

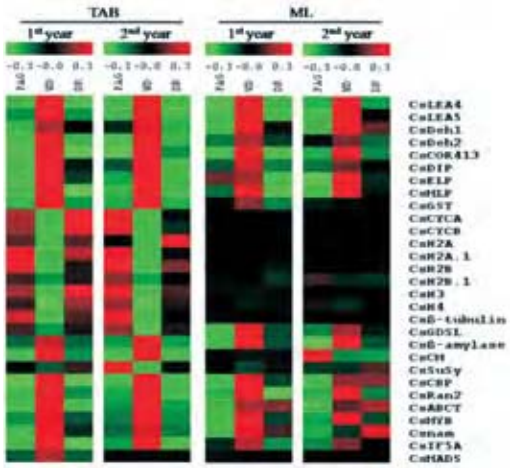


Fig. 65 Expression of selected genes during PAG, WD and DR for two consecutive years in ML and TAB. Green and red color indicate down- and up-regulation of genes, respectively relative to the average expression over time at mean maximum (white bar) and minimum (black bar) air temperatures

Extraction and characterization of saponins from tea seeds of Kangra valley

Four triterpene saponins extracted from seeds were tested for their cytotoxicity against five human cancer cells lines-OVCAR-5 (ovarian carcinoma cells), MCF-7 (human breast adenocarcinoma cells), PC-3 (human prostate cancer cells), COLO-205 (colorectal adenocarcinoma cells), and HL-60 (human promyelocytic leukemia cells) (**Table 15**). Cytotoxicity of these saponins was evaluated by methyl thiazole tetrazolium and sulfo-rhodamine B assays. High cytotoxicity activity was observed by 16-O-acetyl-21-O-angeloyltheasapogenol E 3-O-β-D-galactopyranosyl (1->2) β-D-xylopyranosyl(1->2)-β-L-arabinopyranosyl(1->3)-β-D-glucopyranosiduronic acid and 16,28-di-O-acetyl-21-O-angeloyltheasapogenol E 3-O-β-D-galactopyranosyl (1->2) β-D-xylopyranosyl (1->2)-β-L-arabinopyranosyl (1->3)-β-D-glucopyranosiduronic acid (99 %) on PC-3 cells at concentration of 100 µg/ml. None of the saponins showed significant activity when tested against human PBMCs by lymphocytes proliferation assay.

Table 15 *In vitro* cytotoxicity of tea seed saponins against different human cancer cell lines by SRB assay

Saponins	Conc. (µg/ml)	Tissue/Cell lines			
		Ovary/OVCAR-5	Breast/MCF-7	Colon/Colo-205	Prostate/PC-3
		% Growth inhibition			
	10	14	20	31	17
	30	78	69	79	75
S_1	100	98	78	86	99
	10	20	22	21	9
	30	78	69	79	75
S_2	100	98	78	86	99
	10	0	0	13	0
	30	0	0	13	0
S_3	100	0	0	14	0
	10	15	28	41	9
S_4	30	75	68	76	70
	100	95	76	85	98
Adriamycin	(1µM)	60	72	69	66
Paclitaxel	(1µM)	73	80	57	71

21-O-tigloyltheasapogenol-E-3-O-β-D-galactopyranosyl(1->2)β-D-xylopyranosyl (1->2)-β-L-arabinopyranosyl (1->3)-β-D-glucopyranosiduronic acid (IC_{50} = 1.72 mg/ml) showed high metal-chelating activity at a concentration of 20 mg/ml

BAMBOO

Micropropagation and transfer to field

Guadua angustifolia

A study was conducted to identify the contaminants present in the *in vitro* cultures of *G. angustifolia*. The cultures were found to be contaminated by *Pantoea agglomerans* and *P. ananatis* bacteria. These were eliminated using 10 µg/ml kanamycin in the multiplication medium for 10 days. Healthy, bacteria free shoots proliferated after transfer onto antibiotic free medium (**Fig. 66**).

Fig. 66 Healthy *in vitro* shoots of *G. angustifolia* growing in medium containing kanamycin

Dendrocalamus membranaceous

In vitro seed germination was attempted in *D. membranaceous*, an economically important edible bamboo. Germination (77.8%) was recorded, when surface sterilized seeds were treated overnight with 50 mg/l GA_3 and incubated in complete darkness at 30°C. The shoots

from the seedlings were initially incubated on medium containing 8.8 µM BAP for 1 week and then multiplied on medium containing 2.3 µM kinetin and 8.8 µM BAP. The rooted plants were successfully hardened in potting mix.

Phyllostachys pubescens (moso bamboo)

P. Pubescens is a multipurpose commercial bamboo of temperate regions. It was introduced in Palampur, HP in 2010-11. Emergence of edible shoots (culms) was observed in the current year (**Fig. 67**).

Fig. 67 New culms of edible bamboo species emerging from the base

Genetic transformation

Dendrocalamus hamiltonii

A protocol for raising transgenic plants was developed to increase the range of plant adaptability, for plantations in denuded areas of dry temperate zones. The constraints of necrosis and death due to polyphenol oxidation, thickening of epidermal cells due to wound response and difficulties in *Agrobacterium* attachment due to surface waxes in somatic embryos were removed. Somatic embryos immersed in *Agrobacterium* culture containing 0.01% Tween-20 and 500 mg/l PVP for 15 min followed by co-cultivation for 48 h yielded good frequency of putative transformants. Strong signals in GUS histo-chemical assay, PCR, slot blot and southern hybridization confirmed successful transformation (**Fig. 68)**. The study paves the way for producing transgenic bamboos expressing useful traits.

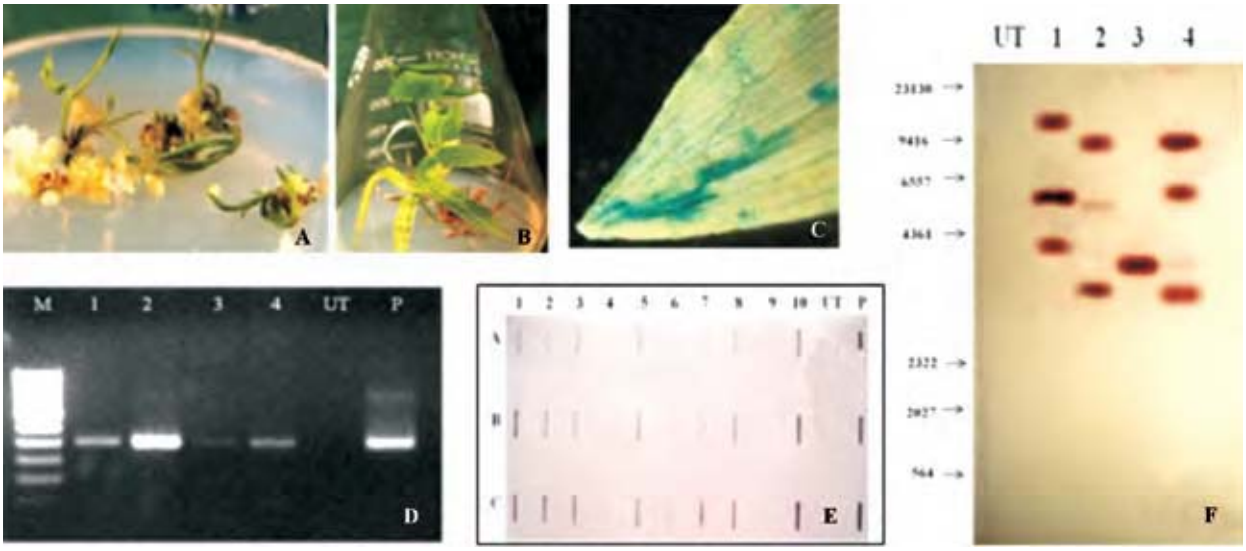


Fig. 68 Genetic transformation of *D. hamiltonii* (A) putatively transformed plantlets (B) transgenic plant (C) GUS transient expression on leaf explants of 1 year old transgenic plant (D) PCR of *gus* transgenic (E) Slot blot showing positive signals using 15, 30 and 45 ng DNA (F) Southern hybridization analysis of transgenic lines (UT: un-transformed control and P: positive control; 1-10: transgenic lines)

Genetic characterization of industrially important reed bamboo (*Ochlandra travancorica*)

Among the different bamboo species, *Ochlandra* is widely distributed in the forests of Kerala in the leeward side of the Western Ghats. Besides its importance in the cottage industry, the species is a major source of fibre (with a length of 4.03 mm), used in paper and pulp industries. A high level of genetic diversity was recorded in randomly collected populations of this genus from Kerala, India. Fifty primers (8 AFLP & 42 RAPD) detected 914 polymorphic loci. Cluster and Principal Coordinate Analysis (PCA) based on combined AFLP & RAPD data grouped all the random accessions into three different populations (**Fig. 69**). Further, AMOVA revealed a moderate to high level of genetic variation with 54% within population and 46% among population. Highly significant and high PhiPT estimate (Fst value; 0.456) indicated that these populations are not panmictic and are significantly isolated.

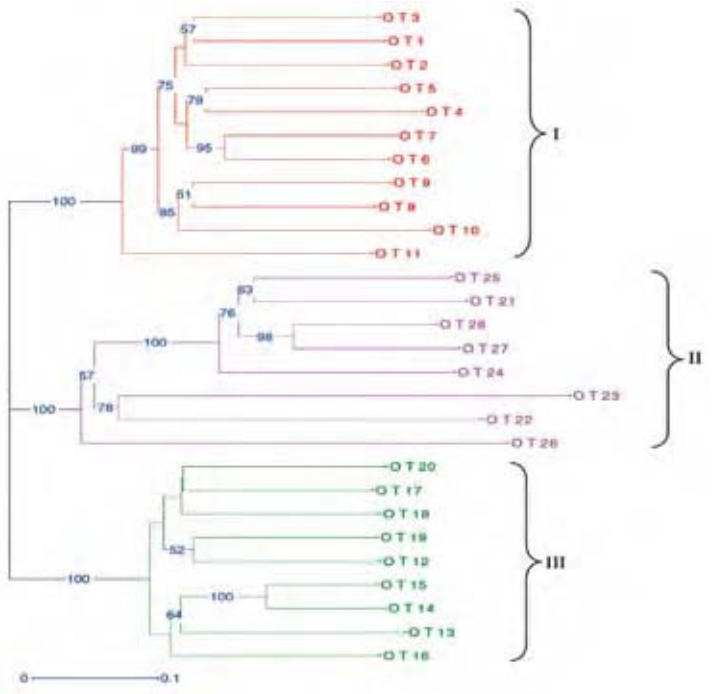


Fig. 69 Genetic relationship among the *O. travencorica* population based on 8 AFLP and 42 RAPD markers. Tree branches with bootstrap values ≥60 %

DAMASK ROSE (*Rosa damascena*)

Estimation of total chlorophyll content

The polynomial regression models were found to be suitable for non-destructive estimation of total chlorophyll (Chl.) based on experimental data. The model predicted values were very close to traditionally measured values with a root mean square prediction error (RMSE*p*) of less than 0.20 mg g^{-1} of Chl. Confidence interval (95%) was built up (**Fig. 70**) for developed models indicating a 95% chance of a new observation falling within the lower and upper bounds. The model is important because the Chl. status of leaf provides valuable information about the physiological condition of plants. In contrast, the conventional methods for measuring Chl. content in leaf are destructive, costly, time consuming and do not allow repetitive measurements.

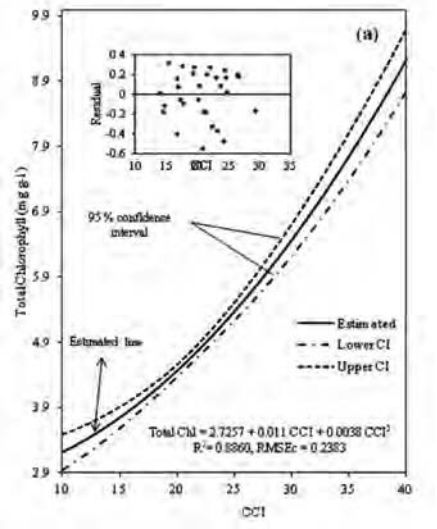


Fig. 70 The polynomial regression model showing the mathematical relationship between Chl content index (CCL) and non-destructive estimation of total chl.

Effect of pruning on quality of essential oil

Field experiment was conducted to standardize the level and time of pruning for higher yield and quality of essential oil from flowers. Pruning at 90 cm from ground level (FGL) recorded significantly higher flower yield (13.22 g/new shoot) as compared to pruning at 120 FGL but remained statistically at par at 60 cm FGL. The maximum flower yield (14.32 g/new shoot**)** was recorded when pruning was done on 15th December followed by pruning on 30th November (13.07 g/new shoot). The lowest amount of flower yield was recorded with pruning on 31st October.

Although there was no significant effect of the level and time of pruning on the essential oil content of flowers, yet analyzed data suggested that the major and minor components of rose oil were affected.

Effect of organic and inorganic manures on quality of essential oil

A field experiment was conducted during 2008-2012 to study the effect of different manures on yield and composition of essential oil. Application of 90:80:90kg NPK ha^{-1} outshone all other treatments and recorded significantly higher number of flowers per plant, fresh flower weight per plant, number of branches and chlorophyll concentration index. This treatment recorded 50% higher flower yield as compared to control (**Fig. 71**). Geraniol content was also highest (26.2%) when the plants were fertilized with 90:40:90kg NPK ha^{-1}. Citronellol and nerol/ geraniol ratio were also higher in fertilized plots.

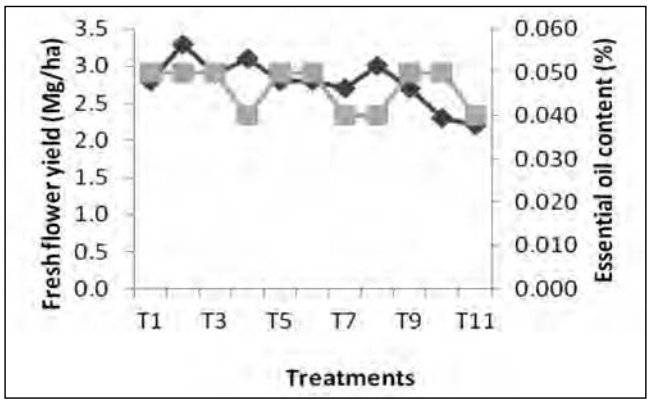


Fig. 71 Effect of organic and inorganic manures on flower yield and essential oil content of damask rose

T1 (90:40:90 kg NPK ha^{-1}); T2 (90:80:90 kg NPK ha^{-1}); T3 (120:40:90 kg NPK ha^{-1}); T4 (120:80:90 kg NPK ha^{-1}); T5 (90:40:120 kg NPK T1 (90:40:90 kg NPK ha^{-1}); T2 (90:80:90 kg NPK ha^{-1}); T3 (120:40:90 kg NPK ha^{-1}); T4 (120:80:90 kg NPK ha^{-1}); T5 (90:40:120 kg NPK ha^{-1}); T6 (90:80:120 kg NPK ha^{-1}); T7 (120:40:120 kg NPK ha^{-1}); T8 (120:80:120 kg NPK ha^{-1}); T9 (FYM 25 t ha^{-1}); T10 (FYM 50 t ha^{-1}); T11 (Control)

Effect of harvesting date on quality of essential oil

Experiment was conducted to study the effect of harvesting date on essential oil content and composition of damask rose flowers. Significantly higher oil content (0.051%) (**Fig. 72**) and concentration of citronellol and nerol (36.8±2.3%) (**Table 16**) was recorded in flowers harvested on 19th April.

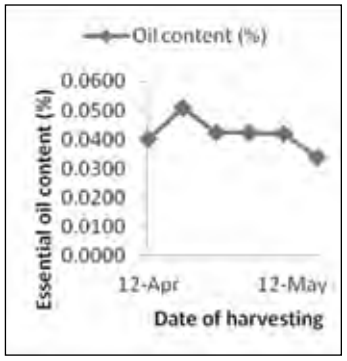


Fig. 72 Effect of harvesting date on yield of essential oil

Table 16 Effect of harvesting date on major constituents of damask rose oil

Major compounds	Harvesting date					
	12-April	19-April	26-April	3-May	10-May	17-May
β-Citronellol+nerol	26.2±4.3	36.8±2.3	32.1±0.9	28.7±3.7	26.5±0.2	15.0±1.7
E-Geraniol	23.2±6.6	21.7±0.6	20.6±0.4	23.5±3.4	21.7±4.4	13.3±2.5

Processing

About 10580.7 kg fresh rose flowers were processed at pilot plant to produce 3.789 L rose oil (0.036%, v/w) and rose water (1800 L).

AGARWOOD (*Aquilaria* spp.)

Agarwood: Isolation and characterization of microorganisms involved in its formation and constituents of its oil (Colaboration with CSIR-National Chemical Laboratory, Pune)

Agarwood also called as aloeswood, eaglewood, jinkoh, gaharu is the world's most valuable incense. The exact mechanism leading to the fragrant resin formation in agarwood tree trunk due to microbial infection is not understood. In order to understand the microorganisms responsible for the formation of agarwood and the volatile components in *Aquilaria agallocha* at different stages of development, studies were undertaken. 16S rRNA gene of 78 bacterial and ITS region of 16 fungal isolates were sequenced. Among bacterial isolates, the dominant species were *Bacillus* sp. followed by *Pseudomonas*, *Enterobacter*, *Staphylococcus*, *Lactobacillus*, *Citrobacter*, *Flavobacterium* and *Stenotrophomonas*. Five isolates showed 95.9% sequence similarity with the most closely related species *Pectobacterium cacticida*. One isolate showed 95.6% sequence similarity with the most closely related species *Brenneria salicis*.

In *Bacillus*, sixteen isolates were most closely related to *B. altitudinis*, six to *B. subtilis* subsp. *inaquosorum*, six to *B. safensis*, five to *B. aryabhattai*, one isolate each to *B. anthracis, B. cereus*, *B. stratosphericus,* and *B. tequilensis*. Nine isolates belonged to *Pseudomonas* with four isolate closely related to *P. aeruginosa*, and one isolate each to *P. delhiensis*, *P. hibiscicola, P. nitroreducen, P. psychrotolerans* and *P. taiwanensis*. Eight isolates belonged to *Enterobacter* with one isolate most closely related to *E. aerogenes*, six to *E. oryzae* and one to *E. ludwigii*. Three isolates belonged to *Staphylococcus* with one isolate most closely related to *S. gallinarum* and two to *S. succinus*. Two isolates belonged to *Lactobacillus* and both were closely related to *L. pentosus*. Five isolates belonged to *Pectobacterium* and showed 95.9% 16S rRNA gene sequence similarity with the most closely related species, *P. cacticida*. Two isolates belonged to *Achromobacter* and *Bordetella*. One isolate each belonged to *Acinetobacter*, *Bordetella*, *Brenneria*, *Citrobacter*, *Flavobacterium*, *Luteibacter*, *Pantoea*, *Staphylococcus* and *Stenotrophomonas*, respectively. Out of sixteen fungal isolates, six showed highest relatedness with *Fusarium* sp., six with *Penicillium* sp., two with *Mucor* and one each with *Fungal* sp. and *Trichoderma*, respectively (**Table 17**).

Table 17 BLASTn analysis of 16S rRNA gene/ITS region sequencing of bacteria and fungi isolated from agarwood

Bacterial isolates			
Isolate	**Most Closely Related Species**	**Isolate**	**Most Closely Related Species**
33N1	*Achromobacter xylosoxidans* DSM 10346(T)	18N2A	*Klebsiella variicola* F2R9(T)
39N1	*Achromobacter xylosoxidans* DSM 10346(T)	18Y3	*Klebsiella variicola* F2R9(T)
22N2	*Acinetobacter bereziniae* ATCC 17924(T)	16N3	*Pantoea dispersa* LMG 2603(T)
3N2	*Bacillus altitudinis* 41KF2b(T)	23N1	*Pseudomonas aeruginosa* LMG 1242(T)
3C4	*Bacillus altitudinis* 41KF2b(T)	29C1	*Pseudomonas aeruginosa* LMG 1242(T)
3N3	*Bacillus altitudinis* 41KF2b(T)	47Y1	*Pseudomonas delhiensis* RLD-1(T)
16N2	*Bacillus altitudinis* 41KF2bT	39N2A	*Pseudomonas hibiscicola* ATCC 19867(T)
30C3	*Bacillus altitudinis* 41KF2b(T)	13Y1	*Pseudomonas taiwanensis* BCRC 17751(T)
30N1(A)	*Bacillus altitudinis* 41KF2b(T)	5N2	*Staphylococcus gallinarum* ATCC 35539(T)
31N1(A)	*Bacillus altitudinis* 41KF2b(T)	5N1	*Staphylococcus succinus* subsp. *casei* SB72T
42C1	*Bacillus altitudinis* 41KF2b(T)	50N1	*Staphylococcus succinus* subsp. *casei* SB72T
42N1	*Bacillus altitudinis* 41KF2b(T)	9C1	*Bacillus safensis* FO-036b(T)
43N1	*Bacillus altitudinis* 41KF2b(T)	12C1	*Bacillus safensis* FO-036b(T)
45P1	*Bacillus altitudinis* 41KF2b(T)	28N3	*Bacillus safensis* FO-036b(T)
50N2	*Bacillus altitudinis* 41KF2b(T)	48N2	*Bacillus safensis* FO-036b(T)
53N1	*Bacillus altitudinis* 41KF2b(T)	45N1	*Bacillus stratosphericus* 41KF2a(T)
56Y1	*Bacillus altitudinis* 41KF2b(T)	15N1	*Bacillus subtilis* subsp. *inaquosorum* BGSC 3A28(T)
57P1	*Bacillus altitudinis* 41KF2b(T)	16N1(A)	*Bacillus subtilis* subsp. *inaquosorum* BGSC 3A28(T)
3Y4	*Bacillus aryabhattai* B8W22(T)	39N2(B)	*Bacillus subtilis* subsp. *inaquosorum* BGSC 3A28(T)
18N2(B)	*Bacillus aryabhattai* B8W22(T)	52N1	*Bacillus subtilis* subsp. *inaquosorum* BGSC 3A28(T)
17N1	*Bacillus aryabhattai* B8W22(T)	54C1	*Bacillus subtilis* subsp. *inaquosorum* BGSC 3A28(T)
17N2	*Bacillus aryabhattai* B8W22(T)	52C1(A)	*Bacillus tequilensis* 10b(T)
31N2B	*Bacillus aryabhattai* B8W22(T)	28Y2	*Brenneria salicis* LMG 2698(T)
54Y1	*Bacillus anthracis* ATCC 14578(T)	8N2	*Citrobacter koseri* CDC 3613-63
47Y2	*Bacillus cereus* ATCC 14579(T)	24N1(B)	*Enterobacter oryzae* Ola 51(T)
9N1	*Bacillus safensis* FO-036b(T)	37C1	*Enterobacter oryzae* Ola 51(T)

Isolate	Most Closely Related Species	Isolate	Most Closely Related Species
9C1	*Bacillus safensis* FO-036b(T)	30C1	*Flavobacterium oceanosedimentum* ATCC 31317(T)
52P1A	*Bacillus subtilis* subsp. *inaquosorum* BGSC 3A28(T)	40N1	*Gibbsiella quercinecans* FRB 97(T)
14P2	*Bordetella avium* 197N	57Y1	*Lactobacillus pentosus* JCM 1558(T)
11N2	*Enterobacter aerogenes* KCTC 2190(T)	5P2	*Lactobacillus pentosus* JCM 1558(T)
13P2	*Enterobacter oryzae* Ola 51(T)	8C2	*Pectobacterium cacticida* LMG 17936(T)
21N1	*Enterobacter oryzae* Ola 51(T)	28C2	*Pectobacterium cacticida* LMG 17936(T)
24N1A	*Enterobacter oryzae* Ola 51(T)	28N1	*Pseudomonas aeruginosa* LMG 1242(T)
37C1	*Enterobacter oryzae* Ola 51(T)	29C1	*Pseudomonas aeruginosa* LMG 1242(T)
31Y1	*Enterobacter ludwigii* DSM 16688(T)	31N1	*Pseudomonas nitroreducens* DSM 14399(T)
6N1	*Luteibacter yeojuensis* R2A16-10(T)	3C2	*Pseudomonas psychrotolerans* C36(T)
6P2	*Pectobacterium cacticida* LMG 17936(T)	50C1	*Staphylococcus succinus* subsp. *succinus* AMG-D1(T)
8N1	*Pectobacterium cacticida* LMG 17936(T)	6Y3	*Stenotrophomonas panacihumi* MK06(T)
28N2	*Pectobacterium cacticida* LMG 17936(T)		
Fungal isolates			
3C3	*Fusarium* sp. 166AS/T	4C1	*Penicillium sumatrense* strain CBS 416.69
6C1	*Fusarium solani* strain NRRL 22400	4Y1	*Penicillium meleagrinum* var. *viridiflavum* strain KUC1678
8Y1	*Fusarium solani* isolate PCO.30	13P3	*Penicillium* sp. PSF41
22Y2	*Fusarium solani* strain LW-1	13Y3	*Penicillium* sp. strain 92506
30N1B	*Fusarium solani* isolate PCO.30	13P6	*Penicillium* sp. 92506
30P1(B)	*Fusarium solani* isolate MZ01	3Y1	*Penicillium sumatrense* strain CBS
5Y1	*Mucor circinelloides* strain OTU31	4P1	*Trichoderma* sp. E10502a
25Y1	*Mucor circinelloides*	3C1	*Fungal* sp. strain ARIZ B141

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

The agarwood tree (*Aquilaria malaccensis*) is a precious floral wealth of northeastern India. The resinous patches of fragrant wood traditionally known as "agar" are in great demand in Egypt, Arabia and all Eastern countries. In the genomic DNA of 62 accessions of *A. malaccensis* representing 11 populations of northeastern India, a total of 305 fragments were detected. Of these, 257 (84.5%) fragments were found to be polymorphic with an overall rate of 85.6 polymorphic loci per primer combination (**Fig. 73**). The average accession wise genetic similarity was 55%, while population wise average genetic similarity ranged from 20.6 to 75.0%. Further, cluster

analysis based on AFLP data using both UPGMA and neighbor joining distances distinguished 11 populations representing 62 accessions into four major groups. A high level of gene flow between *A. malaccensis* populations prevailing in northeastern states of India was indicated by genetic variations among and within the populations in AMOVA (**Fig. 74).**

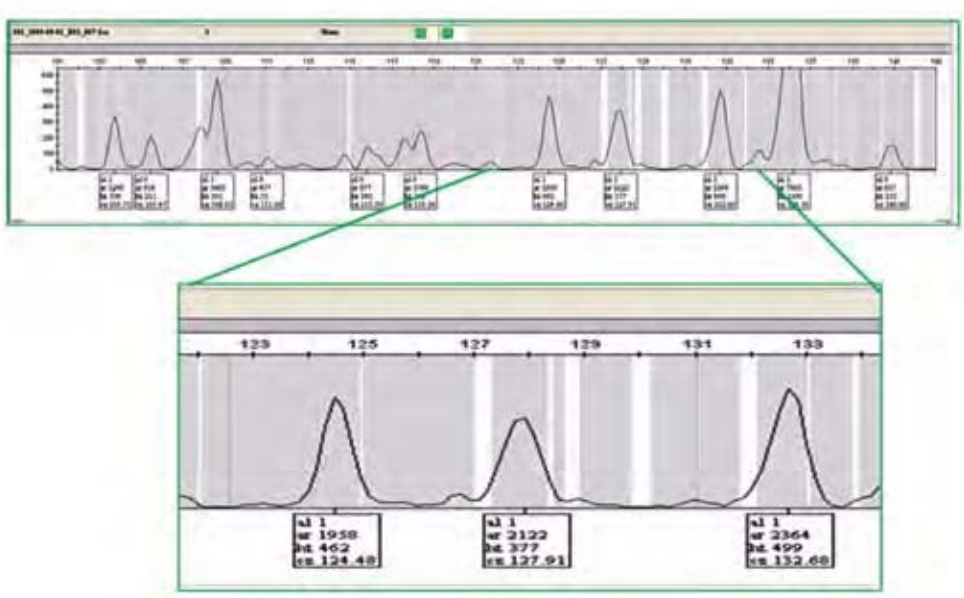


Fig. 73 Bins and sizing of AFLP fragments by Genemapper

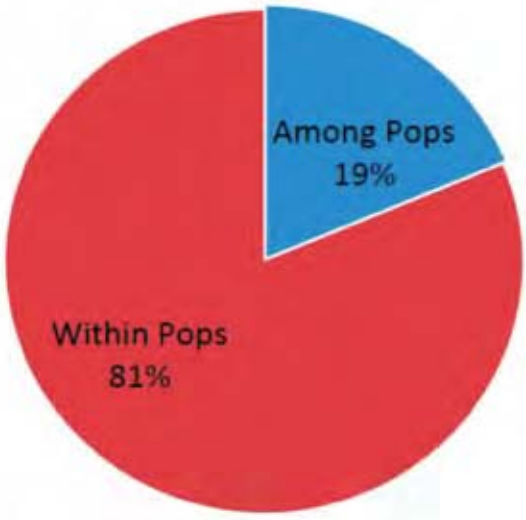


Fig. 74 Graphical representation of partitioned genetic variations within and among populations

EDIBLE AND SPICE CROPS

APPLE *(Malus* sp.)

Improvement of apple through biotechnological interventions (Sponsored by Department of Biotechnology, Govt. of India)

Enhancing productivity of apple through understanding the molecular basis of host-pathogen interactions

In continuation to the work on *Venturia inaequalis* pathogenesis, the transcriptome of *V. inaequalis* was assembled *de novo*, annotated and characterized. *Venturia* transcripts expressed during its biotrophic stage of apple infection were sequenced using Illumina RNAseq technology. A total of 94,350,055 reads (50 bp read length) specific to *Venturia* were obtained after filtering. The reads were assembled into 62,061 contigs representing 24,571 unique genes. Gene ontology suggested the prevalence of genes involved in metabolism, transport and response to stimulus and also molecular function like binding, catalytic activities and transferase activities were found in majority. EC and KEGG pathway analyses suggested prevalence of genes encoding kinases, proteases, glycoside hydrolases, cutinases, cytochrome P450 and transcription factors (**Fig. 75**). Several putative pathogenicity determinants, candidate effectors in *V. inaequalis* and a large number of transcripts encoding membrane transporters were identified. Comparative analysis revealed the number of transporters encoded by *Venturia* were significantly more than those involved in other plant fungal pathogens. Phylogenomics analysis revealed a close relationship of *V. inaequalis* with *Pyrenophora tritici-repentis,* the causal organism of tan spot in wheat.

De novo assembly, annotation and characterization of *V. inaequalis* transcriptome

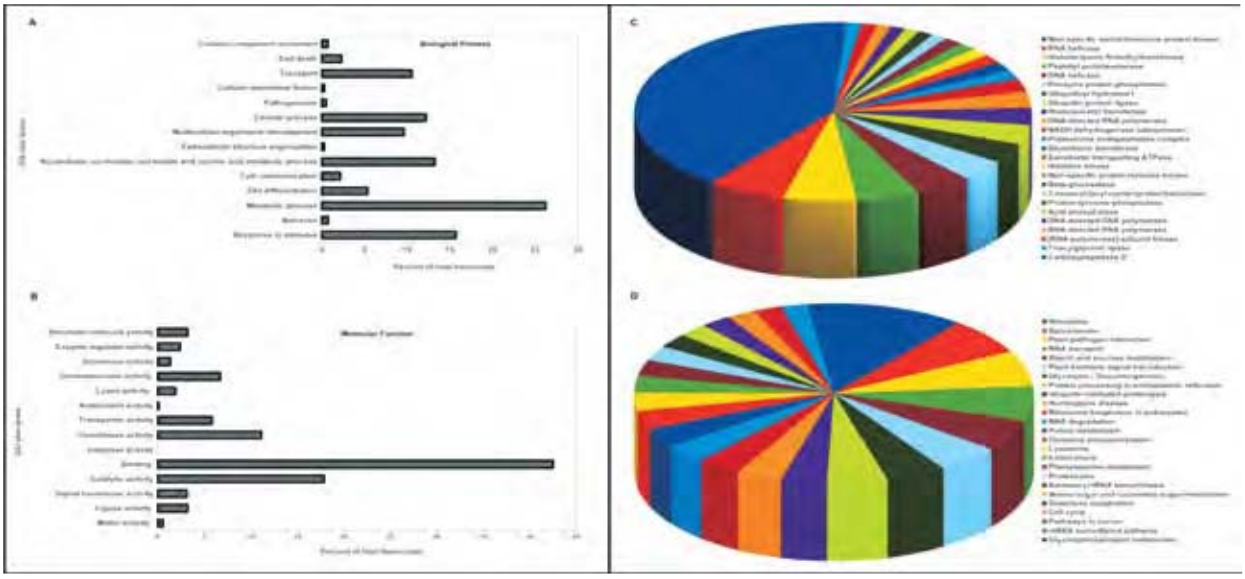


Fig. 75 (A and B) Summarization of transcripts based on gene ontology (C) enzyme classes identified (D) KEGG pathways (Area under each pie represents the value in percent)

Candidate virulence factors

BLASTP analysis against kinase database resulted in 240 hits classifying the sequences into 9 kinase groups **(Table 18)**. A total of 88 transcripts encoding CYP subfamily proteins were identified in *V. inaequalis* while selecting the unique hits from Pfam and InterproScan searches and BLASTp analysis against fungal Cytochrome P450 database.

Table 18 The number of genes encoding protein kinases in *V. inaequalis*

Kinase group	No. of occurrences
AGC (protein kinase A, G and C group)	31
Atypical kinases (His k, BRD, PDHK)	35
CAMK(Calcium/Calmodulin regulated kinases)	33
CK1 (Casein kinase 1 group)	14
CMGC (CDK, MAPK, GSK3 and CLK kinases)	58
STE (MAP kinase cascade kinases)	38
TK (Tyrosine kinase)	0
TKL (Tyrosine kinase-like group)	0
Other	31
Total	240

Secretome of *V. inaequalis*

Secretome or the secreted pathogenic proteins and effectors are crucial for establishing infection on host plant as these disable plant defense or sabotage cellular processes to suit the needs of invading pathogens. Proteins which contain signal peptides but lack transmembrane helices are considered as secreted proteins. Following such criteria, 463 set A transcripts and 483 set B transcripts were predicted to be secreted. *V. inequalis* was found to harbor similar number of secreted proteins as majority of other phytopathogenic fungi (**Fig. 76**).

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

Field efficacy trial of different acaricides against apple mites

Biorational pesticides (spiromesifen, chlorfenapyr, fenpyroximate, hexythiazox, abamectin and neem formulation) and conventional acaricides (fenazaquin and dicofol) were evaluated against apple mites (*Panonychus ulmi*) in a field trial laid at Marhi, Kullu (HP). All the treatments showed significant reduction in mite population over control up to 28 days, except horticultural mineral oil (HMO) and neem formulation. HMO was the least efficacious in controlling mites.

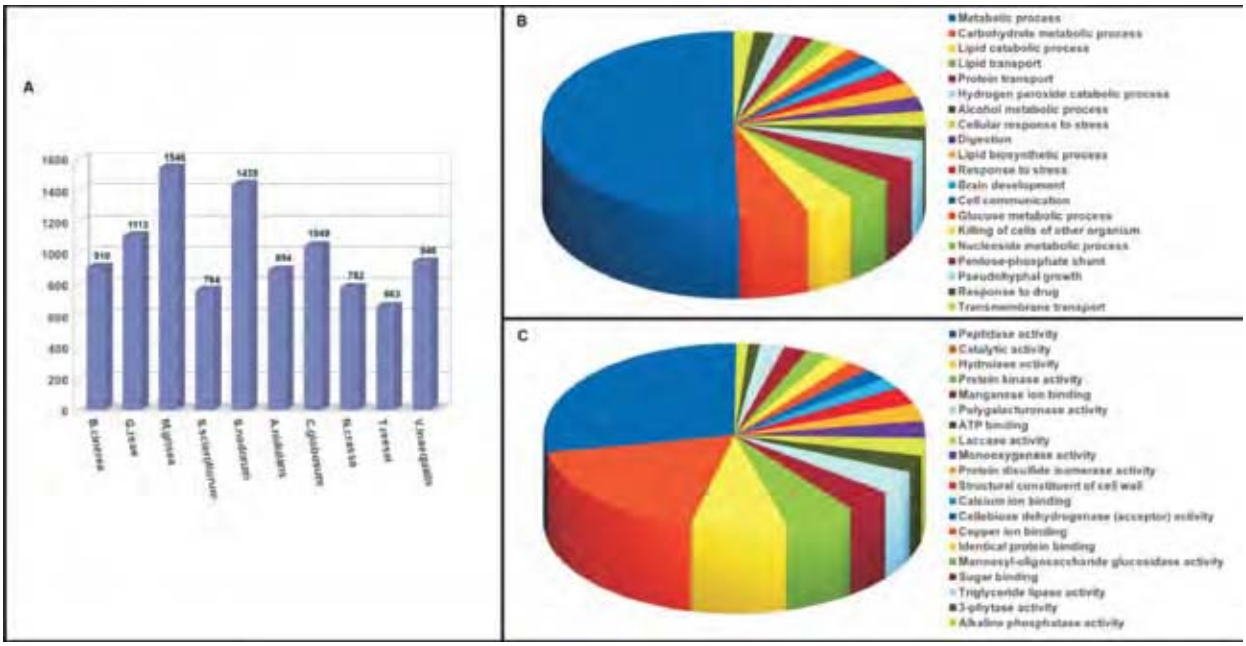


Fig. 76 Prediction of *V. inaequalis* secretome (A) comparative analysis of secretome sizes of various filamentous fungi (B) genes involved in metabolic processes (C) molecular function based on GO data analysis (Area under each pie represents the value in percent)

Biotechnological interventions for improvement of apple through virus and genetic fidelity certification and production of virus tested elite planting material

The complete nucleotide sequence of an Indian isolate of *Apple chlorotic leaf spot virus* (ACLSV) encoding three ORFs was determined and found to be 7,525 nt in length. The genome organization was similar to known isolates of the virus. Comparisons indicated high sequence variability among known isolates with overall nucleotide sequence identities of 80 to 84%. A striking variable region was identified among the replicase protein upstream of the RNA-dependent RNA polymerase (1510–1590 aa). It showed 41 to 43% match with the corresponding region in other isolates. Phylogenetic analysis at the nucleotide level clustered the isolates into three groups without any relation to geographical origin. Recombination analysis showed that the isolate is a recombinant with recombination sites spread throughout the genome, especially in the polymerase gene region (4700–5400 nt). Most recombination sites were bordered by GC-rich upstream region (5') and downstream region (3') of AU-rich sequences of similar length (**Fig. 77**). The interlineage recombinations in the apple host was more in comparison to intralineage recombinations.

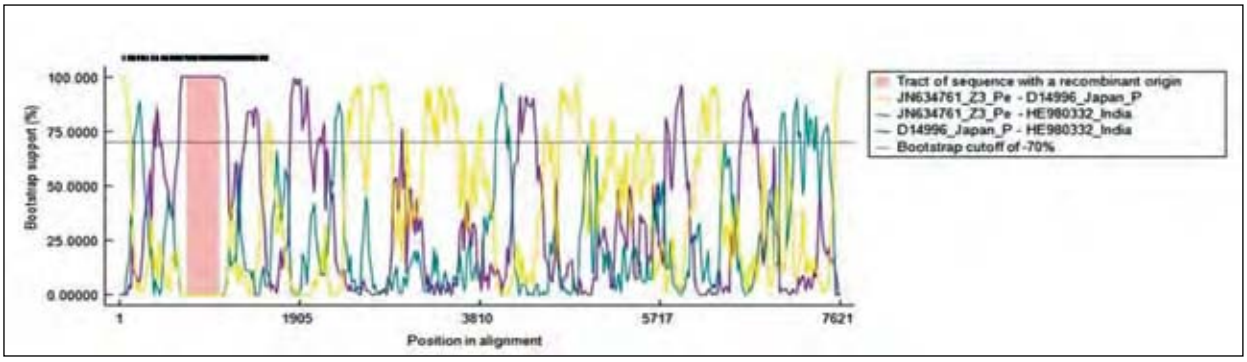


Fig. 77 Description of the recombination sites in ACLSV

Expression of ASGV coat protein (CP) in pET-32a(+) and pHIS expression system

CP gene was amplified and cloned in pET-32a(+) expression vector. Protein was induced optimally in soluble fraction containing (1 mM) IPTG at 30°C (pET-32a)/28 °C (pHIS) (**Fig. 78**).

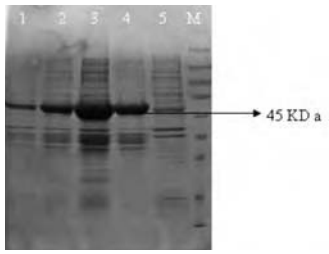


Fig. 78 ASGV CP as His Tag fusion protein. Lanes 1-4: 45 kDa His Tag fusion protein expressed after 1, 2, 3 and 4 h of induction, respectively; Lane 5: Control with no IPTG. Lane M: Prestained protein marker (Fermentas)

The protein was purified and its identity was confirmed by Western blotting (**Fig. 79**).

Purified protein was used for rabbit immunization. The IgG was extracted and purified from the antiserum using Protein A antibody purification system. This IgG was used for testing of field samples where the antisera developed was equally effective when compared to commercial kits.

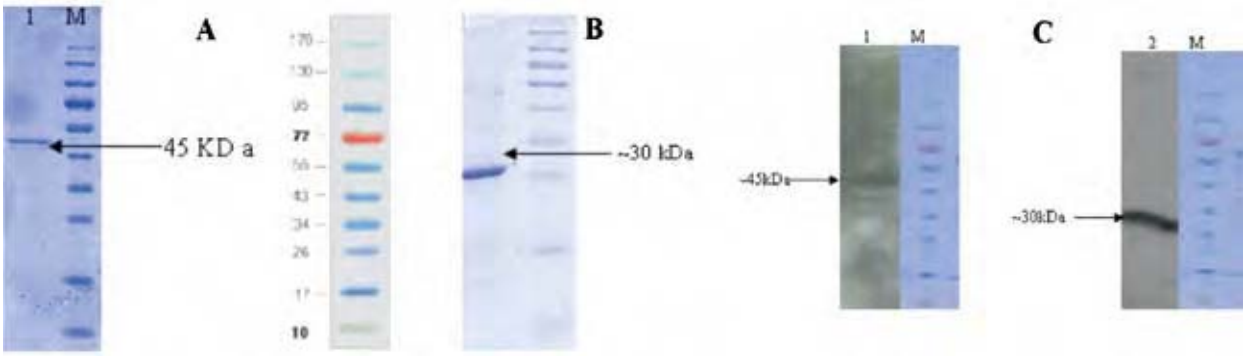


Fig. 79 The purified ASGV CP as (A) His Tag fusion protein in pET-32a (B) and pHIS parallel vectors (C) confirmation by Western blotting

Detection and identification of ASGV from nectarine, peach, wild cherry, almond and apricot

Various stone fruits such as nectarine, peach, wild cherry, almond and apricot were tested for ASGV by ELISA and confirmed positive through RT-PCR (**Fig. 80**).

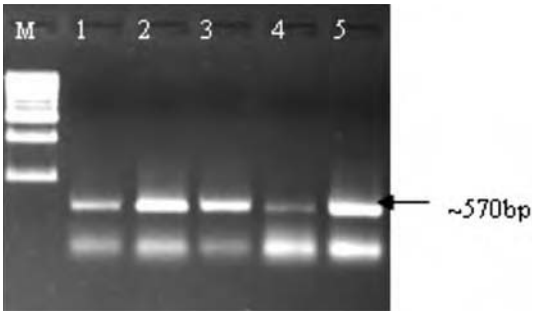


Fig. 80 Amplifications with detection primers for ASGV. M1kb ladder, 1: Nectarine, 2: Peach, 3: Wild cherry, 4: Almond & 5: Apricot

Genetic transformation of apple rootstock MM106 (Funded by Department of Biotechnology Govt. of India)

In continuation to previous activity, transgenic lines of apple rootstock MM106 were tested for RT-PCR expression of *gus* gene. Positive signals were obtained in the tested lines (**Fig. 81A**). These were multiplied on BAP and NAA supplemented MS medium (**Fig. 81B**) and rooted prior to their transfer to soil for maintenance under contained polyhouse conditions (**Fig. 81C**).

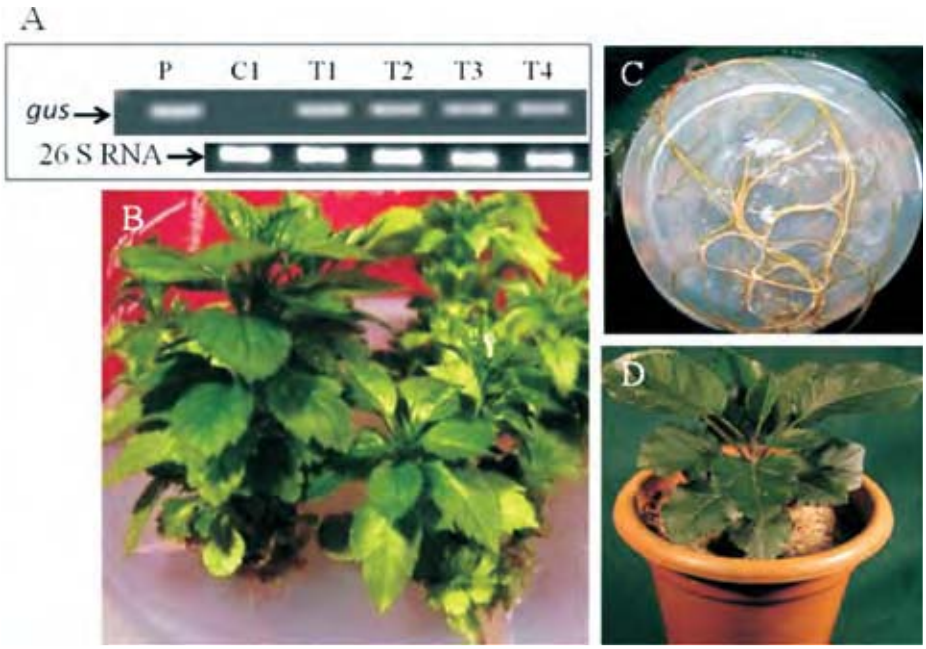


Fig. 81 Transgenic apple rootstock MM106 (A) RT-PCR analysis where T1-T4: transgenic lines, C1: untransformed control and P: positive control (B) multiplication of transgenic lines (C) rooting of microshoots (D) transgenic plant growing in soil under poly house

STEVIA (*Stevia rebaudiana*)

Stevia accumulates up to 30% of diterpenoid steviol glycosides (SGs) of the total leaf dry weight. SGs are approximately 300 times sweeter than common table sugar and are used as non-calorific sweetener in many countries of the world.

Effect of foliar spray of nutrients on leaf area index (LAI) and crop growth rate (CGR)

A field experiment was conducted to (i) record the effect of nipping and foliar fertilization on the productivity and quality of stevia, and (ii) break the apical dominance and increase physiological activities. Increased branching and dry leaf yield by 13 to 17% was recorded as compared to not-nipped. Foliar application of nutrient solutions also affected the growth parameters, yield attributes and chlorophyll content. Crop fertilized with 0.5% KNO_3 recorded maximum LAI and CGR (**Fig. 82**). Among the foliar spray treatments, 0.5% KNO_3 and 0.406% $Ca(NO_3)_2$ were most effective in improving the dry leaf yield.

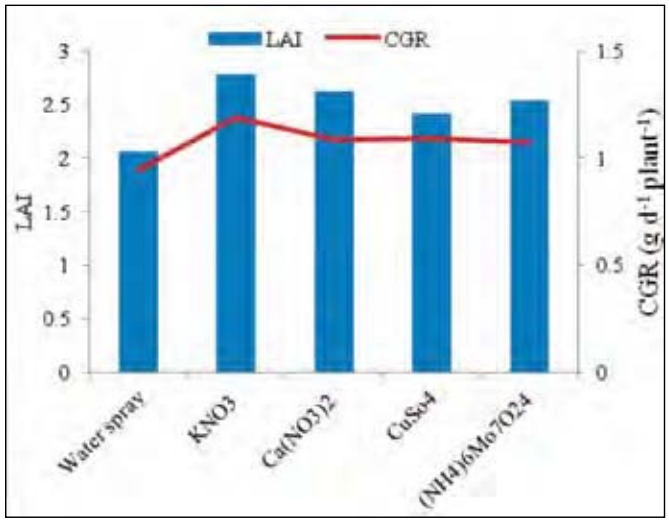


Fig. 82 Effect of foliar application of nutrient solutions on leaf area index (LAI) and crop growth rate (CGR)

Effect of types of crop and harvest management system

A field experiment on comparative evaluation of annual and perennial crops of stevia revealed that two cuts per crop season resulted in higher dry leaf yield as compared to single cut and triple cuts. Irrespective of the number of harvests, the performance of stevia as a perennial crop was superior (increased dry leaf yield by 137%) to annual crop (**Fig. 83**).

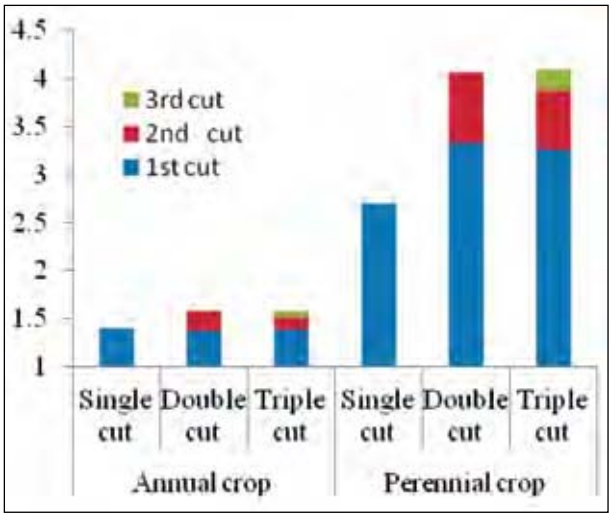


Fig. 83 Effect of types of crop and harvest management system on stevia

Molecular regulation of steviol glycosides (SGs) biosynthesis

The molecular regulation studies of SGs biosynthesis revealed various genes such as *SrDXS, SrDXR, SrCPPS, SrKS, SrKO* and three glucosyltransferases, *SrUGT85C2, SrUGT74G1* and *SrUGT76G1* were identified. Additionally, 15 genes including *SrMCT, SrCMK, SrMDS, SrHDS, SrHDR, SrIDI* and *SrGGDPS* were cloned and subjected to expression analysis. Maximum accumulation of SGs in leaf followed by stem and root was corroborated by similar pattern of gene expression (**Fig. 84**).

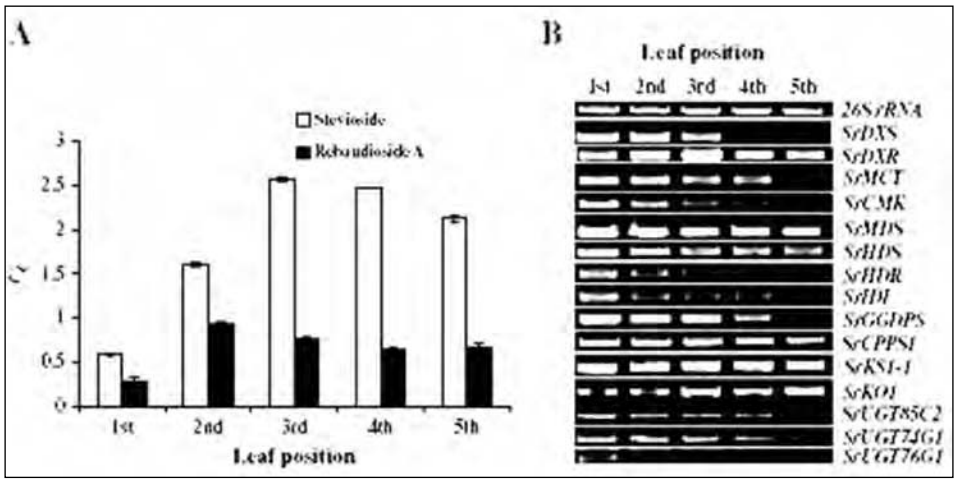


Fig. 84 Molecular of regulation steviol glycosides biosynthesis (A) SGs content (B) expression of SGs biosynthetic pathway genes in leaves at different node positions

Crop improvement by mutation

To improve leaf yield and sweet glycoside content, leaves and seeds were treated with colchicine to induce mutations. Treatment of seeds with 0.2 to 0.6% colchicine reduced the survival rate of young seedlings to below 50%. While maximum number of polyploids (tetraploids) were obtained with 0.6% colchicine treatment for 24 h; mixoploidy was observed at 0.2% colchicine treatment for 6 h. The nuclear DNA content (2C-value) of diploid *S. rebaudiana* variety Madhuguna was estimated to be 2.72 pg by flow-cytometry (**Fig. 85A**). Polyploids C7-3-4, C7-3-5, C9-1-1 and

C9-4-3 were distinguished from diploid control plants as their DNA content doubled, suggesting autotetraploidy. Chromosome count in root-tip cells of polyploids (2n=44) confirmed the tetraploid status (**Fig. 85B**). The autotetraploids had significantly increased leaf size and thickness, chlorophyll content and reduced internode length.

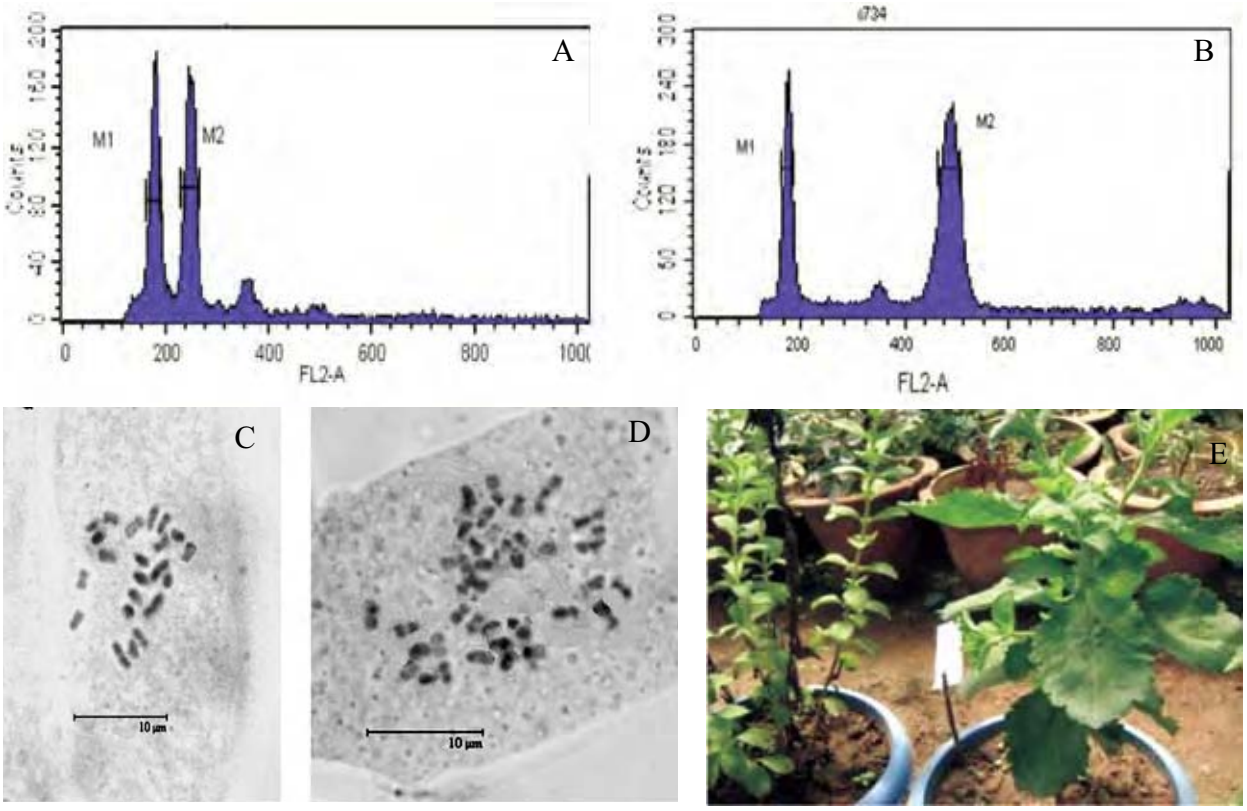


Fig. 85 Flow-cytometry histogram peaks differentiating (A) diploid (B) tetraploidplants (C) chromosome count diploid with 2n=22 (D) tetraploid with 2n=44 and (E) morphological variations among diploid control and tetraploid (C7-3-4) plants developed through colchicine treatment

SAFFRON (*Crocus sativus*)

Demonstration plots of saffron were established at Sher-e-Kashmir University of Agricultural Sciences and Technology (SKUAST-K), Srinagar, J&K in September, 2009. Growth performance of *in vitro* derived cormlets and *in vivo* corms of corresponding size was evaluated under field conditions. As compared to *in vivo* corms (5.0-6.0 g), sprouting of *in vitro* cormlets (<5.0 g) was delayed by one month, and the percent sprouting (62.20) was lesser than *in vivo* cormlets (76.78). The time required for flowering was similar in the *in vitro* and in vivo corms. The in vitro cormlets behaved similar to that of *in vivo* corms under natural conditions. Daughter cormlets produced under natural conditions after first growth phase were re-planted for second year. In the second and third year, the growth parameters were comparable in the *in vivo* and *in vitro* corms. At the end of third growth phase, 3-4 daughter corms developed from *in vitro* corms, whereas, 5-6 were formed from *in vivo* ones. Well developed root system comparable to *in vivo* corms was also observed (**Table 19**).

Table 19 Growth performance evaluation of *in vivo* corms and corms derived from *in vitro* cormlets

Parameters	Growth season under natural habitat			
	Second year		Third year	
	< 5.0 g (*in vitro*)	5.0-6.0 g (*in vivo*)	< 5.0 g (*in vitro*)	5.0-6.0 g (*in vivo*)
Average plant height (cm)	30.00	35.00	34.00	34.67
Average number of leaves/ditch	14.67	32.33	44.00	41.67
Mean flower weight per corm	0.40	0.40	0.40	0.40
Average fresh pistil weight per flower (g)	0.035	0.036	0.036	0.032
Average dry pistil weight per flower (g)	0.0067	0.0066	0.007	0.006

LARGE CARDAMOM (*Amomum subulatum* Roxb.)

Studies on the essential oil composition of large cardamom populations growing in HP

The essential oil components of large cardamom growing in different agro-climatic zones of HP showed qualitative and quantitative variations. Based on GC and GC-MS analysis, 55 compounds representing 98% of oil were identified (**Table 20**). Major components included 1,8-cineole, α-terpineol, dl-limonene, nerolidol, 4-terpineol, δ-terpineol, δ-3-carene, β-myrcene, germacrene D, α-terpinene and longifolenaldehyde. The oil ranged between 9.8-19.5 g/kg. Cardamom oil from HP was found to contain new compounds, *viz.* 4-terpineol, δ-3-carene, *trans*-sabinene hydrate, 1-phellandrene, α-terpinene, bicyclo-germacrene, isopinocarveol and ledenoxid-II. α-Terpenyl acetate, a major constituent of small cardamom essential oil was also detected in the oil of large cardamom. The five most intense aromatic components were identified as dl-limonene, 1,8-cineole, β-myrcene, α-pinene and α-basabolol.

Table 20 Percent composition of essential oil from *A. subulatum* seeds

BP-20	HP-5	Compound	Kullu	Mandi	Sirmour	Bilaspur	Chamba	Palampur	Mode of identification
1147	1000	δ-3-Carene	2.02 ± 0.17	1.95 ± 0.13	2.17 ± 0.07	2.18 ± 0.09	2.05 ± 0.05	1.22 ± 0.46	KI, MS
1162	981	β-Myrcene	1.51 ± 0.17	1.45 ± 0.25	1.34 ± 0.31	1.59 ± 0.42	1.16 ± 0.36	2.36 ± 0.95	KI, MS
1167	997	1-Phellandrene	0.74 ± 0.07	0.76 ± 0.05	0.83 ± 0.04	0.54 ± 0.05	0.53 ± 0.04	0.34 ± 0.10	KI, MS
1181	1008	α-Terpinene	0.95 ± 0.08	0.94 ± 0.13	1.14 ± 0.09	1.01 ± 0.08	0.98 ± 0.06	0.70 ± 0.33	KI, MS
1205	1028	*dl*-Limonene	11.76 ± 0.85	11.33 ± 1.02	11.37 ± 1.33	10.93 ± 1.39	10.06 ± 1.42	5.49 ± 4.88	KI, MS
1215	1002	1,8-Cineole	57.31 ± 2.70	51.93 ± 2.19	52.22 ± 2.35	50.55 ± 1.87	52.39 ± 1.55	60.46 ± 3.50	KI, MS
1282	1054	α-Terpinolene	0.38 ± 0.04	0.40 ± 0.04	0.47 ± 0.03	0.42 ± 0.03	0.42 ± 0.01	0.30 ± 0.15	KI, MS
1485	1366	Copaene	0.07 ± 0.02	-	-	-	-	0.08 ± 0.02	KI, MS
1521	1099	*trans*- Sabinene hydrate	0.92 ± 0.26	-	0.78 ± 0.06	1.33 ± 0.16	1.76 ± 0.42	2.16 ± 0.73	KI, MS
1532	1409	β-Damascone	0.13 ± 0.03	0.10 ± 0.01	0.11 ± 0.03	0.10 ± 0.01	0.06± 0.01	-	KI, MS
1539	1121	Campholenicaldehyde	0.09 ± 0.02	0.11 ± 0.02	0.11 ± 0.02	-	-	-	KI, MS
1582	1091	Linalool	0.15 ± 0.01	0.17 ± 0.01	0.21 ± 0.02	0.20 ± 0.01	0.16 ± 0.01	0.14 ± 0.03	KI, MS
1587	1153	Pinocarvone	0.18± 0.01	0.17 ± 0.02	0.21 ± 0.03	0.1± 0.01	0.11± 0.01	0.12 ± 0.01	KI, MS

BP-20	HP-5	Compound	Kullu	Mandi	Sirmour	Bilaspur	Chamba	Palampur	Mode of identification
1591	1033	*cis*-Sabinene hydrate	0.49 ± 0.07	0.86 ± 0.17	-	-	-	-	KI, MS
1601	1408	trans-β-Caryophyllene	0.09 ± 0.02	0.11 ± 0.01	0.10 ± 0.01	0.15 ± 0.02	0.15 ± 0.01	0.34 ± 0.09	KI, MS
1615	1170	4-Terpineol	4.89 ± 0.16	4.60 ± 0.21	5.39 ± 0.22	4.63 ± 0.16	5.09 ± 0.26	2.60 ± 0.87	KI, MS
1628	1184	1R-(-)-Myrtenal	0.15 ± 0.01	0.1± 0.01	0.17 ± 0.03	-	-	-	KI, MS
1650	1148	Isopinocarveol	0.30 ± 0.04	0.25 ± 0.07	0.26 ± 0.06	0.11 ± 0.04	0.16 ± 0.01	0.12 ± 0.03	KI, MS
1657	1382	α–Caryophyllene	-	-	-	-	-	0.05	KI, MS
1665	1191	δ-Terpineol	2.86 ± 0.13	3.21 ± 0.17	3.30 ± 0.29	3.35 ± 0.21	3.16 ± 0.27	2.98 ± 0.33	KI, MS
1670	1196	*cis*-Piperitol	0.10 ± 0.05	-	-	0.13 ± 0.02	-	-	KI, MS
1677	1344	α-Terpenyl acetate	0.08 ± 0.01	0.14 ± 0.02	0.11 ± 0.01	0.11 ± 0.01	0.14 ± 0.01	0.44 ± 0.13	KI, MS
1681	1451	Germacrene D	0.55 ± 0.08	0.65 ± 0.05	0.52 ± 0.05	1.34 ± 0.12	0.90 ± 0.13	2.28 ± 0.78	KI, MS
1685	1181	α–Terpineol	15.84 ± 1.20	14.88 ± 0.64	15.33 ± 1.21	15.82 ± 1.49	16.48 ± 1.34	15.30 ± 0.86	KI, MS
1696	1496	Bicyclogermacrene	0.10 ± 0.02	0.12 ± 0.02	0.10 ± 0.01	0.25 ± 0.03	0.18 ± 0.02	0.63± 0.1	KI, MS
1704	1242	Carvone	0.21 ± 0.03	0.21 ± 0.02	0.31 ± 0.06	0.10 ± 0.02	0.11 ± 0.02	0.09 ± 0.03	KI, MS
1715	1518	β-Cadinene	-	-	-	0.16 ± 0.02	-	0.36 ± 0.11	KI, MS
1721	1209	Paramenth-1-en-3-one	-	0.13 ± 0.02	-	0.12 ± 0.01	0.15 ± 0.01	0.15 ± 0.09	KI, MS
1747	1206	Myrtenol	-	0.20 ± 0.09	-	0.14 ± 0.03	-	-	KI, MS
1780	1217	1-Carveol	0.24 ± 0.02	-	0.36 ± 0.07	0.17 ± 0.03	0.13 ± 0.01	0.07 ± 0.03	KI, MS
1897	1273	Isogeraniol	0.10 ± 0.01	0.17 ± 0.03	0.18 ± 0.04	0.09± 0.01	0.11 ± 0.01	0.08 ± 0.01	KI, MS
1926	1530	Nerolidol	3.79 ± 0.49	5.29 ± 0.93	4.39 ± 0.31	5.18 ± 0.71	6.04 ± 0.65	5.91 ± 1.12	KI, MS
1977	1594	Spathulenol	-	0.70 ± 0.03	0.43 ± 0.12	0.82 ± 0.04	0.42 ± 0.14	0.51	KI, MS
2000	1876	Longifolenaldehyde	0.85 ± 0.08	1.50 ± 0.32	0.91± 0.13	1.36 ± 0.20	0.88 ± 0.12	0.32 ± 0.33	KI, MS
2050	1639	Isospathulenol	-	-	0.1± 0.01	0.11 ± 0.01	-	-	KI, MS
2057	1663	α–Cadinol	-	-	-	0.28 ± 0.05	0.21 ± 0.03	0.20 ± 0.08	KI, MS
2095	1682	Ledenoxide-II	-	0.09 ± 0.06	-	0.12 ± 0.02	0.07 ± 0.02	-	KI, MS
2110	2399	Tetracosane	0.12 ± 0.03	0.26± 0.04	0.45± 0.05	0.32± 0.02	0.32 ± 0.02	0.18± 0.01	KI, MS
2261	1807	2-Ethyl-2-methyl-tri-decanol	-	0.19± 0.03	0.11 ± 0.04	0.12 ± 0.02	0.44 ± 0.57	0.10 ± 0.02	KI, MS
2385	1768	Myristic acid	-	-	-	-	0.27 ± 0.05	0.10 ± 0.00	KI, MS
Oxygenated monoterpenes			71.46	65.71	65.31	69.04	71.21	75.54	
Monoterpene hydrocarbons			17.12	16.13	16.38	16.78	15.36	10.53	
Aldehydes			1.06	1.61	1.10	1.36	0.88	0.32	
Ketones			0.57	0.91	0.94	0.83	0.87	0.39	
Fatty acids			0.08	0.13	0.10	0.11	0.41	0.54	
Alkanes and alkenes			0.52	0.53	0.55	0.40	0.46	0.69	
Sesquiterpene hydrocarbons			4.64	5.65	5.02	7.01	7.04	8.91	
Bicyclic sesquiterpenes			0	0	0	0.28	0.21	0.20	
Oxygenated sesquiterpenes			0	0.66	0.49	0.93	0.42	0.51	
Others			0.620	1.70	1.98	2.92	2.70	1.66	
% of identified components			96.07	93.03	91.87	99.66	99.56	99.29	

FLOWER CROPS

ORNAMENTAL ROSE (*Rosa* spp.)

Breeding

Hybridization among scented, ornamental and wild roses was undertaken to generate new floral variations (**Table 21**). Inter-specific hybridization was carried out among 6 different rose species (*Rosa damascena*, *R. bourboniana*, *R. multiflora*, *R. centifolia*, *R. rugosa* and *R. chinensis minima*) to generate desirable variations for flower, fruit and essential oil characters. Inter-varietal crosses involving reciprocals were attempted in *R. damascena* and *R. hybrida* (ornamental roses), respectively. Overall, 112 seeds were obtained from 76 pollinations in crosses involving ornamental roses, 93 seeds from 202 pollinations in back-crosses, 19 seeds from 61 pollinations in inter-varietal crosses among varieties of damask rose and 981 seeds from 317 pollinations involving inter-specific crosses.

Table 21 Seed set obtained under inter-varietal and inter-specific hybridization program

Cross	No. of pollinations	No. of seeds
Inter-varietal		
a) Damask rose	61	19
b) Ornamental rose	76	112
Inter-specific	317	981
Back-cross	202	93

Himalayan Wonder-a thornless ornamental rose

Rose is universally acclaimed as the "queen of flowers". The plant has a wide range of adaptability to various soil and climatic conditions. It has a long blooming period and its flowers are beautiful with good shelf life. Besides its use as cut flowers, rose is grown in beddings and gardens for its ornamental values. However, the presence of thorns in the plant irritates the consumer and is an undesirable trait. Therefore in an earlier work, a thornless 'bud sport' ornamental rose was selected naturally from among 30 plants of cv First Red having thorns. In the current year, the performance of the thornless 'bud sport' was evaluated under polyhouse conditions (**Fig. 86 A,B & C**). The vegetative and reproductive parameters of this thornless 'bud sport' ornamental rose were recorded (**Table 22**). The flower colour of this thornless 'bud sport' was Red Purple as per the Royal Horticulture Society (RHS) Colour chart.

Fig. 86 Himalayan Wonder-a thornless 'bud sport' ornamental rose of cv First Red (A) plants in full bloom and (B) close up flower in full bloom

Fig. 86 (C) Flower with thornless stalk

Table 22 Salient features of the cultivar 'Himalayan Wonder'

Diameter of flowering shoot (cm)	0.71
Diameter of flower bud (cm)	2.59
Length of flower bud (cm)	4.51
Diameter of bud neck (cm)	0.52
No. of flowering shoot per plant/year	26.6
No. of flowering shoot/m^2 net area/year	213
Size of fully open flower (cm)	10.23
No. of petals per flower bud	31.4
Colour of stem/shoot	Green
Colour of upper surface of leave	Green
Colour of lower surface of leave	Green
Outer colour of petal	Red Purple
Inner colour of petal	Red Purple
Vase life (days)	7

Rose is propagated by seeds, budding, grafting, layering, cutting and through micropropagation for disease free planting materials. Asexual propagation allows plants to grow true to type. It is commercially propagated by budding. T-budding is the most widely accepted method for propagating ornamental roses. It was observed that the highest survival (80%) in plants through T-budding of rose cv First Red was obtained in February in mid hills.

GERBERA (*Gerbera jamesonii*)

Breeding

In continuation to the gerbera breeding program, variability was generated and characterized for improvement of floral traits through hybridization. Considerable variations were observed

for the floral traits *viz.*, flower colour (different hues of white, yellow, yellow-orange, orange, red and red-purple), shape (single, semi-double and double types), diameter (standard and mini sizes), disc colour (dark brown/green), scape length (tall/dwarf), disc diameter, ray floret width (spider/standard types) and ray floret number among the parental genotypes and their progenies. The promising gerbera genotypes (IHBT-Gr-24-5, IHBT-Gr-24-6 and IHBT-Gr-11-6) were selected on the basis of flower characteristics (**Table 23** and **Fig. 87**).

Table 23 Details of floral features of gerbera F_1 selections

Plant No.	Flower colour	Peduncle length (cm)	Flower diameter (cm)	Flower shape	Disc colour	Flower type
IHBT-Gr-24-5	Red	41.2	10.8	Double	Brown	Standard
IHBT-Gr-24-6	Yellow orange	29.6	11.7	Semi-double	Brown	Standard Dwarf
IHBT-Gr-11-6	Yellow	33.1	7.9	Double	Green	Mini Dwarf

Fig. 87 Flower of F_1 selections of gerbera

CARNATION (*Dianthus caryophyllus*)

Five cultivars of standard carnation *viz*. White Dona, Red Dona, Pink Dona, Yellow Soto and Mazanda Dona were procured and planted under polyhouse conditions for multiplication.

LILIUM (*Lilium* sp.)

Among the different types of lilies, the Asiatic hybrid lily is very popular. Experiment was conducted to standardize the foliar spray of fertilizers and mulching in lilium growing beds. The cv Novecento produced maximum number (5.93) and weight (71.66 g) of bulbs and bulblets, when a foliar spray of 250 ppm of fertilizer at 19:19:19 was used .

Sprouted and dormant bulbs of Asiatic hybrid lily cv Grand Paradiso were grown under Palampur conditions. Number of days to flowering was increased, when dormant bulbs were used. Maximum length of flower shoot (123.30 cm) and flower bud (8.14 cm) were recorded in dormant and sprouted bulbs, respectively. Largest size of bulbs were produced, when dormant bulbs were used.

In the performance evaluation of Asiatic hybrid lily cvs Novecento, Polyana and Parato in village Jagla, Lahaul & Spiti (HP) in July, 2011, maximum length of flower shoot (165 cm) and flower bud numbers (14.33 per shoot) were observed in cv Novecento.

Two cultivars of hybrid lily namely Pavia and Menorca were collected and planted under shade house conditions for evaluation, multiplication and utilization. Menorca and Pavia produced flower shoots of length 82 and 88.50 cm with 11 and 9 cm flower buds, respectively.

LISIANTHUS *(Eustoma grandiflorum)*

Lisianthus belongs to the family Gentianaceae and originated from central and north America. It is grown as a cut flower, border plant of gardens and as pot plants. An experiment was conducted to standardize the optimum quantity of NPK for quality flower production under poly house conditions. Maximum flower shoot length (58.00 cm) and flower size (7.32 cm) was observed when 175 ppm nitrogen, potash and 100 ppm phosphorus was applied to the crop **(Fig. 88).**

Fig. 88 Flowers of Lisianthus

ORCHIDS

The regeneration potential of *Cymbidium giganteum* and *Rhyncostylis retusa* was assessed using single, segmented and clumps of protocorm like bodies (PLBs). After 60 days of inoculation, 100% regeneration was observed in the clumps of *C. giganteum* when 4.53 µM 2,4-D and 8.88 µM BAP were used. Although the single and segmented protocorms of *C. giganteum* and *R. retusa* showed regeneration, they turned brown with time. In a separate study, clumps of PLBs emerged from the base of *C. giganteum* seedlings and these proliferated on medium supplemented with 8.88 µM BAP and 2.0 g/l AC (**Fig. 89**). Most of these PLBs turned dark green and developed into plantlets.

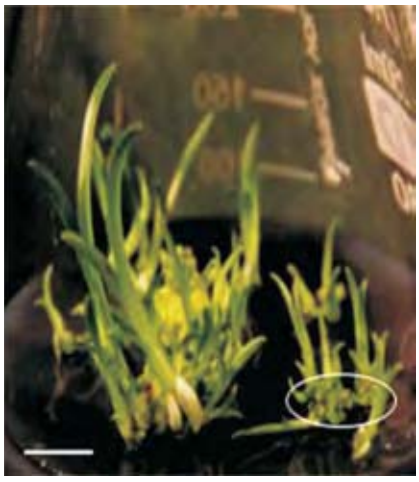


Fig. 89 Formation of PLBs at the base of *C. giganteum* seedlings on basal MS medium containing 8.88 µM BAP and 2.0 g/l AC (bar line=2.0 cm)

MICROBIOLOGY AND PLANT PROTECTION

Bioprospecting microbes for enzyme production

Twenty two previously identified protease producing bacterial isolates were characterized for isozyme variation on casein-zymogram. A total of 15 isoforms were detected and majority of them were identified to be as serine type of proteases. All the isolates were active at low temperature and alkaline pH. Crude proteases from 7 isolates were compatible with commercial detergents.

Gene encoding serine alkaline protease from psychrotrophic *Acinetobacter* sp. MN12 (MTCC 10786) was cloned and expressed in *E. coli*. The amino acid sequence deduced from the complete ORF (1323 bp) revealed that the protein was 441 amino acids long with an estimated molecular weight of 46.6 kDa and had a theoretical pI value of 8.85. The protease exhibited sequence similarities with members of the subtilisin family (S8). Based on the amino acid homology to previously described sequences contained a signal peptide (1-21 residues), a prepeptide (22-143 residues), a mature peptidase (144-433 residues) and a small propeptide (434-441) amino acid. The protease from *Acinetobacter* sp. MN12 formed a cluster with other species of the same genus, while the proteases from other genera were grouped into another cluster.

Twenty seven bacterial isolates from cold deserts of Himalayas were tested for CMCase activity using the method recommended by the International Union of Pure and Applied Chemistry. CMC hydrolysing activity was significantly higher at pH 6 in all the isolates. At pH 9, all the isolates exhibited more than 50% CMC hydrolysing activity. Three genes encoding endoglucanase from a promising isolate *Paenibacillus* sp. were amplified and cloned using T & A cloning vector into *E. coli* DH5 and sequenced. Molecular analysis showed that the endoglucanase genes have ORF encoding a protein of 334, 537 and 573 amino acid residues including a signal peptide. Comparison of deduced amino acid sequence with other cellulases indicated that the enzymes can be classified as a family 5 glycoside hydrolase. The evolutionary relationship between endoglucanase gene corresponding to ~63kDa protein from *Paenibacillus* sp. IHB B 3084 and closely related bacterial endoglucanases is shown (**Fig. 90**). The active recombinant endoglucanase from one clone corresponding to ~63kDa enzyme was partially purified using ion exchange chromatography. Potential probiotic bacteria

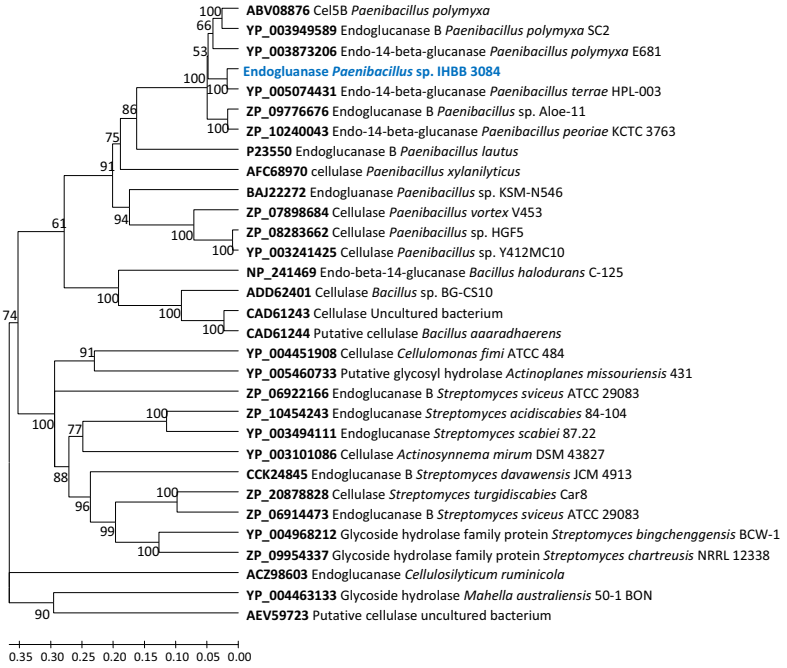


Fig. 90 Evolutionary relationship between endoglucanase gene corresponding to ~63kDa protein from *Paenibacillus* sp. IHB B 3084 and closely related bacterial endoglucanases

belonging to different genera were screened for cholesterol reduction ability. *Enterococcus lactis, E. faecium* and *Lactobacillus plantarum* were found to reduce cholesterol. Additionally, bacteria isolated from yak milk were evaluated for probiotic traits under *in vitro* conditions. Two bacteria showing cholesterol reduction were identified as *Lactobacillus* on the basis of 16S rRNA gene sequencing. Cholesterol was reduced in the presence of bile and bile salts under anaerobic conditions. Bile deconjugation ability and production of bile salt hydrolase was also present. Work on gut microbiome determination of aged individuals (above 85) and respective families was initiated. Bacteria were isolated under aerobic and anaerobic conditions from the stool samples of individuals and further selected on the basis of potential probiotic traits.

Systematic pathogens of fruit tree crops in India: Molecular investigation and development of control strategies (Funded by Department of Science & Technology, Govt. of India)

Grape (*Vitis vinifera*) is known to be infected by Grapevine leaf roll associated viruses (GLRaV's), Grapevine fleck virus (GFkV), Grapevine fanleaf virus (GFLV) and Grapevine virus A & B (GVA & GVB). During survey of grapevine orchards in Kullu, HP, symptoms related to viral infection (leaf yellowing, vein greening, reduced leaf size, downward rolling/cup shaped leaves to reduced fruit bearing) were observed (**Fig. 91**).

Fig. 91 Symptoms observed in vineyards during survey (A) leaves displaying characteristic symptoms of grapevine leafroll associated viral disease on white grapes such as leaf yellowing, reduced leaf size, downward rolling/cup shaped leaves and reduced fruit bearing (B) red grapevine with red leaves and green main veins (C) reduced leaf size with yellowing or mosaic pattern and green main veins (D) plants at Bajaura (Kullu)

During analysis, specific amplification in RT-PCR for GLRaV-1 (~232 bp), GLRaV-3 (~300 bp), GFkV (~179 bp) and GVB (~440 bp) confirmed the presence of these pathogens (**Fig. 92**). Nucleotide sequences of GLRaV-1 and GLRaV-3 showed 99% similarity with US isolates (JF811849, GU983863) whereas GVB and GFkV nucleotide sequences showed 88 and 98% similarity with Chinese (JF927940) and Italian (AJ309022) isolates, respectively. At amino acid level, a sequence similarity of 99, 100, 90 and 100% with Acc. No. ACT31733 (China), AAR02009 (Czech), ACX30795 (China) and NP542613 (Italy) was found for GLRaV-1, GLRaV-3, GVB and GFkV respectively. ELISA and RT-PCR results confirmed the presence of GLRaV-3 (66.7%), GLRaV-1& GFkV (50%), and Grapevine virus B (GVB) (12.5%) in symptomatic plants. None of the samples were found positive for GFLV, GLRaV-2 and phytoplasma.

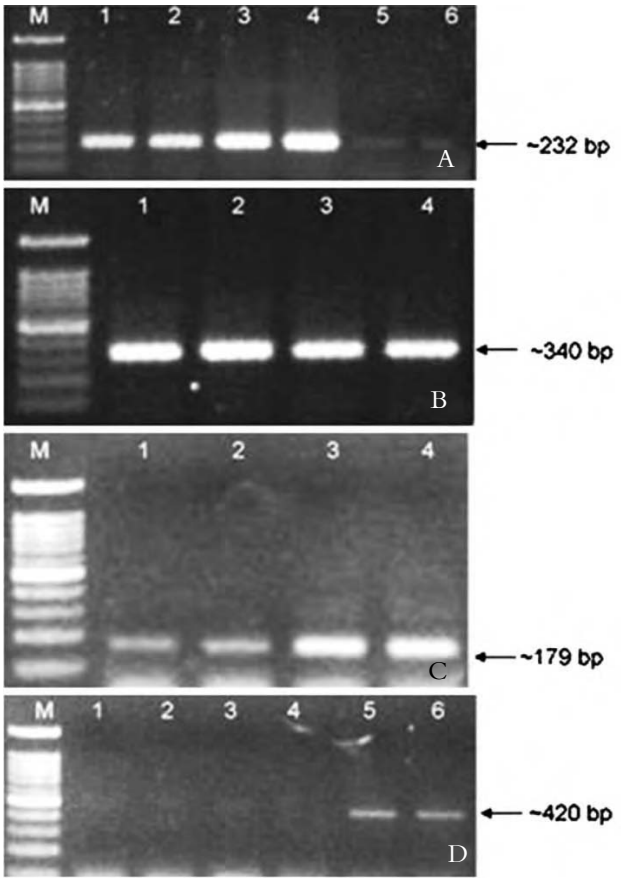


Fig. 92 RT-PCR based detection of grape viruses in HP (A) amplicons of GLRaV-1; lane M marker (100 bp) (B) amplicons of GLRaV-3 (C) amplicons of GFkV (D) amplicons of GVB samples

Biological and molecular characterization of *Cucumber mosaic virus* subgroup II isolate causing severe mosaic in cucumber

Cucumber mosaic virus causing severe mosaic (CMV) and chlorosis was characterized at the molecular level. Its phylogenetic analysis with other 31 CMV isolates reported worldwide, clustered it with subgroup II strains (mild strains). The genome comprised of RNA 1 (3379 nucleotides), RNA 2 (3036 nucleotides) and RNA 3 (2206 nucleotides). The isolate showed highest homology with subgroup II isolates: 95.1-98.7%, 87.7-98.0% and 85.4-97.1% within RNA1, RNA2 and RNA3, respectively. RNA1 and RNA2 were closely related to the Japanese isolate while RNA3 clustered with an American isolate.

It was found to be closely related to an isolate infecting carrot (EU642567; Aligarh isolate). The isolate is very competitive in its infection of different host plants (**Fig. 93**). Host range studies revealed severe mosaic symptoms on tobacco and cucumber but mild filiform type symptoms in tomato.

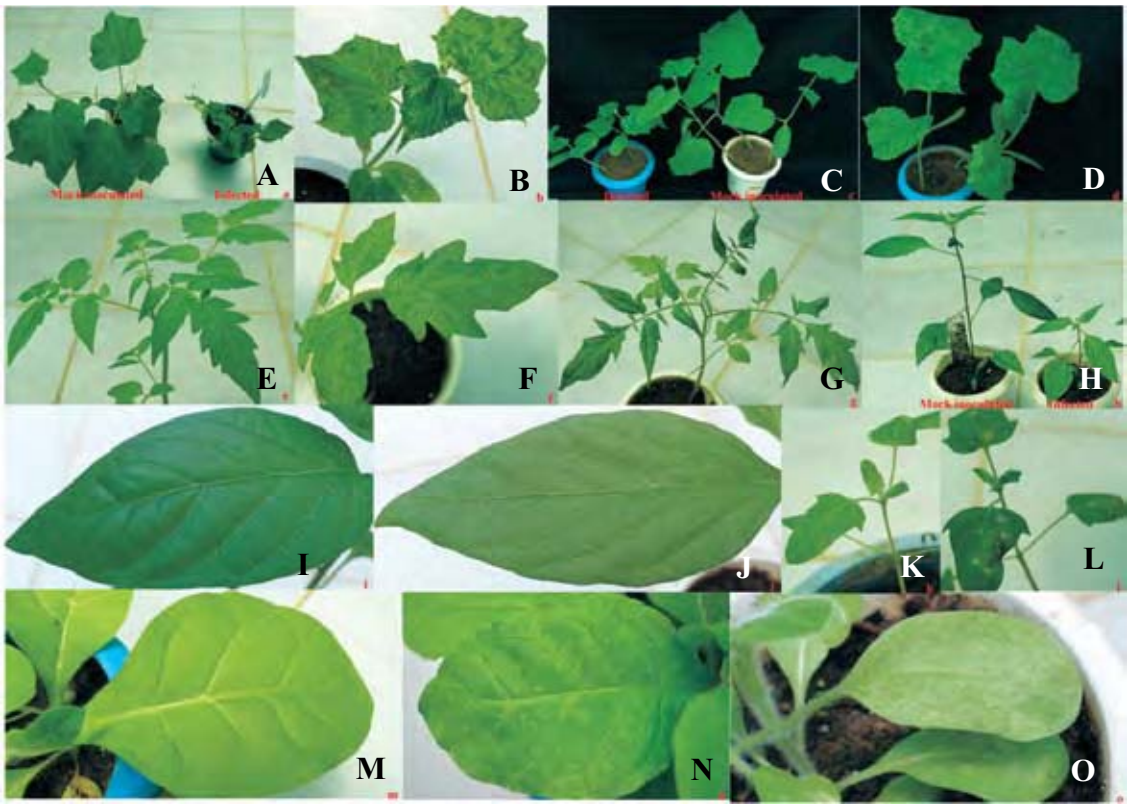


Fig. 93 Symptoms induced by CMV on different host plants (A and C) stunting of infected cucumber plants var. veer and summer green (B and D) chlorosis and mosaic on leaves after two weeks post inoculation (E-G) tomato (E) mock infected (F) chlorotic patches on leaves (G) leaf deformation and curling (H-J) chilli (H) stunted growth of infected plant (I) mock infected leaf (J) infected leaf with chlorotic patches (K-L) chenopodium (K) mock infected plant (L) leaves with chlorotic necrotic lesions (M-O) tobacco (M) mock infected leaf (N) leaves with mosaic pattern and lesions (O) infected leaf with concentric chlorotic lesions

In vitro expression and production of antibody against *Cymbidium mosaic virus* coat Protein (CP)

Polyclonal rabbit antisera were produced using CP of *Cymbidium mosaic virus* (CymMV) Indian isolate expressed in *E. coli* as GST fusion. The expressed protein was purified by GST-fusion protein purification kit for use as an immunogen in rabbits. The antisera thus prepared, reacted in double antibody sandwich enzyme-linked immunosorbent assay (DAS ELISA) with extract from CymMV-infected tissue. The polyclonal antisera prepared from expressed CymMV coat proteins were useful in detecting CymMV in an array of assays. As compared to internationally available kits, the developed kit is highly effective for detection of Indian strain of the virus.

Genomic sequence analysis of four new *Chrysanthemum virus B* isolates reveals evidence of RNA recombination (Funded by Department of Biotechnology, Govt. of India)

Sequence diversity of *Chrysanthemum virus* B (CVB), a member of the genus carlavirus, family Betaflexiviridae was studied by analysing four complete genome sequences representing the genetic diversity of these strains. The analysis by maximum likelihood indicated a close relationship of the four new full genome sequences with one another as compared to other carlavirus including CVB-S from Japan.

Seven recombination analysis method implemented in the program, RDP3 were used to check the presence of recombination within the full-genome sequences of CVB and representatives of other carlavirus species. Evidence of 16 potentially unique recombination events was detected by more than three recombination detection methods. One potential recombination event detected in the evolution of isolate CVB-S was found significant (P-Values: RDP=$6.69x10^{-154}$, GENECONV=$1.49x10^{-143}$, BOOTSCAN=$3.49x10^{-162}$, MAXIMUM CHI SQUARE=$4.49x10^{-62}$, CHIMAERA=$1.39x10^{-44}$, SISCAN=$1.39x10^{-114}$, 3SEQ=$1.19x10^{-19}$). CVB-S was found to be a recombinant of UP as the major parent and TN as the minor parent. The potential recombination beginning and ending breakpoints were predicted to be at nucleotide positions 538 and 4260, respectively (**Fig. 94**). The recombinant region lay in the replicase region of the viral genome. The CP gene of CVB may be a recombination cold-spot.

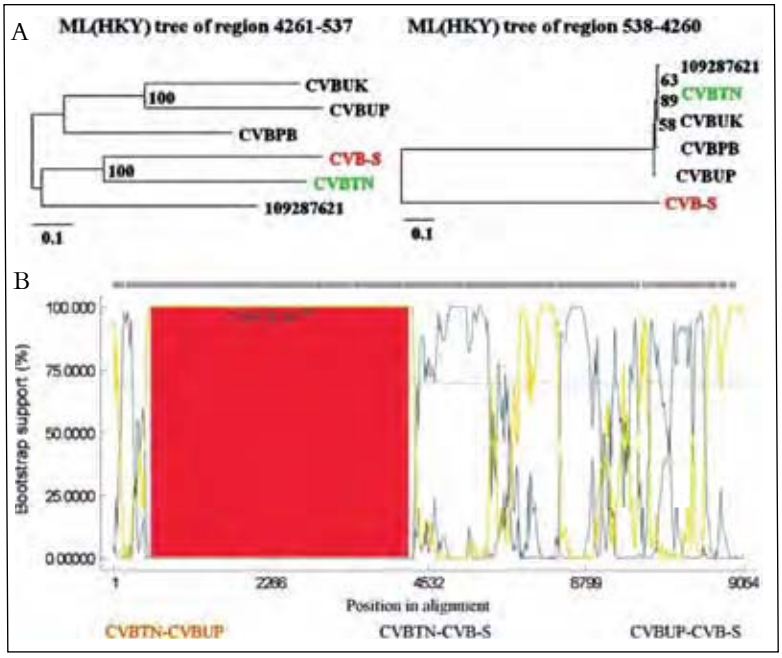


Fig. 94 Evidence of isolate CVB-S as a recombinant of viruses resembling isolates CVB-UP and an unknown CVB-TN-like virus (A) maximum-likelihood trees (model HKY, 100 bootstrap replicates) constructed using different portions of the CVB genome (B) BOOTSCAN evidence for the recombinant origins of different portions of CVB-S (100 bootstrap replicates, Jukes Cantor distances) constructed for 200-nucleotide sequence windows, step size 20

Chitinase expression due to reduction in fusaric acid level in an antagonistic *Trichoderma harzianum* S17TH

Antagonistic *Trichoderma* spp. were screened for their ability to reduce the level of fusaric acid (FA), a phytotoxin produced by *Fusarium* spp. Although the *T. harzianum* isolate S17TH tolerated high levels of FA up to 500 ppm, it was unable to reduce the toxin to a significant non-toxic level when added to minimal synthetic broth (MSB). When the effect of 400 ppm FA on chitinase gene expression was studied using PCR assays, the isolate reduced the FA to a non-toxic level. It displayed similar level of antagonism over control in liquid medium after 7 days (**Fig. 95**). Significant repression of nag1 but only slight repression of ech-42 was observed. Chitinase activity was either reduced or absent. Selection of S17TH as a toxin insensitive isolate commensurated the negative effects on chitinase activity. This makes it a potential antagonist against *Fusarium* spp.

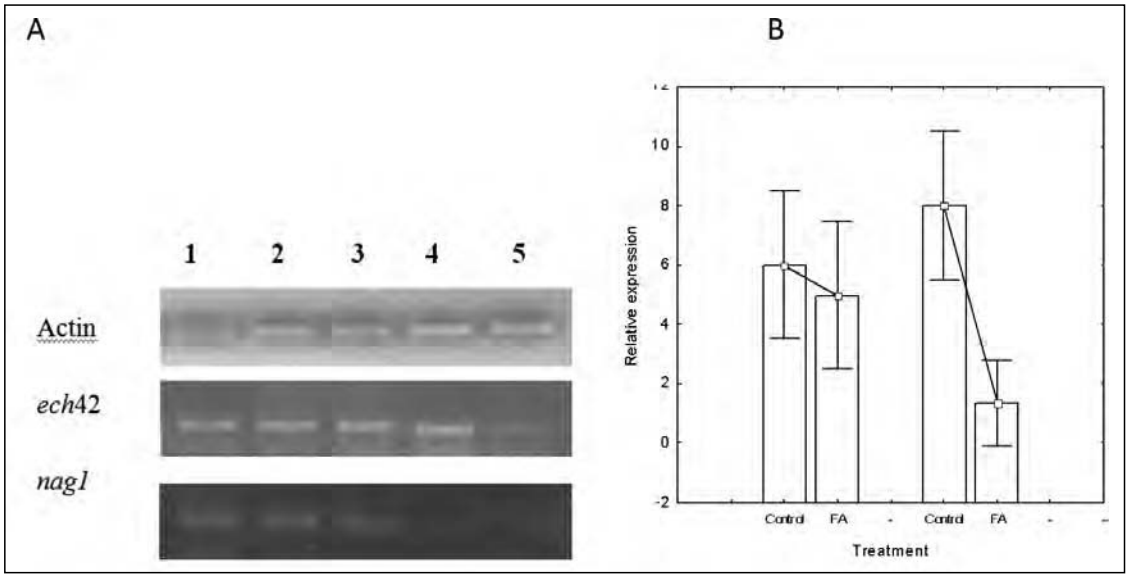


Fig. 95 Expression of antifungal chitinases in S17TH (A) semi-quantitative PCR Lanes 1: control (MSB alone), 2: 100 ppm, 3: 200 ppm, 4: 300 ppm, 5: 400 ppm (B) quantitative RT-PCR for enzyme induction by 400 ppm FA

Control of rhizome rot of ginger by chitinolytic *Bacillus atrophaeus* strain S2BC-2

A highly chitinolytic antagonistic *Bacillus* S2BC-2 was identified from apple rhizosphere. Standard bacteriological tests and sequencing of 16S rRNA, *gyrA* and *rpoB* genes indicated its taxonomic affiliation to *Bacillus atrophaeus*. It showed enhanced growth and chitinase production with increased anti-fungal activity against vascular wilt pathogens. Extracellular proteins of cell-free extracts of media amended with chitin and fungal cell wall contained 4–10 novel polypeptides **(Fig 96A).** Under bamboo structures covered with polyvinyl sheet, a chitin supplemented talc-based formulation of the S2BC-2 was challenge inoculated with *Fusarium oxysporum* f.sp. *zingiberi*. It recorded low disease indices (84.9% and 79.2% for yellows and rhizome rot, respectively). This correlated with 113.3% maximum rhizome production **(Fig. 97)** and 2-fold higher chitinase induction over pathogen control. In native gel activity assays, S2BC-2 expressed more chitinase isoforms than the pathogen control upon challenge-inoculation **(Fig. 96B).** *B. atrophaeus* can be used in biocontrol of rhizome rot of ginger.

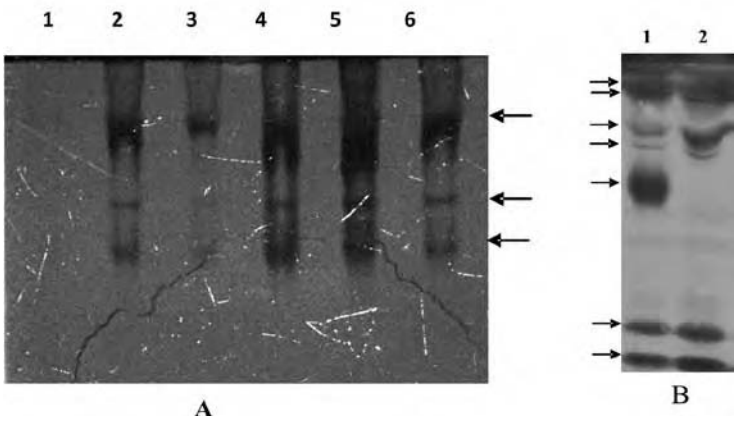


Fig. 96 Native gel assays for induced chitinase profiles of S2BC-2 (A) extracellular proteins of the culture media. Lanes 1: MSB 2: MSB+GIFOZ-UHF 3: MSB+GIFOL-IHBT 4: MSB+Chitin 5: MSB+Chitin+GIFOZ-UHF 6: MSB+Chitin+GIFOL-IHBT (B) proteins induced in ginger challenged with GIFOZ-UHF. Lanes 1: plants treated with S2BC-1, 2: pathogenic control (arrows indicate the isoforms)

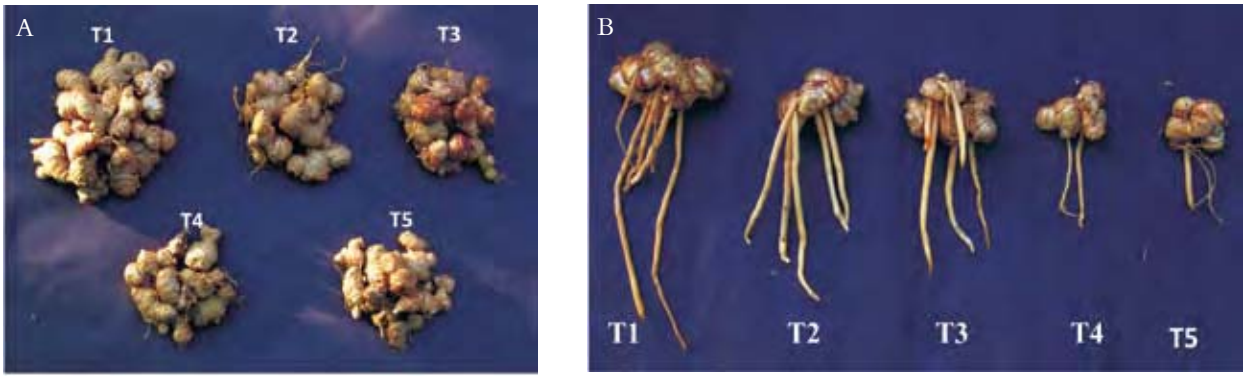


Fig. 97 Performance of chitinolytic S2BC-2 against ginger rhizome rot under shade conditions (A) rhizome yield (B) root length (T1 S2BC-2 T2 carbendazim+mancozeb T3 hot water treatment T4 pathogenic control T5 untreated control)

Evaluation of plant extracts for pesticidal activities

Different solvent extracts of *Zanthoxylum armatum* were evaluated against larvae of *Plutella xylostella*. *n*-Hexane extract showed maximum larvicidal activity followed by ethyl acetate extract, whereas, chloroform leaf extract was least effective (**Fig. 98**). The GC-MS analysis of *n*-hexane fraction led to the characterization of twenty two compounds representing 90.48% of the constituents detected. *n*-Hexane fraction of the leaf extract of *Z. armatum* showed maximum larvicidal activity, which may be due to two major compounds *i.e.* 2-undecanone and 2-tridecanone. The results of present study would be useful in integrated pest management (IPM) of lepidopteron pests.

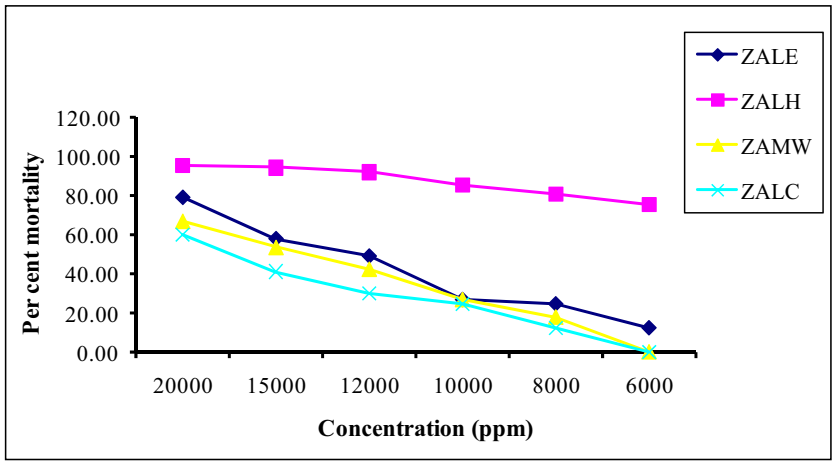


Fig. 98 Efficacy of *Zanthoxylum armatum* extract against *Plutella xylostella* (48 hrs after treatment)

In another study, ethanoloic extract of the underground parts of *Costus speciosus* were evaluated. The extract showed promising activities (80-100% mortality) at 15000-20000 ppm against second instar larvae of *P. xylostella*.

In another study, six fern extracts were screened pesticidal activities against diamondback moth (*Plutella xylostella*), tobacco caterpillar (*Spodoptera litura*), aphids (*Aphis craccivora*) and mites (*Tetranychus urticae*). One sample IHB-PED-M001 showed promising larvicidal activity against *P. xylostella*. It resulted in 90, 60 and 47% mortality at 2.0, 1.5 and 1.0% concentrations, respectively, after 48 hrs of treatment.

FUNCTIONAL FOOD AND NUTRACEUTICALS

Tea anthocyanins as nutraceuticals

Four anthocyanins were purified and characterized from purple coloured tea shoots growing in the Tea Experimental Farm of the Institute. The chemical structures were elucidated on the basis of 1-D and 2-D NMR, and LC/MS. The purified anthocyanins were, cyanidin-3-glucoside (AN-1): ESI-MS m/z 449 $[M]^+$ (calcd. For $C_{21}H_{21}O_{11}^+$ was m/z 449.1213).UV–Vis λmax 0.01% HCl–MeOH (nm):517.cyanidin-3-O-β-D-(6-(E)-coumaroyl) glucopyranoside (AN-2): HR-ESI-MS m/z 595 $[M]^+$ (calcd. For $C_{30}H_{27}O_{13}^+$ was m/z 595.14462). UV–Vis λmax 0.01% HCl–MeOH (nm):522. delphinidin-3-O-β-D-(6-(E)-coumaroyl) glucopyranoside (AN-3): HR-ESI-MS m/z 611 $[M]^+$ (calcd. for $C_{30}H_{27}O_{14}^+$ was m/z 611.13953). UV–Vis λmax 0.01% HCl–MeOH (nm):529. cyanidin-3-O-(2-O-β-xylopyranosyl-6-O-acetyl)-β-glucopyranoside (AN-4): HR-ESI-MS m/z 623 $[M]^+$ (calcd. For HR ESI-MS m/z 623.3868 [M]+ (calc. for $C_{28}H_{31}O_{16}$ 623.4412). UV–Vis λmax 0.01% HCl–MeOH (nm):534.

The antioxidant activity of the purified anthocyanins was evaluated by 2, 2-diphenyl-1-picrylhydrazyl (DPPH) and 2, 2'-azino-bis (3-ethylbenzothiazoline-6-sulphonic acid) (ABTS) assays. Anti-cancer activity was determined by sulfo-rhodamine B (SRB) assays against C-6 (glioma) and A549 (human lung carcinoma) cell lines. Apoptosis induction was resolved by Caspase-3/7 activity assay and immune-stimulatory activity was evaluated by lymphocyte proliferation assay against human PBMCs. Highest antioxidant activity was recorded in AN-2 ($IC_{50\text{-}DPPH}$=25.27±0.02 μg/ml, $IC_{50\text{-}ABTS}$=10.71±0.01μg/ml). AN-1, AN-2, AN-3 showed higher activity on C-6 cells at concentration of 200 μg/ml. However, AN-4 did not show any significant effect on C-6. The effect of all the compounds on A549 cells was not prominent. The results of immunostimulatory activity suggest that all the compounds induce T-lymphocyte proliferation.

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

Earlier, the process for extraction of dietary fiber from apple pomace was developed and dietary fiber enriched food such as bakery and extruded products were prepared **(Fig. 99)**.

Fig. 99 Dietary fiber from apple pomace and its use in enriched food products (A) dietary fibre (B) bakery (C) extruded products

In a previous study, a prototype for mechanical separation of seeds at industrial scale was also developed and filed for patent. In current year, the separated seeds **(Fig. 100)** were used to extract oil, with average yield of 15-20%. When the edible properties of the seed oil were examined, it was found to be rich in linoleic and oleic acid and had comparable physico-chemical properties of edible oils.

Fig. 100 Apple seeds extracted from separator prototype

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

Fresh pomace collected from the processing unit of HPMC, Parwanoo (HP) was dried using oven, sun and freeze drying methods. Oven drying at 60°C was the best method **(Fig. 101A)**. However, freeze-drying method (-40 to-80°C) was found to retain maximum antioxidant properties as per the ferric reducing antioxidant power (FRAP) assay **(Fig. 101B)**.

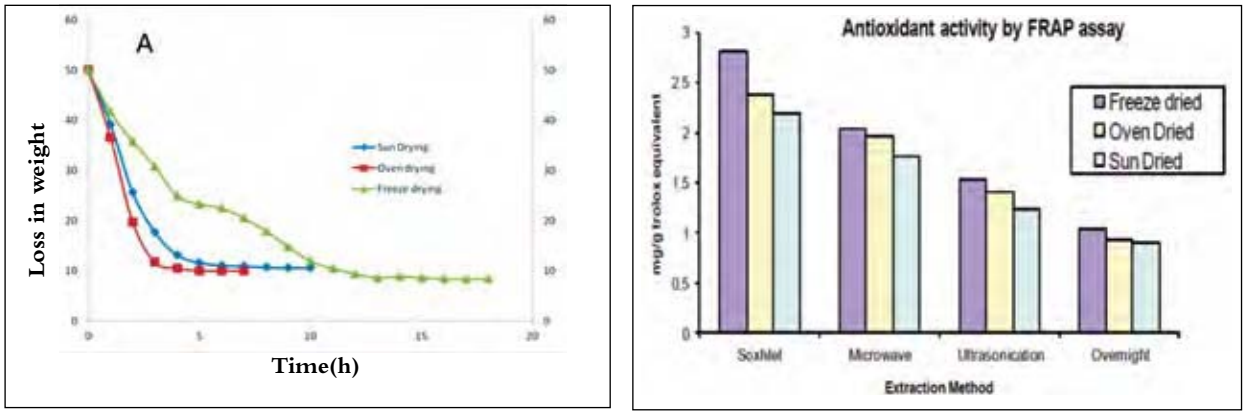


Fig. 101 (A) Effect of different drying methods on apple pomace and (B) antioxidant activity of dried fractions of apple pomace

Pectins were extracted from apple pomace by three methods at different temperatures, pH and acid treatment. The alditol acetate derivatives of purified pectins were analyzed by GC-MS. The uronic acid content was also determined by Folin–Ciocalteau reagent.

The GC-MS analysis of alditol acetate derivatives from hydrolyzed samples of dietary fiber of apple pomace showed the presence of sugars such as arabinose (7.02%), glucose (7.66%) and mannose (7.55%).

Value added products from buckwheat

Buckwheat (*Fagopyrum* spp.) is a traditional crop of high altitude region. Keeping in view its importance for highlanders, R&D work on its value addition was initiated. Snack products such as Puffed buckwheat and Puffed buckwheat bars were developed and analyzed for their nutritional compositions. The products were also launched at the tribal fair at Keylong, district Lahaul and Spiti (HP) in August, 2012 to motivate the farmers of the area for its large scale cultivation (**Fig. 102**).

Nutritional value of *Puffed buckwheat*	
Composition	**Values**
Energy value	383 kcal
Protein	1.1%
Fat	5.46%
Total carbohydrates	67.8%

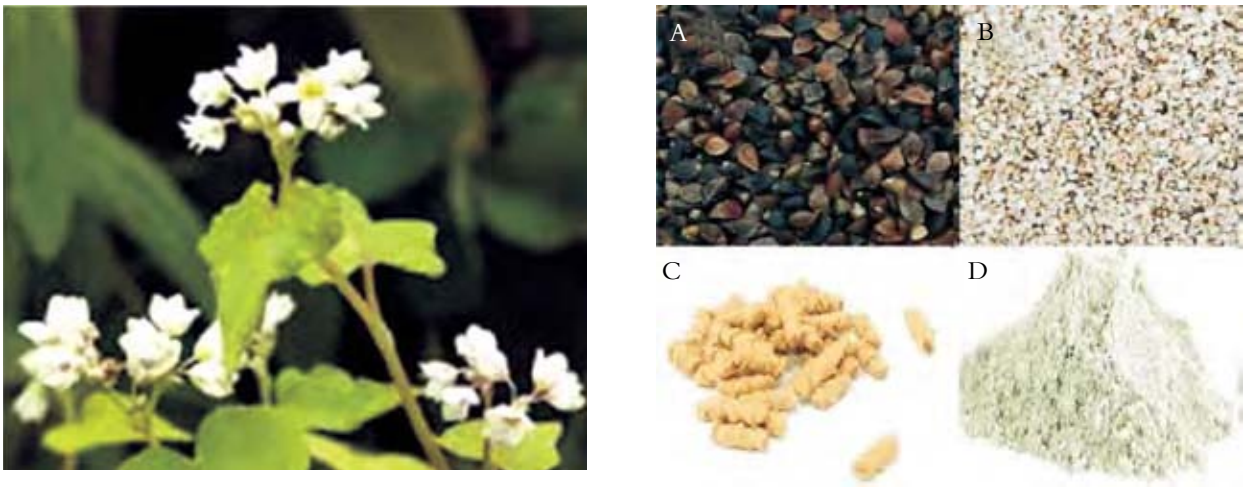


Fig. 102 (A) Buckwheat seeds (B-C) snacks (D) flour

Nutritionally enriched food products to combat malnutrition

CSIR-IHBT identified certain bioresources with nutritional value having potential to be incorporated into food products. Calcium and iron rich products such as as Mango Bar and Puffed Rice Bar were developed using low cost affordable technology.

Mango Bar

Puffed Rice Bar

Mango Bar and Puffed Rice Bar meets 40 and 60% of RDA requirement of iron and calcium, respectively. These products will be disseminated in a single serve pack under national mission programme of S&T intervention to combat malnutrition with the help of NGOs and other organizations closely link to the masses.

RURAL DEVELOPMENT

CSIR-IHBT worked in a network mode with other stake holders to enhance the livelihood options and quality of life in rural and periurban areas across the country. Associated notable stake holders were the District Watershed Development Agency, Shimla; State Departments of HP namely, Agriculture, Horticulture, Forest, Rural Development, Ayureveda, Tea Board and National Mission on Bamboo Applications (NMBA), India. A total of 1100 farmers, extension officials, entrepreneurs and students visited plantations, research and demonstration plots of commercially important cut flower crops, medicinal & aromatic plants, botanical and biodiversity garden, bamboo nursery and museum at CSIR-IHBT, Palampur. The exposure created awareness in the individuals on improved farming practices and alternate options of enhancing productivity, quality and income generation. Scientists and technical personnel of the Institute extended different technical know-how through trainings and demonstrations. Quality planting materials were supplied on a regular basis and periodic field advisory services were rendered as per the need and demand of local growers. Query based counseling of visitors was entertained with due diligence. Relevant literature in terms of technical bulletins and technical brochures were generated and distributed to the growers. More than 250 farmers were registered for value added product development during the year.

CSIR-IHBT also disseminated its technological know-how with the help of the press and media including national and regional newspapers, television channels such as Delhi, Shimla and Jalandhar Doordarshan and Akashvani.

Trainings

Trainings on advances in tea husbandry practices and nursery management were organized in the institute for trainees from different regions of Kangra district of HP.

Training of tea growers on advances in tea husbandry practices

Exposure visits of the tea growers

Activity	Date	Area	No. of growers
Adoption of improved technology: Tea farm mechanization	19.09.2012	Bir & Baijnath	17
Adoption of improved technology: Pruning and skiffing and other winter operations in tea plantation and large cardamom cultivation	14.12.2012	Palampur	23
	17.12.2012	Bir & Chauntra	27
	26.12.2012	Baijnath	30
	27.12.2012	Palampur	28
Adoption of improved technology: Fertilizer application and other winter operations in tea plantation and large cardamom cultivation	26.02.2013	Palampur and Dharmshala	20
	27.02.2013	Bir	20
Coordinator: R.K. Sud; Team members: V.S. Dhadwal, Khushal Katoch and Bhushan Kumar			

Workshop on the uniqueness of Kangra tea

A workshop was organized on the uniqueness of Kangra tea on April 6, 2012 at CSIR-IHBT, Palampur in which 74 participants (including 1 from UK and 2 from Ethiopia) participated. The workshop was held with a view to highlight the distinctiveness of Kangra tea and exhibit its premium brands. A tea tasting session was also conducted to apprise the growers on importance of quality tea and its production.

Coordinator: R.K. Sud; Team members: Ashu Gulati, H.P. Singh, V.S. Dhadwal and Khushal Katoch

Tea tasting session for growers

Visit of tea board officers to the experimental tea farm

Shri MGVK Bhanu, Chairman, Ms. Roshni Sen, Deputy Chairman and Shri B. Boriah, Director, Tea Development, Tea Board of India visited the CSIR-IHBT Tea Experimental Farm on August 4, 2012 and witnessed different R&D and extension work undertaken by the institute on tea husbandry.

Visit of tea board officers to IHBT tea experimental farm

TRANSFER OF CUT-FLOWER PRODUCTION TECHNOLOGY

Transfer and advisory services

CSIR-IHBT played a catalytic role in promoting commercial floriculture in the hilly states. Motivation of farmers through advisory visits, trainings, demonstrations, and distribution of planting materials by the institute led to the extension of area under cultivation for commercial flower crops in HP and neighbouring states. This impacted their socio-economic status. The impact of this intervention was evident from the sale of cut flowers worth Rs. 60 lakhs by the farmers of Lahaul & Spiti, HP in the market of Delhi during 2012-13.

Cultivation of lilium and rose at Lahual & Spiti and Bilaspur

Advisory visits to farmer's field for gerbera cultivation at Kangra

Consultancy visits to M/s Neva Plantation Pvt. Ltd., Gopalpur, Kangra (HP) for cultivation and post harvest technology of lilium bulb production

Demonstration plots

Demonstration plots of chrysanthemum, alstroemeria, gerbera, lilium, bird of paradise and marigold were established at CSIR-IHBT and at farmers' field.

Demonstration plot of chrysanthemum at CSIR-IHBT, Palampur

Multiplication and distribution of planting materials

Planting materials of cut flower crops *viz*., chrysanthemum, lilium, gerbera, alstroemeria, bird of paradise, gladiolus, agapanthus and marigold were multiplied and distributed to the growers and extended to approximately 14.5 h area for commercial floriculture during the year. Virus tested lilium cvs. Brunello, Prato, Adelina and Polyanna were mass multiplied *in vitro*. Twelve hundred bulblets of each cvs were planted in field for optimum size of bulbs. Gerbera cvs Jaffona was mass propagated by tissue culture and twelve thousand *in vitro* propagated plants were hardened. Ten culture bottles of cv Jaffona were supplied to M/s Rajat Biotech, Ghumarwin, Bilaspur, HP for mass multiplication under material transfer agreement.

Details of the planting materials of floriculture crops distributed to farmers

Crop	Form of planting materials	Qty./No. distributed	Location of supply
Lilium	Bulbs	25548	Kangra and Lahaul & Spiti
Chrysanthemum	Cuttings	2570	Kangra, Mandi and Kullu
Marigold	Seedling	19320	Kangra, Chamba and Una
Alstroemeria	Plants	561	Kangra, Chamba and Shimla
Agapanthus	Plants	859	Kangra
Bird of Paradise	Plants	681	Kangra, Kullu and Shimla
Gladiolus	Corms	597	Kangra and Mandi

Extension of area under cultivation of commercial floriculture in HP

Crop	Area (h)	Location
Lilium	2.50	Kangra, Lahaul & Spiti, Mandi, Kullu and Solan
Chrysanthemum	0.50	Kangra, Mandi and Solan
Marigold	7.00	Kangra, Mandi, Chamba, Sirmaur and Una
Rose	1.0	Kangra
Gladiolus	1.50	Kangra, Mandi and Kullu
Carnation	1.50	Bilaspur, Kangra, Kullu and Solan
Gerbera	0.50	Una, Kangra
Total	**14.50**	

Training programmes organized

Activity: Demonstration-cum-training	Date	Coordinator:/Team	No. of growers
Cultivation and post harvest technology of commercially important cut flower crops	19-21.02.2013 19-21.02.2013	Markandey Singh/ D Dhyani, Vipin Hallan, Sanat Sujat Singh, Raja Ram and Sanjay Kumar	20 20
Cultivation and post harvest technology of lilium at Shishu, Lahaul & Spiti.	26.09.2012	Markandey Singh	14
Cultivation and post harvest technologies of commercially important flower crops from district Shimla.	2012-13	Markandey Singh and Sanjay Kumar	206 10 batches
One thousand seventy nine farmers and students visited the demonstration plots of commercially important cut flower crops at CSIR-IHBT, Palampur during the year.			

Demonstration-cum-training on floriculture crops

Glimpses of meeting at Karga, Lahaul & Spiti

Participation in exhibition

CSIR-IHBT along with other state departments and local farmers participated in a meeting on "Scope of horticulture and medicinal crops in district Lahaul & Spiti, HP" held on September 25, 2012 at Karga, Lahaul & Spiti organized by the Department of Horticulture, Keylong, Lahaul & Spiti, HP.

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

In another activity, CSIR-IHBT along with other CSIR institutes exhibited its technologies in Agrovision, 2013 at Nagpur from January 24-27, 2013. More than 800 farmers visited the CSIR stall and showed interest in commercial cultivation of stevia, damask rose, gerbera, gladiolus, chrysanthemum and lilium.

Glimpses of Agrovision, 2013 at Nagpur

CSIR-IHBT participated and exhibited technologies in a "Kisan Mela" at Jammu organized by CSIR-IIIM, Jammu, J&K on March 17, 2013 and Holi Mela at Pragati Maidan, Palampur during March 25-28, 2013. More than 400 farmers and students visited the institute stall and showed interest in commercial cultivation of flowers and medicinal & aromatic crops.

Glimpses of Kisan Mela at Jammu

Glimpses of Holi Mela-cum-Flower Show at Palampur

Multiplication and distribution of plant propagules of medicinal, aromatic and culinary herb

Various MAPs *viz*. rosemary (2 lakhs), lavender (1.5 lakhs), damask rose (0.50 lakh), ginkgo (0.20 lakh) and stevia (0.25 lakh) were propagated in bulk in the institute's nursery for distribution to growers. Mother stock of other MAPs like ashwagandha, bacopa, chameli, taxus, gingko, aloe, muskbala, bacopa, lemon grass, viola, oregano, eucalyptus etc. were maintained and propagated in small quantities and supplied to small growers. The plant propagules distributed by the Institute were adequate to cover 15.0 ha approximately.

Mass propagation of rosemary saplings for distribution

List of propagated planting materials distributed to growers

Crop	Material form	Qty./No. distributed	Area equivalent (ha)	Location of supply (district/state)
Rosemary	Plants	161302 no.	4.35	HP, Punjab and Uttarakhand
Lavender	Plants	80137 no.	3.61	HP
Stevia	Plants	2540 no.	0.03	HP and Punjab
Stevia	Seeds	100 g.	0.03	Hissar (Haryana)
Tagetes	Seeds	2.6 kg.	1.00	Solan (HP) and Punjab
Scented geranium	Plants	1211 no.	0.03	HP and Punjab
Kapur kachari	Rhizomes	466 kg.	0.38	Bangalore
Damask rose	Plants	21572 no.	2.43	HP, Punjab and Uttarakhand
Ashwagandha, bacopa, chameli, taxus, gingko, aloe, muskbala, lemon grass, viola, oregano, eucalyptus etc.	Plants	1100 no.	Nursery and back yard planting on about 0.14	HP, Punjab, Haryana, New Delhi, J&K and Uttarakhand
Total area equivalent			**15.00**	

Large cardamom

With a view to promote large cardamom cultivation in suitable niche areas, nucleus planting material (200 rhizomes) of suitable cultivars were supplied to six interested growers of Kangra region during the year. Trainings on the cultivation of large cardamom were also imparted to growers of different regions of Kangra district of HP.

Specialized trainings

District Watershed Development Agency, district Shimla sponsored 10 batches of training-cum-orientation workshop at CSIR-IHBT in order to show-case its know-how on sustainable utilization of regional bioresources and floriculture. The objective was to enhance the livelihood options of the people. People from Theog, Rampur and Basantpur Development Blocks of HP participated in these specialized trainings.

Activity: Training-cum-Orientation Workshop	Date	No. of growers
Sustainable Utilization of Regional Bioresources and Floriculture for Enhancing Livelihood Options	17-19.04 2012	23
	01-03,.05.2012	23
	16-18.05.2012	24
	26-28.06.2012	21
	17-19.07.2012	19
	01-03.08.2012	20
	29-31.08.2012	18
	04-06.09.2012	20
	18-20.9.2012	16
	16-18.10.2012	22




Demonstration-cum-orientation workshop on sustainable utilization of regional bioresourcs

Detail of group visits conducted on MAPs and floriculture crops at the institute

Theme	Date	Duration (Days)	No. of Participants	From
Demonstration cum field training on "medicinal, aromatic and cut flower crops" at CSIR-IHBT, Palampur	23.05.2012	1	31	Shopian, J&K
	31.05.2012	1	25	DWDA, Shimla
	16.08.2012	1	11	J&K
	31.03.2013	1	50	J&K

Field advisory services to growers' fields were also undertaken as per the demand of growers from district Kangra, HP.

Field screening trial

A new field demonstration plot was set up on medicinal, aromatic and floriculture crops at farmer's field in periurban area of Gurdaspur, Punjab. A field trial was laid out for 12 crops. The main crops were rosemary, chamomile, oregano, brahmi, peppermint, marigold, sataver, carvon mint, kitchen mint, basil and stevia.

Planting of different crops under screening trial

Exhibition in Lahaul & Spiti Tribal Fair- 2012

The institute participated as major partner in the annual Tribal Fair organized by Lahaul & Spiti district administration at Keylong during August 14-16, 2012. A team of scientists and technical staff from the institute presented the technologies related to floriculture, value added plants, products and processes for industrial, societal and environmental benefits.

The local MLA and the DC, Lahaul & Spiti launched two premier products namely, "Lauli Puff-Nutri Bar" and "Lauli Puff–Healthy snack" that were developed by CSIR-IHBT from buck wheat, a widely grown non-cereal grain. Different varieties of cut flowers *viz*., lilium, gladiolus etc. and medicinal and aromatic crops *viz*., rose, lavender, *Artemisia* sp., *Gingko biloba* etc. were displayed and the villagers were educated on the benefits of growing these crops in the region. Disease free production of planting stocks of saffron and other commercially viable crops were also demonstrated. The goals and current activities of the research centre 'CSIR-Centre for High Altitude Biology' at Tandi, district Lahaul & Spiti were also popularized among the locals.

Glimpses of Lahaul & Spiti Tribal Fair, 2012

AUG
16
2012

IHBT launched two premium products

Lahaul and Spiti

Mohan Lal Relingpa Keylong :Institute of Himalayan BioresourceTechnology based at Palampur, having its branch in Tandi Lahul is dedicated in the field of providing research and development services on economic bioresources in Western Himalayan region leading to vslue added plants, products and processes for industrial, societal and environ,ental benefits. Keeping in view to boost the tribal economy oh lahul situated in high altitude rugged terrain, the research wing of this premier institution IHBT has launched two premium products prepared from buckwheat , a widely grown cereal grain, namely under brand name Lauli Puff-Nutri Bar and Lauli puff healthy snake food on the eve of tribal fair at keylong, by local MLA Ram Lal and DC ,SS, Guleria. Widely grown and underutilized crop of buckwheat is locally called in lahul under different names like Brafo, Bres, Fafda and Kathu. Team of IHBT scientists Dr. Amit Chawla, Dr. Mahesh Gupta, and Er. Mohit Sharma has claimed that their two products namely Lauli Puff- nutri bar and snake food prepared from buck wheat is a rich source of protein, carbohydrate,fibre and nutritional value like antioxidants and very usefull in reducing cholesterol of heart. Scientists of the IHBT say that their product is gluten free and has more potential to fight celiac disease problem . Scientists say that they are further doing more research to make it more acceptable,marketablr, and competitive by using different flavor and taste.

Promotion and utilization of bamboos

During the year, different varieties of bamboo plants were supplied to private growers, forest departments of HP and Arunachal Pradesh and farmers from HP and neighbouring states for covering approximately 30 ha area. A notable plantation moso bamboo (10 ha) was established with the help of DFO, Forest Range Basbha in Chail Chowk block near Sundernagar, district Mandi, HP.

A total of 2.5 lakh plants were propagated in nurseries using seeds and nodal cuttings. Out of these, 11774 plants were supplied to various planters.

Distribution of bamboo plants to different planters

Species and plant supplied	Name of planter
Phyllostachys pubescens moso (8414)	1. Mr. Rajpal Singh, Kukonet, Hoshiarpur, Punjab 2. Hon'ble Justice HP High Court, Shimla, Himachal Pradesh 3. Mr. Hari Shankar Jha, Horticulturist, Kamang, Bomdila, Arunanchal Pradesh 4. Dr. G. Murtem, SFRI & Nodal Officer, State Bamboo Mission, Govt. of Arunanchal Pradesh 5. Mr. Subesh Singh Gill, Kathgarh, Indora, Kangra, Himachal Pradesh 6. NHPC, Kullu, Himachal Pradesh 7. Range Officer, Forest Range Basbha, Block Chail Chock, Sundar Nagar, Himachal Pradesh 8. DWDC, Shimla, Himachal Pradesh 9. Mr. Ashok Goswami, Dharer, Baijnath, Kangra, Himachal Pradesh 10. Mr. Jitender Singh Sandhu, Lohna, Bandla, Palampur, Kangra, Himachal Pradesh
Dendrocalamus hamiltoni (2498)	1. Mr. Rajpal Singh, Kukonet, Hoshiarpur, Punjab 2. Mr. K.G.Butail, Tea Estate Sungal, Kangra, Himachal Pradesh 3. Trident Group, Patiala, Punjab 4. Mr. Subesh Singh Gill, Kathgarh, Indora, Kangra, Himachal Pradesh 5. Dr. D.S.Dhaliwal, 91- Punjab Bagh, Patiala, Punjab
Dendrocalamus membranaceous (188)	1. Trident Group, Patiala, Punjab 2. Adhaarsila School Dehan near Thakudwara, Kangra, Himachal Pradesh
Dendrocalamus asper (395)	1. Trident Group, Patiala, Punjab 2. Mr. Subesh Singh Gill, Kathgarh, Indora, Kangra, Himachal Pradesh 3. Mr. Rajpal Singh, Kukonet, Hoshiarpur, Punjab
Bambusa multiplex (23)	1. Adhaarsila School, Dehan near Thakudwara, Kangra, Himachal Pradesh 2. Ms. Radhika Sharnik Surya Yadvara, Dadh, Kangra, Himachal Pradesh
Phyllostachys aurea (18)	1. Adhaarsila School, Dehan near Thakudwara, Kangra, Himachal Pradesh 2. Mr. Jitender Singh Sandhu, Lohna, Kangra, Himachal Pradesh
Phyllostachys nigra (13)	1. Adhaarsila School, Dehan near Thakudwara, Kangra, Himachal Pradesh 2. Mansimbal Tea Estate, Thakudwara, Kangra, Himachal Pradesh
Dendrocalamus strictus (200)	1. Trident Group, Patiala, Punjab
Sasa auricoma (25)	1. Mansimbal Tea Estate, Thakudwara, Kangra, Himachal Pradesh 2. Ms. Radhika Sharnik Surya Yadvara, Dadh, Kangra, Himachal Pradesh
Total 11774 plants supplied	

In a separate activity, women trainees were exposed to the know-how of making various edible products from bamboo like candies, nuggets, cake, doughnuts, syrups and papad.

Besides imparting trainings, a one day workshop was organized for the forest officials on propagation methods and value addition of bamboo through charcoal and bamboo candy making.

Bamboo World Day was also celebrated on September 18, 2012 at the institute for genetating awarenes among students about the benefits of bamboo. Children and teachers from different schools attended the programme.

Glimpses of trainings and celebration of 'Bamboo World Day'

The 'House of Bamboo' was also duly inaugurated during June 21, 2012 by the Hon'ble D.G. CSIR, Prof. Samir K. Brahmachari and bamboo based dishes like bamboo candies, cakes, doughnuts, syrups were prepared and served.

FACILITIES AND S & T SERVICES

State of the art facility at pilot plant

FT-NMR (600 MHz, Bruker) was installed at Natural Plant Products Division. The facility will be used for recording high resolution NMR spectra of natural and synthetic compounds. The facility will also benefit Institutes/universities.

A membrane filtration unit having spiraly wound polymeric membrane filtration area of 15 m^2 and ceramic membrane filtration with an area of 1 m^2 was installed and commissioned at Pilot Plant. This will be used for concentration/purification/ separation of plant extracts.

Polymeric UF/NF and ceramic membrane filtration unit

FT-NMR (600 MHz, Bruker)

Regulatory Research Centre (RRC)

In the current year, the fully equipped *in-vitro* lab was further advanced with new equipments and basic animal cell culture facilities. Many different tissue representative human cancer cell lines were procured and are being cultured in the lab.

Elongated Chambers (EC) for Carbondioxide CO_2 gradient studies

Plant species distributed along a wide altitudinal range are exposed to different partial pressures of CO_2 that decline with increase in altitude. Varying partial pressure of CO_2 is known to impact plant processes. However, it is not clear if plants response to partial pressures of CO_2 is comparable to the corresponding concentrations of CO_2. Therefore, the EC facility was constructed at the Institute's experimental farm (Chandpur) to study the response of different plant species to ambient and sub-ambient concentrations of atmospheric CO_2.

The salient features of EC facility:

- EC facility has ten inter-connected elongated chambers, each 10 m long.

- Air blown from one end of the first chamber passes through the next and so on before escaping out through the distal end of the last.
- In the process, CO_2 in the air is fixed by plants in each chamber and its concentration continues to decline as the same air moves from the first to the last chamber.
- Plants growing in the last chamber get exposed to a much lower concentration of CO_2 than that in the ambient air.
- EC facility has provision to control irrigation in each pot and also regulates temperature and relative humidity in each chamber.
- Data is recorded at regular intervals through PC operated software.

The inside view of the chamber and top view of the tunnel

S&T Services/ Technical Services Rendered

CSIR-IHBT prepared the digital fire maps of Dharamshala, Nurpur and Palampur forest divisions of Kangra district and Chamba forest division of Chamba district of HP using Remote Sensing (RS) and Geographic Information System (GIS) environment. The maps depicted various thematic information such as fire incidences, fire lines, boundaries of division, range boundaries, block, beat, drainages, transportations, name of locations, check posts, inspection huts, rest house etc. This service was provided to State Department of Forests, HP.

Seven potato samples received from M/s Mahindra Shubhlabh, Palampur were tested for Potato virus Y, Potato virus X and Potato virus S.

Damask rose weighing 337 and 98 kg supplied by Mr. B.B.L Butail and Mahaavtar Yogiraj Baba, respectively were distilled at the Pilot Plant, Chandpur for rose water.

Processing services were provided to IVRI, Palampur for defatting tea seeds weighing around 24.8 kg.

Technical services were rendred for laboratory distillation of *Senecio* spp. and production of essential oils.

Steam distillation of lemon grass on a pilot scale was conducted for a farmer from Jaisinghpur. The technical service was rendered to farmers to facilitate processing of their harvest for value added product.

Spray drying of samples of tea extracts from tea growers for making new products.

राजभाषा गतिविधियां

पश्चिमी हिमालय क्षेत्र में आर्थिक महत्व की जैवसंपदा के आधार पर मूल्यवर्धित पौधों, उत्पादों तथा पक्रमण विधियों द्वारा औद्योगिक, सामाजिक और पर्यावरणीय लाभ हेतु शोध एवं विकास सेवाएं प्रदान करने के लक्ष्य के साथ–साथ सीएसआईआर–आईएचबीटी, पालमपुर भारत सरकार की राजभाषा नीति के कार्यान्वयन एवं हिंदी भाषा के माध्यम से विज्ञान के प्रचार–प्रसार में सतत् प्रयासरत है। इस दिशा में संस्थान अपने अनुसंधान एवं विकास से संबन्धित विविध आयामों पर हिंदी में संसाधन सामग्री भी तैयार करता है। राजभाषा हिंदी को बढ़ावा देने हेतु संस्थान कई प्रकार के कार्यक्रमों का भी आयोजन करता है। अपने शोध को आम लोगों, किसानों उद्यमियों तक पहुंचाने के लिए समाचारपत्रों, पत्रिकाओं, रेडियो तथा दूरदर्शन के माध्यम से राजभाषा हिन्दी में पहुंचाना भी संस्थान का लक्ष्य है। संस्थान ने जो कृषि तकनीकें विकसित की हैं उनको किसानों एवं उद्यमियों तक पहुंचाने के लिए न केवल प्रदेश अपितु अन्य राज्यों में भी प्रशिक्षण कार्यक्रम राजभाषा हिन्दी के माध्यम से किए गए हैं। वर्ष 2012–13 की प्रमुख उपलब्धियां निम्न प्रकार से हैं:

''आईएचबीटी संवाद'' तिमाही ऑनलाइन पत्रिका

संस्थान ने रजत जयंती वर्ष के उपलक्ष्य में एक ऑनलाइन तिमाही न्यूजलेटर शुरु करने का निर्णय लिया था। इसी क्रम में अब तक इसके 16 अंक संस्थान की वेबसाइट में उपलब्ध है।

वेबसाइट अद्यतनीकरण

संस्थान की हिन्दी वेबसाइट का अद्यतनीकरण किया गया तथा सामग्री को यूनिकोड में करने का कार्य हो गया है तथा यह वेबसाइट पर उपलब्ध है।

पुस्तकें, पत्रिकाएं एवं संदर्भ सामग्रियों को उपलब्ध कराना

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

संगोष्ठी में प्रतिभागिता

हैदराबाद स्थित सीएसआईआर की प्रयोगशालाओं सी.सी.एम.बी., आई.आई.सी.टी. एवं एन.जी.आर.आई. द्वारा 22–24 अगस्त 2012 सीएसआईआर अनुसंधान– सामाजिक संदर्भ संयुक्त राष्ट्रीय वैज्ञानिक हिन्दी संगोष्ठी में संस्थान की ओर से वरिष्ठ अनुवादक श्री संजय कुमार ने प्रतिभागिता की।

प्रशिक्षण कार्यशाला

17.09.2012 यूनिकोड एवं कम्प्यूटर, श्री केवल कृष्ण, वरि. तकनीकी निदेशक राजभाषा विभाग, भारत सरकार, नई दिल्ली

लोकप्रिय विज्ञान लेखन तथा प्रकाशन

संस्थान की ओर से इस अवधि में 4 लोकप्रिय विज्ञान लेख ''विज्ञान प्रगति' में तथा कुछ लेख दैनिक समाचार पत्रों में प्रकाशित हुए। 'लाहौल में लिलियम की खेती' पर एक हिंदी में तकनीकी ब्रोशर तैयार किया गया। 'पादप सूक्ष्म प्रवर्धन–एक व्यावहारिक पुस्तिका' एवं 'पुष्प उत्पादन की तकनीक' विषय पर दो पुस्तकें हिंदी में प्रकाशित की गई हैं।

दूरदर्शन वार्ता

वर्ष के दौरान दूरदर्शन के दिल्ली, शिमला, जालंधर केन्द्र तथा जी न्यूज, हेडलाइन टूडे जैसे चैनलों से विभिन्न कार्यक्रमों के अन्तर्गत 14 तथा अकाशवाणी के धर्मशाला केन्द्र से 2 वार्ताएं प्रसारित हुई।

हिंदी दिवस समारोह

संस्थान में हिन्दी दिवस समारोह के अन्तर्गत 14 सितम्बर 2012 को निदेशक महोदय ने अपना संदेश सभी स्टाफ सदस्यों को दिया। हिन्दी सप्ताह के अन्तर्गत वैज्ञानिकों एवं तकनीकी कर्मचारियों के लिए हिन्दी में लोकप्रिय विज्ञान लेखन, प्रशासनिक कर्मचारियों के लिए हिन्दी टिप्पण एवं पत्र लेखन एवं रिसर्च स्कॉलर के लिए भाषण प्रतियोगिता का आयोजन किया गया। सभी प्रतियोगिताओं के विजेताओं को प्रथम पुरस्कार के रूप में 1000 रुपये, द्वितीय पुरस्कार के रूप में 700 रुपये तथा तृतीय पुरस्कार के रूप में 500 रुपये तथा प्रमाणपत्र प्रदान किये गए। इसके अतिरिक्त हिन्दी टिप्पण प्रोत्साहन योजना के अन्तर्गत भी कर्मचारियों को पुरस्कृत किया गया।

संस्थान मे हिन्दी सप्ताह समारोह–2012 दिनांक 11 से 17 सितम्बर 2012 तक संस्थान परिसर में आयोजित किया गया। इसके अन्तर्गत निम्नलिखित कार्यक्रमों का आयोजन किया गया

11.09.2012	हिंदी भाषण प्रतियोगिता, (रिसर्च स्कॉलर के लिए)
विषयः	आई.एच.बी.टी. शोध की समाज के लिए देन एवं संभावनाएं
12.09.2012	हिन्दी टिप्पण एवं पत्र लेखन, (प्रशासनिक कर्मचारियों के लिए)
13.09.2012	हिन्दी में लोकप्रिय विज्ञान लेखन, (वैज्ञानिकों एवं तकनीकी कर्मचारियों के लिए)
विषयः	आई.एच.बी.टी. शोध की समाज के लिए देन एवं संभावनाएं
14.09.2012	हिंदी दिवस समारोह–2012 मुख्य समारोह

हिंदी दिवस का मुख्य समारोह 14 सितम्बर 2012 को आयोजित किया गया। समारोह में अपने स्वागत भाषण में संस्थान की वैज्ञानिक डा. अपर्णा मैत्रा ने हिन्दी दिवस के आयोजन के उदेश्य पर प्रकाश डालते हुए संस्थान की हिन्दी संबन्धी गतिविधियों के बारे में विस्तार से बताया। संस्थान के वरिष्ठतम वैज्ञानिक डा. आर. डी. सिंह 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 समाचारपत्रों में प्रकाशित करें। समारोह के मुख्य वक्ता आयुष विभाग, भारत सरकार के सलाहकार डा. एस. के. शर्मा ने ''आयुर्वेद–प्राचीन भारत का ज्ञान और आधुनिक जीवन में उसकी उपयोगिता'' विषय पर संभाषण दिया।

अन्य विविध कार्य

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

SUPPORT SERVICES

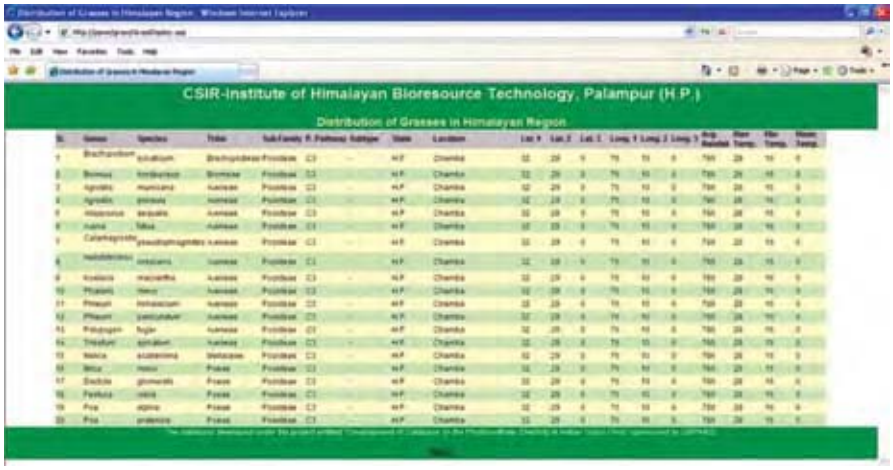
PROJECT PLANNING, MONITORING & EVALUATION CELL

In a major initiative, a web based system was designed for the project entitled "Development of database on the photosynthetic diversity in Indian grass flora". It shows the distribution of grasses in the Indian Himalayan regions with respect to C3 and C4 pathways.

In another activity, queries on location and physical parameters such as temperature, rainfall etc. were raised, and about 350 entries were made during 2012-13 into the Institutional Repository of CSIR-IHBT hosted at Central Harvester maintained by CSIR-URDIP, Pune.

In a joint activity of the Stores, Finance, Administration and ESU, the PPME also undertook the task of role mapping of IHBT staff, generation of personal information, project data entry and generation of payroll slip through ONECSIR portal. Test checks of the process were also carried out successfully under OneCSIR–Enterprise Transformation Portal.

Besides the above activities, PPME successfully created Notional projects for all IHBT staff with ESS tag. It entered the information of various networked, non-networked, sponsored, grant-in-aid projects into project database. It also facilitated information collection for vehicle master, guest house master, store and



material master, facility master, building master etc. through ONECSIR portal. Different HR processes like viewing payslips, GPF, CEA, telephone reimbursement, leaves, NOC, LTC, TA, indents, transport request etc. were also facilitated through ERP system.

As a part of routine activity, information pertaining to projects, staff, papers, patents, ECFs, royalties, MoUs etc. and also information in CSIR-IHBT website and intranet were maintained and updated regularly. It also monitored the performance of CSIR-IHBT through publications, ECFs patents and ToTs. It also compiled reports on significant achievements of the institute for CSIR HQ on a monthly basis and sent regular inputs to CSIR and CSIR-IHBT Annual report. It also conducted the 48th meeting of the Research Council of CSIR-IHBT on 8th December 2012 at CSIR Science Center, New Delhi. It also organized the celebration of National Technology Day, IHBT Foundation Day, CSIR Foundation Day and National Science Day on behalf of the Institute.

In an extension of routine activites that PPME performs, the compilation and strengthening of 'XIIth Five Year Plan' projects was facilitated and information of 12 completed projects was included in the compendium. The compendium now has information on 151 Projects. The cell recorded the initiation of 14 new projects funded by various agencies. Moreover, PPME furnished information on 13 cases under RTI Act and filed quarterly report to RTI portal www.rti.gov.in.

PPME was instrumental in building the image of the institute in the current year. It popularized science among school and college children and also arranged the visit of over eleven hundred students. It handled queries of about 202 students for training at the institute and actually facilitated the training of selected students (47) as winter and summer trainees in different divisions of the institute. Most importantly, it organized the INSPIRE Internship 2012 Science Camp on September 24-28, 2013 for 98 students.

PPME also emphasized the writing of notices and circulars in Hindi and also furnished replies in Hindi to category "A" states.

COMPUTER CELL

CSIR-IHBT has campus wide network facilities for more than 300 data nodes over fiber backbone, wi-fi, video-conferencing, and a fleet of servers from HP and IBM. Under National Knowledge Network, a dedicated 1Gbps leased line was provided for Internet facility throughout the campus including hostel and staff quarters. Network security hardware like Unified Threat Management Solutions, IDS, IPS, Centralized Anti-Virus on client server based model and SMTP spam/virus protection software and its policies were deployed to protect CSIR-IHBT resources centrally.

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

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

CSIR-IHBT-KNOWLEDGE RESOURCE CENTRE (IHBT-KRC)

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

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

Collection development: Collection is one of the major functions of the library that supports research and academic projects of the scientists, scholars, students, staff and other users. Books, journals, theses, reports, standards and other reading material in science and technology were added to existing library collection.

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

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

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

Reference, referral and documentation: Reference service was provided to users in locating information or document of their choice. Library was visited by 6044 visitors. Scientists, students, research scholars, faculty members from several academic and R&D institutions consulted library resources. The library loaned 1159 books and other documents to its members during the year. Photocopying/ laser printing service was one of important services offered by the library and provided more than 4.5 lakhs of pages of photocopies/printing to the scientists, research scholars and staff of the institute.

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

PHOTOGRAPHY UNIT

This unit provided a comprehensive photographic and videography services including recording research activities in labs, fields, surveys as well as demonstration plots established at remote and rugged terrains. It strove to achieve the highest standards using traditional skills and modern technologies and ensured best reproduction in theses and publications. The unit also covered all official functions, trainings, workshops, conferences and symposia organised by the Institute both within and outside the campus. Regular assistance was rendered in designing cover pages of annual reports, books, brochures, the in-house magazine, '*Manthan*', banners and certificates. It also recorded interviews of farmers and entrepreneurs depicting successful adoption of technology provided by the Institute.

PATENTS, PUBLICATIONS, HUMAN RESOURCES AND PUBLICITY

PATENT FILED

India

Krishna Kumar Singh, Anil Sood and **Om Prakash** (2012) A simple portable type charcoal kiln for wood, sticks and leaves, 0035NF2011/IN dated 08/10/2012.

Rajesh Thakur, Anil Sood and **Paramvir Singh Ahuja** (2012) A bioreactor vessel for large scale growing of plants under aseptic conditions, 0013NF2012/IN dated 06/08/2012.

Shashi Bhushan, Sakshi Gupta, Garikapati Dyva Kiran Babu, Mohit Sharma and **Paramvir Singh Ahuja** (2012) Method and apparatus for the separation of seeds from fruit pulp/slurry/pomace, 0116NF2011 dated 07/11/2012

Yelam Sreenivasulu, Rimpy Diman, Ramamurthy Srinivasan, Shripad Ramachandra Bhat and **Paramvir Singh Ahuja** (2013) Novel bidirectional promoter trap construct to trap/identify novel promoters, 0109NF2013/IN dated 25/03/13.

Abroad

Anish Kaachra, Surender Kumar Vats, Paramvir Singh Ahuja and **Sanjay Kumar** (2012) A method for enhancing status of carbon, nitrogen, biomass and yield of plants, 0057NF2011/WO dated 19/04/2012.

Harsh Pratap Singh and **Ajay Rana** (2013) An economical process for purification of bio amino acids, 0135NF2011/WO dated 08/02/2013.

Karnika Thakur and **Gopaljee Jha** (2012) A universal fungal pathogen detection system, 0169NF2009/PL, 0169NF2009/TR, 0169NF2009/EP dated 14/09/2012, 0169NF2009/CN dated 09/10/2012.

PATENT GRANTED

India

Garikapati Dyva Kiran Babu and **Ravindranath Srigiripuram Desikacha** (2012) A field convenient jacketed leaf inactivator for green tea processing, 252566 dated 23/05/2012.

Abroad

Pralay Das, Dharminder Sharma and **Bikram Singh** (2013) Substituted cyclohexane-1, 3-dione compounds, process for preparation thereof and its applications, US 2013/0079545A1 dated 28/03/2013.

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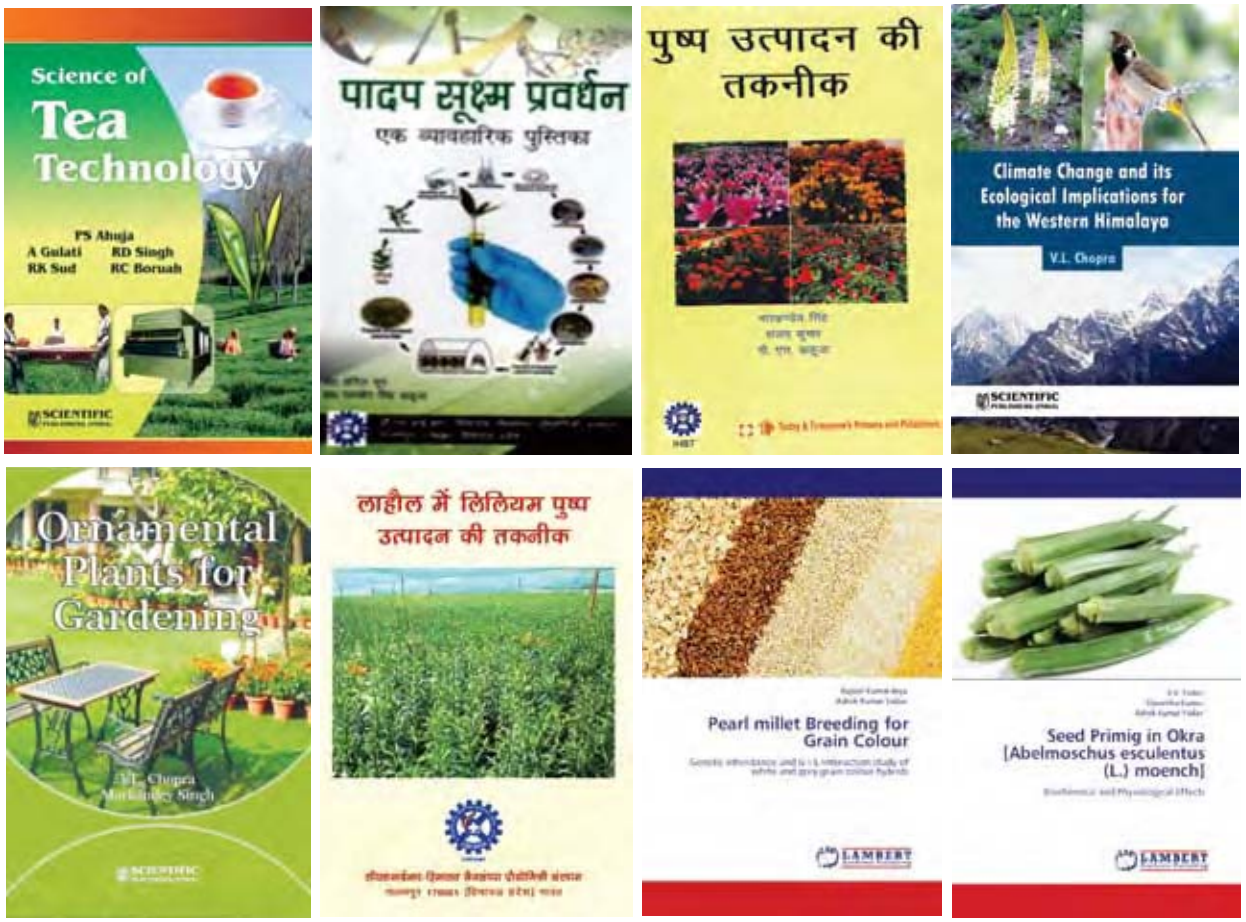

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PROGRAMMES TELECAST ON TV CHANNELS & RADIO

fo"k; **Subject**	fnukd Date	fo'k"kK **Specialist**
दूरदर्शन केन्द्र दिल्ली से नवोन्मेश भारत श्रृंखला के अन्तर्गत **Telecast from DD National under Innovative Technology India Series**		
सेब के पोमेश से मूल्यवर्द्धित उत्पाद बनाने हेतु उपयोग Utilization of apple pomace for value added food product development	05 May 2012	डा. शशी भूषण एवं परमवीर सिह आहूजा Dr. Shashi Bhushan and Dr. PS Ahuja
दूरदर्शन केन्द्र शिमला द्वारा प्रसारित नवोन्मेश कार्यक्रम के अन्तर्गत **Telecast from DD Shimla Under Innovative Technology**		
कांगड़ा चाय का स्वाद Flavour from Kangra tea	08 May 2012	डा. अषु गुलाटी Dr Ashu Gulati
दूरदर्शन केन्द्र शिमला द्वारा प्रसारित कृषि दर्शन कार्यक्रम के अन्तर्गत **Telecast from DD Shimla Under Krishi Darshan Programme**		
एलस्ट्रोमेरिया की खेती और फसलोपरांत तकनीक Cultivation and post harvest technologies of Alstroemeria	15 June 2012	डा. मारकण्डेय सिंह एवं श्री संजय कुमार Dr. Markandey Singh and Sh. Sanjay Kumar
औषधीय,सगंध एवं उच्च मूल्ययुक्त पौधों की कृषि तकनीक Cultivation of medicinal & aromatic plants and high value crops	29 June 2012	डा. वीरेन्द्र सिंह एवं डा. आर.के. सूद Dr.Virendra Singh and Dr. RK Sud
जरबेरा की संरक्षित खेती Protected cultivation of gerbera	09 July 2012	डा. मारकण्डेय सिंह Dr. Markandey Singh
चाय स्वाद और विविध चाय उत्पाद Tea aroma and diversified tea products	10 July 2012	डा. अषु गुलाटी Dr. Ashu Gulati
लिलियम के बल्व उत्पादन और फसलोपरांत तकनीक Bulb production and post harvest technologies of Lilium	19 July 2012	डा. मारकण्डेय सिंह Dr. Markandey Singh
जरबेरा कर्तित पुष्प की संरक्षित खेती Protected cultivation of Gerbera cut flower crop	28 August 2012	डा. मारकण्डेय सिंह Dr. Markandey Singh

fo"k; **Subject**	fnukd Date	fo'k"kK **Specialist**
क्रेटगस– कम उपयोग में लाया गया वृक्ष *Crataegus* – an under-utilized medicinal tree	05 October 2012	डा. आर.डी सिंह एवं डा. आर.के सूद Dr. RD Singh and Dr. RK Sud
हि.प्र. में उच्च गुणवतायुक्त प्रथम फ्लश चाय पौध का प्रबन्धन Management of high value first flush in tea plantations of H.P	23 April 2013	डा. आर.के. सूद Dr. RK Sud
शिमला दूरदर्शन से प्रसारित **Doordarshan Kendra Shimla**		
सीएसआईआर–आईएचबीटी स्थापना दिवस पर विशेष प्रसारण A documentary on the CSIR-IHBT Foundation Day	28 June 2012	सीएसआईआर–आईएचबीटी CSIR-IHBT, Palampur, HP
जालंधर दूरदर्शन से प्रसारित **Telecast from Jalandhar Doordarshan**		
सीएसआईआर–आईएचबीटी स्थापना दिवस IHBT Foundation Day	23 June, 2012	सीएसआईआर–आईएचबीटी CSIR-IHBT, Palampur, HP
Telecast from Headlines Today		
Kangra tea - Production and processing	28 April, 2012	Dr. RK Sud & Dr. Ashu Gulati
जी न्यूज से सीधा प्रसारित **Telecast from Zee News Live discussion**		
जवानी की बूटी Jawani ki Buti	30 July, 2012	डा. संजय कुमार Dr. Sanjay Kumar
रेडियो वार्ता प्रसार भारती आकाशवाणी केन्द्र धर्मशाला **Relay From Prashar Bharati AIR Dharmashala**		
बांस प्रवर्धन– किसानों के लिए सूचना Bamboo propagation- information for farmer	20 March 2013	डा. अनिल सूद Dr. Anil Sood
कांगड़ा घाटी में पुष्पोत्पादन Cultivation of flowers in Kangra valley	26 March 2013	डा. मारकण्डेय सिंह Dr. Markandey Singh

AWARDS/HONOUR/RECOGNITION

Award

Dr. Paramvir Singh Ahuja: Director, CSIR-IHBT was awarded the prestigious "Dr. William Wight Chair for Plant Improvement" for a period of three years. The chair was instituted by the 'Government of India Centenary Grant' during the centenary year celebration of Tea Research Association, Tocklai.

Dr. Arun Kumar Sinha: Awarded the 2013 "CRSI Bronze medal" for his contribution in the field of chemistry at the 15th Chemical Research Society of India (CRSI) symposium, Banaras Hindu University, Varanasi, January 31- February 3, 2013.

Dr. Sudesh Kumar Yadav: Awarded the "Prof. Hira Lal Chakravarty Memorial Award" for the year, 2012-13 at the 100th Indian Science Congress, Kolkata, January 3-7, 2013.

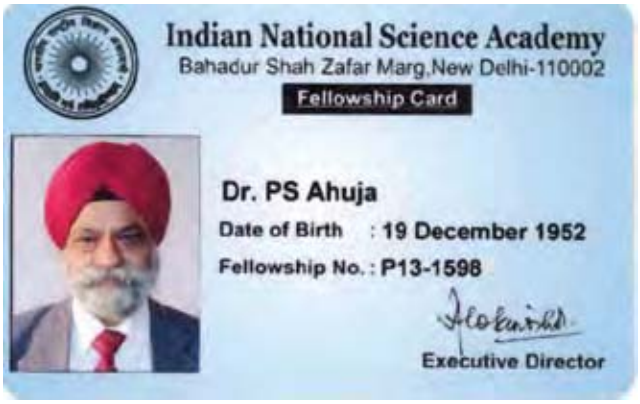
Dr. Rakesh Kumar: Received the "ISA Associateship Award" for the year 2010 at the 3rd International Agronomy Congress, IARI, New Delhi, November 26, 2012.

Mr. Vinay Kumar: SRF was awarded the "AU-CBT Excellence Award" for the year, 2011 by the Biotech Research Society of India, Punjabi University, Patiala, November 21-13, 2012.

CSIR-IHBT received the "Best Flower" (Bird of Paradise) prize in cut flower group at the Flower Show, Palampur (HP) organized by State Level Holi Mela Committee, March, 28 2013.

Fellow

Dr. PS Ahuja: Director, CSIR-IHBT was elected the "Fellow of Indian National Science Academy" from 1st January, 2013 for his noteworthy work in the field of plant biotechnology and his outstanding contribution in establishing a state-of-art research institute on Himalayan Bioresource.



Dr. Sudesh Kumar: Selected as an "Associate" by the National Academy of Agricultural Sciences from 2013.

Dr.V Shanmugam: Selected as the "Fellow of the Society of Plant Protection Sciences (FSPPS)" from 2013.

Dr.V Shanmugam: Selected as the "Fellow of the Phyto-pathological Society of India (FPSI)" for the year, 2012.

Dr. Ravi Shankar: Awarded the "INSA DST Early Career Researcher award" for the year, 2012-13.

Dr. Rakesh Kumar: Received the "MASHAV scholarship" from the Government of Israel on "Agriculture and environment in a changing climate - The Israeli Perspective", Israel, 28 November to 17 December, 2012.

Nomination

Dr. Shashi Bhushan: Nominated by the Asian Productivity Organization, Tokyo, Japan to participate in training course at Manila, Philippines.

Chaired in Conference/Seminar/Meeting

Dr. Bikram Singh: Chaired a session on "Recent Development in Validation of Traditional Medicinal Plants" in an interactive workshop on "Indo-South African workshop on Traditional medicine system: Sharing knowledge and experience" on October 29-31, 2012 organized by JSS College of Pharmacy Ootacamund- 643 001, The Nilgiris, Tamil Nadu, India.

Best Poster Award

Sareen B and **Bhattacharya A** (2013) First prize for poster presentation entitled "*In Vitro* propagation of *Diplazium maximum*- An important edible fern". In: National seminar on pteridophyta: an intriguing flora. environmental and ethnobotanical significance. Indian Fern Society, Department of Botany and Biotechnology, St. Aloysius College, Mangalore, India, 8-9 February.

Sharma A, Kumar R and **Sinha AK** (2013) Best poster award for poster entitled "Green synthesis of natural and unnatural phenolics employing concede hook reaction". In: 15th Chemical Research Society of India (CRSI) symposium, Banaras Hindu University, Varanasi, 31 January - 3 February (Poster No. 252 p.300).

Evaluator/Judge

Dr. Shashi Bhushan and **Dr. Gireesh Nadda** : Judges for evaluation of Scientific Survey Reports in State Child Science Conference, Chamba (HP) India, November 23-27, 2012.

Representator

Dr. Ravi Shankar: CSIR 12th FYP projects leadership Representing CSIR-IHBT for two 12th FYP projects as the major partner. Representing in GENESIS computational biology project and EpiHed, Epigenetics Project (2012-17).

Felicitation by CSIR-IHBT

Dr. AK Sinha: Felicitation by CSIR-IHBT on National Science Day (28 Feb. 2013) for publishing a paper in international journal of high repute (Angew. Chem. Int. Ed. with I.F. 12.73).

Ph.D. AWARDED

Awardees	Title of Thesis	Supervisor	University/Institute
Abha Chaudhary	Chemical investigations of *Cedrus deodara*, *Albizzia chinensis*, *Podophyllum hexandrum* and synthetic modification of himachalenes and their biological activities	Dr. Bikram Singh	Guru Nanak Dev University, Amritsar
Harleen Kaur Nadha	*In vitro* clonal propagation of some important woody bamboos and ascertaining their clonal fidelity.	Dr. Anil Sood	Thapar University, Patiala
Harsharan Singh	Cloning and characterization of genes involved in picrosides biosynthesis in *Picrorhiza kurrooa* Royle ex Bentham	Dr. Sanjay Kumar	Guru Nanak Dev University, Amritsar
Hitesh Kumar	Molecular basis of stevioside biosynthesis in *stevia rebaudiana* bertoni, a source of non-calorific sweetener	Dr. Sanjay Kumar	Panjab University, Chandigarh.
Naina Sharma	Synthetic and bioactivity investigations of some phenolics and heteroaromatic compounds	Dr. Arun Kumar Sinha	Guru Nanak Dev University, Amritsar
Praveen Rahi	Selection of widespread genotypes of plant growth promoting bacteria from Lahaul and Spiti in the Western Himalayas for improving crop productivity	Dr. Arvind Gulati	Guru Nanak Dev University, Amritsar
Priyanka Sood	Development of genetic transformation system for *Dendrocalamus hamiltonii* Nees et Arn. Ex Munro	Dr. Anil Sood	Guru Nanak Dev University, Amritsar
Pushpinder Kaur	Synthesis of biologically active γ-butyrolactone derivatives and chemical investigations of *Ginkgo biloba* and *Crataegus oxyacantha*	Dr. Bikram Singh	Guru Nanak Dev University, Amritsar
Ravi Shankar	Molecular studies on shikonin biosynthesis in *Arnebia euchroma* (Royle) Johnsto	Dr. Sanjay Kumar	Guru Nanak Dev University, Amritsar
Upendra Sharma	Phytochemical investigations of *Tinospora cordifolia, Asparagus racemosus* and synthesis of phthalimide derivatives for immunomodulatory active molecules	Dr. Bikram Singh	Guru Nanak Dev University, Amritsar
Vinay Kumar	Metabolic engineering of tobacco with dihydroflavonol 4-reductase and anthocyanidin reductase for analyzing the influence on flavonoids and antioxidant systems	Dr. Sudesh Kumar Yadav	Guru Nanak Dev University, Amritsar
Vivek Sharma	Cloning and characterization of antifungal glycosyl hydrolase genes from trichoderma spp mycoparasitic to *Fusarium oxysporum* f.sp. dianthi	Dr.V Shanmugam	Guru Nanak Dev University, Amritsar

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

Awardees	Title of Thesis/ Dissertation/ Project	Supervisor	University/Institute
Aashima Mahajan	Techniques in plant genetic engineering	Dr. Sudesh Kumar	Punjabi University, Patiala
Aditi Sharma	Molecular techniques involved in gene cloning	Dr. Som Dutt	Sri Gurunanak Khalsa College, Sriganganagar
Amita Prashar	Financial management and techno-economic evaluation : a case study of CSIR-IHBT	Dr. Aparna Maitra Pati	CT Institute of Management & Information Technology, Jalandhar
Amrita Ghosh	*In vitro* studies in *Cymbidium giganteum* Wall. and *Rhynchostylis retusa* (L.) Bl.: Commercially important orchids.	Dr. Madhu Sharma	CSK HPKV Palampur
Anchal Sharma	Cloning and expression analysis of NAC transcription factor genes from Potato *(Solanum tuberosum L.)*	Dr. Anil Kumar Singh	Thapar University, Patiala
Anjali Rakwal	E-system for recruitment of project staff of CSIR-IHBT	Dr. Aparna Maitra Pati	Central University of Himachal Pradesh, Dharamshala
Anuradha Sharma	Basic techniques in molecular biology	Dr.Y. Sreenivasulu	Guru Nanak Dev University, Amritsar
Arjuna Katal	Equilibrium, kinetics and thermodynamics study before and after chemical modification of apple pomace for the removal of cadmium (II) from water	Dr.Yogesh Balkrishan Pakade	Dr. B.R. Ambedkar National Institute of Technology, Jalandhar
Ashish Kumar	Application of heterogeneous Pd(0) catalyst in Suzuki-Miyaura cross coupling reaction using different techniques	Dr. Pralay Das	Indian Institute of Science Education and Research, Mohali
Ashwani Kumar Bhardwaj	Cloning of a gene encoding "Cathepsin B" : a senescence associated protein	Dr. Som Dutt	Shoolini University, Solan
Balwinder Kaur	Introduction to modern practises and green approaches in synthetic organic chemistry	Dr. A.K. Sinha	Dr. B.R. Ambedkar National Institute of Technology, Jalandhar
Bilkees Khanam	Characterization of *arabidopsis* promoter trap line	Dr.Y. Sreenivasulu	Baba Ghulam Shah Badshah University, Rajouri
Deepika	e-system for recruitment of project staff of CSIR-IHBT	Dr. Aparna Maitra Pati	Central University of Himachal Pradesh, Dharamshala
Garima Rai	Tools & techniques in microbiology	Dr. Ramesh C. Kasana	Panjab University, Chandigarh

Awardees	Title of Thesis/ Dissertation/ Project	Supervisor	University/Institute
Harmandeep Kaur Sekhon	Basic techniques in plant biotechnology	Dr. Amita Bhattacharya	Punjabi University, Patiala
Jyoti	Standardization of *Agrobacterium tumefaciens* mediated transformation protocol for obtaining mutants of *venturia inequalis*	Dr. Gopaljee Jha	Baba Ghulam Shah Badshah University, Rajouri
Kamal Kant	Antioxidant activity guided chemical investigation of *Picrorhiza kurroa* leaves growing in western himalayan region	Dr. Vijai Kant Agnihotri	Kumaun University, Bhimtal Campus, Bhimtal
Kanika Gupta	Study of computational tools for understanding protein interaction and structure	Dr. Ganesh Bagler	Panjab University, Chandigarh
Kshitiz Gupta	Tools and techniques in microbiology	Dr. Ramesh C. Kasana	Panjab University, Chandigarh
Lakhvinder Kaur	Evaluating pesticidal activities of plant extracts, biopesticides and chemical pesticides	Dr. Gireesh Nadda	Panjab University, Chandigarh
Lipakshi Awasthi	Molecular characterization of agriculturally important microbes	Dr. V. Shanmugam	Chandigarh Group of Colleges, Landran campus, Mohali
Mamta Devi	Integrated remote sensing and geographic information system modeling for estimating soil erosion in Kangra district, Himachal Pradesh, India	Er. Amit Kumar	Allahabad University, Allahabad
Monika Bharti	To study the interaction of AC4 protein of tomato leaf curl Palampur virus with Skp1 protein of tomato	Dr. Vipin Hallan	Baba Ghulam Shah Badshah University, Rajouri
Neha Singh	Microsatellite marker based genotyping in stevia	Dr. Ram Kumar Sharma	Lovely Professional University, Phagwara
Parwinder Kaur	Animal tissue culture and histopathology	Dr. Yogendra S. Padwad	Punjabi University, Patiala
Pooja Devi	Extraction, fractionation and isolation of compounds from f*unaria hygrometrica*	Dr. Bikram Singh	Dr. B.R. Ambedkar National Institute of Technology, Jalandhar
Prakashjyoti Kalita	"Studies on the response of proteome of *Picrorhiza kurrooa* Royle ex Benth. to environmental cues'.	Dr. Som Dutt	CSK HPKV, Palampur

Awardees	Title of Thesis/ Dissertation/ Project	Supervisor	University/Institute
Priya Sharma	Basic plant molecular biology techniques	Dr. Gopaljee Jha	Guru Nanak Dev University, Amritsar
Priya	Approaches for Management of Serious Plant Pathogens	Dr.V. Shanmugam	Guru Nanak Dev University, Amritsar
Rajat Dhyani	Diagnostic techniques for plant viruses	Dr.Vipin Hallan	Burdwan University, Burdwan
Rajni Devi	Diagnostic techniques for plant virus	Dr.Vipin Hallan	Lovely Professional University, Phagwara
Ravinder Dhiman	Morphometric analysis and mapping of fluvial erosion susceptibility of watersheds in Kangra, Himachal Pradesh, India using geographic information system	Er. Amit Kumar	Institute of Environmental Studies, Kurukshetra University Kurukshetra
Rishu Rana	Molecular fingerprinting in *Stevia rebaudiana* using genic microsatellite markers	Dr. Ram Kumar Sharma	Guru Nanak Dev University, Amritsar
Sharda Sharma	Studies on evaluation of transgenic tea for cold stress tolerance.	Dr. Amita Bhattacharya	CSK HP Krishi Vidyalaya, Palampur, HP
Shivani	Molecular characterization of soybean infecting begomovirus(es),	Dr.Vipin Hallan	CSK HPKV, Palampur
Sandeep Kaur Saggu	Isolation of genes from *caragana jubata* and their cloning in different vectors	Dr. Sanjay Kumar	Guru Nanak Dev University, Amritsar
Sourabh Soni	Diagnostic techniques for plant viruses	Dr.Vipin Hallan	Panjab University, Chandigarh
Sukhbir Kaur	Techniques related to plant tissue culture, DNA fingerprinting and microbial technology	Dr. Madhu Sharma, Dr. R. K. Sharma & Dr. R.C. Kasana	Central University of Panjab, Bathinda
Suman Bala	Identification and expression analysis of NAC transcription factors family in potato *(Solanum tuberosum L.)*	Dr. Anil Kumar Singh	Jaipur National University, Jaipur
Tanya Chanana	Germplasm resources of the CSIR-IHBT	Dr. Aparna Maitra Pati	Central University of Himachal Pradesh, Dharamshala

BE/BTech

Awardees	Title of Thesis/ Dissertation/ Project	Supervisor	University/Institute
Amit Kumari	Overview of extraction techniques for medicinal and aromatic plants	Er. Mohit Sharma	University Institute of Chemical Engineering & Technology, Panjab University, Chandigarh
Ankita Garg	Genetic characterization of *Picrorhiza kurrooa* through SSR markers	Dr. Ram Kumar Sharma	Thapar University, Patiala
Arushi Vats	Determination of efficacy of anticancer drugs against different cancer cell lines	Dr. Yogendra S. Padwad	Banasthali University, Banasthali
Ashray Gupta	Extraction, purification, identification and estimation of catechins from *Camellia sinensis*	Dr. Ashu Gulati	Beant College of Engineering and Technology, Gurdaspur
Gargi Rastogi	Genetic transformation of woody plants and their characterisation	Dr. Amita Bhattacharya	Banasthali University, Banasthali
Geetika Saini	Identification and characterization of genic microsatellite markers in *stevia rebaudiana*	Dr. R.K. Sharma	Beant College of Engineering & Technology, Gurdaspur
Jasneet Kaur	Anther culture response in *stevia rebaudiana* for the development of haploids	Dr. Ashok Kumar	Thapar University, Patiala
Mishti Chaudhary	Techniques in plant biotechnology	Dr. Madhu Sharma	Jaypee University of Information Technology, Waknaghat, Solan
Neha	Extraction of medicinal and aromatic plants	Er. G.D. Kiran Babu	Beant College of Engineering & Technology, Gurdaspur
Radhika Sharma	Study of epigenetic changes during winter dormancy in tea *[Camellia sinensis* (L.) O. Kuntze]	Dr. Sanjay Kumar	Beant College of Engineering & Technology, Gurdaspur
Rizul Awasthi	Basic techniques in plant biotechnology	Dr. Shashi Bhushan	University Institute of Engineering & Technology, Panjab University, Chandigarh
Shivani	Cloning and characterization of selected genes from plants	Dr. Sanjay Kumar	Shoolini University of Biotechnology & Management Sciences, Solan
Sumit Sharma	Extraction, purification, identification and estimation of catechins from *Camellia sinensis*	Dr. Ashu Gulati	University Institute of Engineering & Technology, Panjab University, Chandigarh
Suraj Prakash	Extraction of medicinal and aromatic plants	Er. GD Kiran Babu	Beant College of Engineering & Tech, Gurdaspur

LECTURES DELIVERED

Spokesperson	Topic	Occasion with Place	Date
Alka Kumari	Biomonitoring of atmospheric pollution levels with *Riccia gangetica* growing in the vicinity of fly ash near NTPC, Kahalgaon	International conference and workshop on monitoring of metals and gases in plants with special reference to bryophyte physiology & climate change, Department of Botany, Bareilly college, Bareilly, UP	December 18, 2012
Amit Kumar	Land-use land-cover mapping	NRDMS-DST sponsored summer training programme on geospatial technologies and applications, Centre for Geo-informatics Research & Training, CSK HPKV, Palampur, HP	July 9, 2012
Anil Sood	Bamboo – A wonder of nature	Lecture delivered to the students from different schools of Palampur on World Fascination Day, CSIR-IHBT, Palampur, HP	May 18, 2012
Anil Sood	Bamboo propagation methods and value addition	National bamboo mission workshop, organized by the Forest Department, HP, Bangana Gram Panchayat, District Una, HP	March 28, 2013
Arun Kumar Sinha	Relevance of green approaches towards protecting-group-free synthesis of natural and non-natural bioactive phenolic compounds	First international workshop on naturural product chemistry held at National Science Foundation of China (NSFC), Beijing	September 24-26, 2012
Arun Kumar Sinha	Green prospective on protecting-group-free synthesis of natural and non-natural phenolics	Asian network for natural and unnatural materials II (ANNUM II), organized by NTU, Singapore	October 2-5, 2012
Arun Kumar Sinha	Green methodologies towards protection-group-free synthesis of natural and non-natural bioactive phenolics	XV NOST-Organic chemistry conference, Agra, UP	October 10-13, 2012
Arun Kumar Sinha	Protection-group-free approaches for natural & non-natural bioactive phenolics	15th Chemical Research Society of India (CRSI) symposium, Banaras Hindu University, Varanasi	January 31- February 3, 2013
Bikram Singh	Recent development in validation of traditional medicinal plants	Workshop on "Indo-South African workshop on traditional medicine system: sharing knowledge and experience, JSS College of Pharmacy, Ootacamund – 643 001, The Nilgiris, TN	October 29-31, 2012

Spokesperson	Topic	Occasion with Place	Date
Brij Lal	Pharmacopoeial standardization of herbal drugs used in indian system of medicine: the basis for electrohomeopathy	Training-cum-orientation workshop on electrohomeopathy, jointly organized by Himachal Pradesh Electrohomeopathic Doctors Association and Rabisan India Electrohomeo Pharma, Chamba, HP	December 8, 2012
Madhu Sharma	Orchids : the wonders of nature	Lecture delivered to the students from different schools of Palampur on World Fascination Day, CSIR-IHBT, Palampur, HP	May 18, 2012
Madhu Sharma	Micropropagation of saffron for production of disease free cormlets	International training programme on cultivation, processing and value addition of saffron, organized by Centre for Environment and Economic Development, New Delhi, at CSK HPKV Palampur, HP	November 07, 2012
Markandey Singh	Scope of commercial floriculture in district Lahaul & Spiti	Workshop on Scope of horticulture and medicinal crops in district Lahaul & Spiti, organized Department of Horticulture Keylong, HP	September 25, 2012
Markandey Singh	Commercial floriculture	Lecture delivered to the students from different schools of Palampur on World Fascination Day, CSIR-IHBT, Palampur, HP	May 18, 2012
Markandey Singh	Cultivation technology of Saffron	International training programme on cultivation, processing and value addition of saffron, organized by Centre for Environment and Economic Development, New Delhi, at CSK HPKV Palampur, HP	November 7, 2012
Markandey Singh	Advances in protected cultivation and post harvest technology of Lilium, Chrysanthemum and Rose	Training on production and marketing of commercially important flower crops,organized by Department of Horticulture, Dharamshala, HP	November 15, 2012
Markandey Singh	Cultivation technology of Alstroemeria, importance of project size in ensuring viability and supply chain logistic including cool chain management		November 16, 2012
Paramvir Singh Ahuja	Challenges and expections from women in present scenario	Women empowerment workshop by Inner-wheel and rotary club, Palampur, HP	May 12, 2012
Paramvir Singh Ahuja	Keynote address	Seminar on pteridophytes, at St. Aloysius college, Mangalore, Karnataka	February 8, 2013

Spokesperson	Topic	Occasion with Place	Date
Raja Ram	Agro and post harvest technology of Carnation and Gerbera technology	Training on production and marketing of commercially important flower crops,organized by Department of Horticulture, Dharamshala, HP	November 15, 2012
Raja Ram	Agro-technology of of Marigold and Bird of Paradise		November 16, 2012
Rakesh Kumar	Potentials of MAPs and floriculture in sustainable agriculture and rural development in cold desert region of India	GBPIHED Himachal Unit, Mohal Kullu, HP	October 18-19, 2012
Rakesh Kumar	Lavender cultivation and its prospectus in Lahaul valley	Workshop on Scope of horticulture and medicinal crops in district Lahaul & Spiti, organized by HP Department of Horticulture Keylong, HP	September 25, 2012
Sanjay Kumar	Molecular basis of biosynthesis of flavonoids and terpenoids: case studies on *Camellia sinensis* and *Picrorhiza kurrooa*	National seminar on current trends in secondary plant metabolite research, Jamia Hamdard, New Delhi	March 19, 2012
Sanjay Kumar	Need, nature: the teacher- by chance: the leaper	INSPIRE organized by DST and CSIR-IHBT, Palampur, HP	September 24, 2012
Som Dutt	Techniques in Proteins and Proteomics	one day seminar on Recent Techniques in Biotechnology-2012, Department of Biotechnology, Panjab University, Chandigarh	September 15, 2012
Sudesh Kumar Yadav	RNAi biology and its potential in plants	Department of Biochemistry, GGD SD College, Chandigarh	February 22, 2013

GUEST LECTURES

Prof. Asis Datta, National Institute of Plant Genome Research, New Delhi, "Dream to bring Science to Society', April 9, 2012

डॉ. ओ.सी. हांडा, पुरातत्व विशेषज्ञ, 'हिमाचल प्रदेश के मंदिरों का शिल्प', मई 14, 2012

Prof. Indrapal Singh Aidhen, IIT, Chennai, 'Recent accomplishments at synthetic front', July 17, 2012

डॉ. एस. के. शर्मा सलाहकार (आयुर्वेद), आयुष विभाग, स्वास्थ्य एवं परिवार कल्याण मंत्रालय, भारत सरकार, 'Fundamental Concepts of Ayurveda and their Application in Clinical Medicine' सितंबर 14, 2012

श्री केवल कृष्ण, वरि. तकनीकी निदेशक, राजभाषा विभाग एवं राष्ट्रीय सूचना विज्ञान केंद्र (एनआईसी), भारत सरकार, ''यूनिकोड और कम्पयुटर'', सितंबर 17, 2012

WORKSHOP/TRAINING/CONFORENCE/MEETING ORGANISED

Period	Theme	Coordinator & Team	Participants (No.)
March 29 - April 28, 2012	Training on improved production and processing technologies for MAP and Tea	Dr Rakesh Kumar	Participants from Ethiopia
April 6, 2012	Workshop on the uniqueness of the Kangra tea	Coordinator: Dr. RK Sud Team: Dr. Ashu Gulati, Dr. HP Singh, Sh. VS Dhadwal and Sh. Khushal Katoch	74 Participants (including 1 from UK, 2 from Ethiopia)
April 6, 2012	Training on advances in tea husbandry practices, nursery management and large cardamom cultivation, sponsored by State Agriculture Department	Coordinator: Dr. RK Sud Team: Sh.VS Dhadwal, Sh. Khushal Katoch and Sh. Bhushan Gupta	61 Participants
April 9-11, 2012	Orientation course in plant tissue culture	Dr. Madhu Shrama	Two personnels from Ethiopia
April 12-20, 2012	Training on processing and quality aspects of Medicinal and Aromatic Plants (MAP's)	Dr. Rakesh Kumar	Representatives of M/s Ethio Agri-CEFT, Ethiopia
June 17-30, 2012	Training on plant tissue culture	Dr. Anil Sood	Mr. Jayesh Pathak Assistant Professor Agroforestry, Aspee College of Horticulture and Forestry, Navsari Agricultural University, Navsari, Gujarat
July 9-10, 2012	Improved production technologies for natural sweetener plant stevia	Dr Rakesh Kumar	Mr Rishi Nirula (Industrialist) D-216, 2nd Floor, Vivek Vihar, New Delhi
September 24-28, 2012	INSPIRE (Innovation in Science Pursuit for Inspired Research) Internship - 2012 Science Camp	Dr. Aparna Maitra Pati	98 Participants
October 3, 2012	Training on how to make bamboo candies?	Dr. Anil Sood	Members of women NGOs working in the region
February 19-March 8, 2013	Training in transmission electron microscopy (sample preparation and imaging)	Dr. Madhu Shrama	Dr. Praveen Kumar Dass, Asstt Prof, Deptt of Anatomy, Dr. Rajendra Prasad Govt. Medical College, Tanda Kangra HP
February 4-16, 2013	Training on plant tissue culture	Dr. Madhu Shrama	Mr. Daljeet Singh C/o M/s Annex Farming Pvt. Ltd., Siliguri (WB)

VISIT ABROAD

Dr. Amit Chawla: Participated in PRECIS training workshop, held at United Kingdom, April 23-27, 2012.

Dr.Anil Sood: Delivered a keynote lecture entitled "Biotechnological approaches for propagation conservation and improvement of important bamboos in the 9th World Bamboo Congress, held at Antwerp, Belgium, April 10-15, 2012.

Dr. Arun Kumar Sinha: Invited talk at Asian network for natural and unnatural materials II (ANNUM II), organized by Nanyang Technological University (NTU), Singapore, October 2-5, 2012.

Dr. Arun Kumar Sinha: Represent India (nominated by CRSI to RSC, London) in the field of natural product chemistry, in the first international workshop on naturural product chemistry symposium held at National Science Foundation of China (NSFC), Beijing, September 24-26, 2012.

Dr. PS Ahuja and **Dr. Sanjay Kumar:** Attended the meeting & discussion on Indo-German project entitled "Imparting drought stress-tolerance to crop plants by heterologous transfer of high altitude plant protection mechanisms", held at Institute of Bio- and Geosciences, IBG-2: Plant Sciences, Forschungszentrum Jülich GmbH, D-52425 Julich Germany, May 5-11, 2012.

Dr. Rakesh Kumar: Attended the training programme entitled "Agriculture and environment in a changing climate - The Israeli perspective", held at Israel, November 28-December 17, 2012.

Dr. Shashi Bhushan: Participated in the training course on "Value addition to agricultural products for greater access to new markets", held at Manila, Philippines, sponsored by Asia Productivity Council, Tokyo, Japan, July 9-14, 2012.

Sh. Mohit Kumar Swarnkar: Attended a workshop in EBI-ENGAGE/GEUVADIS RNA-Seq Workshop Course RNA-Seq, held at Cambridge, UK, December 4-6, 2012.

Sh.Vinay Kumar : Participated in a conference on "Plant abiotic stress and sustainable agriculture: Translating basic understanding to food production", held at Sagebrush Inn and Conference Centre, Taos, New Maxico, USA, January 17-22, 2013.

Sh. Vivek Dogra Participated in Proteomic Forum-2013, Frie University, Berlin Germany, March 17-21, 2013.

LINKAGES

International

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

National

Government/Autonomous/PSUs

- Biotech Consortium India Ltd., New Delhi
- Botanical Survey of India, Dehradun, Uttarakhand
- Commission for Scientific and Technical Terminology, Govt. of India, New Delhi
- CSK Himachal Pradesh Krishi Vishwavidyalaya, Palampur, Himachal Pradesh
- District Rural Development Agency, Mandi, Himachal Prdaesh
- University of Delhi, New Delhi
- Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Prdaesh
- Guru Nank Dev University, Amritsar, Punjab
- Himachal Pradesh Horticultural Produce Marketing & Processing Corporation Limited(HPMC), Shimla, Himachal Pradesh
- Indian Institute of Technology Mandi, Mandi, Himachal Prdaesh
- National Dairy Research Institute, Karnal, Haryana
- The Parbati Hydroelectric Project (Stage-II), under NHPC, Nagwain, Mandi, Himachal Prdaesh
- Panjab University, Chandigarh (UT)
- Punjab Agricultural University, Ludhiana, Punjab
- Punjabi University, Patiala, Punjab
- Space Applications Centre (SAC), ISRO, Ahmedabad, Gujarat
- Tea Research Association, Tocklai, Assam

- The Chief Conservator of Forests (Admn.) cum Project Director, Panchkula, Haryana
- TN Medical College & BYL Nair Ch. Hospital, Mumbai Central, Mumbai
- United Planters Association of South India (UPASI), Valparai, Tamil Nadu
- Uttarakhand Bamboo and Fiber Development Board (UBFDB), Dehradun, Uttarakhand

Private

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

NGO

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

MEMORANDUM OF UNDERSTANDING (MoU)

Date	Agreement with	Purpose
May 4, 2012	M/s Rajat Biotech Farm, Vill- Padyalag, P.O.- Dadhol, Tehsil- Ghumarwin, Distt.- Bilaspur (HP)	Materials transfer agreement
May 22, 2012	M/s Krishidhan Research Foundation Pvt. Ltd.302, Royal House, 11/3. Usha Ganj, Indore	Identification and isolation of novel genes, production of transgenics, somatic hybridization and production of quality planting material through tissue culture
June 5, 2012	M/s A.K. Biotech, Tehsil- Chaurah, Distt. - Chamba (HP)	To facilitate setting up a Tissue Culture Lab
June 25, 2012	M/s Gujarat Biotech Vanaushadh Vikas Parishad, Pvt. Company presently engaged in Stevia and other organic agro produces and has their registered office at Ahmedabad	For material transfer
August 17, 2012	M/s Sagar Biotech, Thakurdwara, Palampur (HP)	For material transfer
December 6, 2012	M/s Nishant Biotech, Vill-Padyalag, PO-Dadhol, Tehsil- Ghumarwin, Distt- Bilaspur (HP)	For material transfer
January 8, 2013	Maharana Pratap University of Agriculture and Technology, Udaipur	For academic collaborations
January 31, 2013	Neva Plantations Pvt. Ltd. Village-Gopalpur, Teh. Palampur, Distt. Kangra -176 059 (HP)	For material transfer
March 8, 2013	Central University of Punjab, Bathinda	For academic collaborations
March 20, 2013	Central University of HP, Dharamshala, District-Kangra (HP)	For academic collaborations

TRAINING/WORKSHOPS/MEETING ATTENDED

Name	Training/Workshop/ Conference/Meeting	Organiser & Venue	Period
Dr. RK Sharma	Special invitee to task force and brain storming meeting on association mapping in plants	Department of Biotechnology, Govt of India, held at Tamil Nadu Agricultural University, Coimbatore	May 2-4, 2012
Er. Amit Kumar	Training on microwave remote sensing applications	National Remote Sensing Centre, Hyderabad, Andhra Pradesh	May 7-18, 2012
Dr. Som Dutt	Training on Radiation safety aspects in research applications in radiation: RA-038	BARC, Mumbai (MH)	May 21-29, 2012
Dr. Aparna Maitra Pati, Dr. RK Sharma and Dr. Shashi Bhushan	Training programme on science and technology communication and presentation skills	CSIR-HRDC, Ghaziabad	May 23-25, 2012
Dr. Anil Kumar Singh	Training programme on creativity and out-of-box thinking	CSIR-HRDC, Ghaziabad	June 11-13, 2012
Dr. Anil Sood, Dr. RD Singh, Dr. Virendra Singh, Dr. RK Sud, Dr. Markenday Singh and Dr. VK Agnihotri	Proposed projects for rural development programme of CSIR-IHBT under CSIR 800	Brainstorm meeting on rural development programme with Dr. Ehrlich Desa, CSIR-IHBT, Palampur	June 15, 2012

Name	Training/Workshop/ Conference/Meeting	Organiser & Venue	Period
Dr. Mahesh Gupta	Participated in Annual Tribal Fair 2012	Keylong (Lahaul & Spiti)	August 14-16, 2012
Ms. Meenakshi	Training on introduction to ArcGIS Desktop 10	ESRI India (NIIT GIS) Ltd., New Delhi	August 27-31, 2012
Dr. Mahesh Gupta	Product/technology demonstration	Kisan Sangoshti, Tandi, Keylong (Lahaul & Spiti)	September 25, 2012
Dr. Som Dutt	Workshop on Launch of NInC-CSIR Cluster Innovation Scale-Up Programme	CSIR-HRDC, Ghaziabad	September 26-28, 2012
Dr. RK Sud and Dr.VK Agnihotri	Workshop: societal interventions: empowering people	CSIR-Institute of Genomics and Integrative Biology, New Delhi	September 27, 2012
Dr. Mahesh Gupta	International workshop on sustainable agriculture in cold dessert region of India	G.B Pant Institute of Himalayan Environment and Development and Jawaharlal Nehru University, New Delhi held at Mohal-Kullu (HP)	October 18-19, 2012
Dr. PS Ahuja, Dr. Anil Sood, Dr. RD Singh, Dr.Virendra Singh and Dr. RK Sud	Video conferencing on formulation of TECHVIL project with Dr. Ehrlich Desa	C-MMACS, Bangalore	November 7, 2012
Dr. RK Sud	CSIR-IHBT technologies suitable for Gopalpur and adjoining villages in the proposed TECHVIL area	Meeting of Pradhans of the proposed Gopalpur- Chachian, CSIR-IHBT, Palampur	November 8, 2012
Dr. Rakesh Kumar Dr. Shashi Bhushan and Dr. Mahesh Gupta	Participated in a committee meeting of coordinated programme for cold desert regions (CODER), of DST, GOI, New Delhi	CSKHPKV, Palampur	November 19, 2012
Dr. Som Dutt	Attended the Training programme on Integrated Scientific Project Management	Centre for Organizational Development, Hyderabad, sponsored by DST	November 19-23, 2012
Mr.Vikrant Gautam and Mr. Jasbeer Singh	ERP implementation- cum-training workshop	CSIR-SERC, Chennai	November 29-30, 2012
Ms. Kiran Rawat	Flow Cytometry	NCBS, Banglore	December 4 -7, 2012
Dr. RD Singh	Project execution committee meeting to review the project on cultivation, value addition and marketing of medicinal and aromatic plants for rural upliftment in Himachal Pradesh	Himachal Pradesh Department of Environment, Science & Technology, Shimla	December 5, 2012
Dr. Anil Sood, Dr. RD Singh, Dr.Virendra Singh, Dr. RK Sud and Dr. MK Singh	Video conferencing on issues of TECHVIL project with Dr. Ehrlich Desa	C-MMACS, Bangalore	December 14, 2012
Dr.Yogendra Padwad and Dr.Vikram Patial	Training course for study directors of GLP Test Facilities	NGCMA, DST, New Delhi	December 17-19, 2012

Name	Training/Workshop/ Conference/Meeting	Organiser & Venue	Period
Dr. A Acharya	3rd International cancer research conference	Jointly organized by University of Calcutta, University of Kansas Medical Center, USA, University of Colorado, USA, University of Oklahoma, USA and University of Pittsburgh, USA at Kolkata	December 18-21, 2012
Dr. Ashu Gulati	Three days training programme on S & T Communication and Presentation Skills	CSIR-HRDC, Ghaziabad	November 29 - December 1, 2012
Dr. Sanatsujat Singh	Participated in the first meeting of the task force for finalizing distinctiveness, uniformity and stability test guidelines for tea	Organized by Protection of Plant Varieties & Farmers' Rights Authority, Govt. of India, New Delhi	January 23, 2013
Er. Amit Kumar	DST sponsored national workshop on hyperspectral remote sensing and application	MS University of Baroda,Vadodara, Gujarat	January 17-18, 2013
Er. Amit Kumar	Training on hyper spectral applications in agriculture	Sponsored by Department of Science & Technology, GoI at Indian Agricultural Research Institute, New Delhi	February 18-27, 2013
Sh. Dharmesh Kumar and Ms. Kiran Rawat	Image Flow Cytometry	Imperial Life Sciences, Gurgaon	March 01, 2013
Dr. RK Sud	Innovation and Entrepreneurship in Higher Education Institutes, MHRD-IPR Chair	Indian Institute of Technology, Roorkee	March 2-3, 2013
Dr. RK Sud	Short Term Course on Promotion of Innovation in Higher Educational Institutions	Indian Institute of Technology, Roorkee	March 1-5, 2013
Dr. Mahesh Gupta	AAHAR 2013, International Food Fair	Pragati Maidan, New Delhi	March 14-18, 2013
Dr. Madhu Sharma	Attended and participated in programme on work life balance for women scientists and officers	CSIR-HRDG, Ghaziabad	March 20-22, 2013
Dr. Anil Sood, Dr. Arvind Gulati and Dr. RK Sud	Market promotion schemes of Tea Board	Tea Board of India, Regional Office, Palampur	March 22, 2013
Dr. RD Singh	Workshop on Biodiversity in HP: the way forward	State Biodiversity Board, Shimla	March 22-23, 2013
Dr. RD Singh	To review utilization of funds and to assess the impact of the financial support provided under Star College Programme of Department of Biotechnology, Government of India, New Delhi.	Government Post Graduate College, Dharamshala, Himachal Pradesh	March 28, 2013

PARTICIPATION IN EXHIBITIONS

Dr. Markandey Singh: "AGROVISION 2013" exhibition at Nagpur, Maharashtra, January 24-27, 2013.

Sh. Sanjay Kumar and **Sh.Arvind Kumar:** Exhibited CSIR-IHBT technologies, Kisan Mela, Jammu, organized by CSIR-IIIM, Jammu (J&K), March 17, 2013.

Sh. Sukhjinder Singh and **Sh. Sanjay Kumar:** Exhibited CSIR-IHBT technologies at State Level Holi Festival, Palampur (HP) organized by State Government from March 25- 28, 2013.

Dr. Markandey Singh: "Flower Show'at State level Holi Festival, Palampur (HP) organized by State Government on March 26, 2013

DISTINGUISHED VISITORS

Dr. RK Khandal, Director, Shriram Institute for Industrial Research, Delhi, May 11, 2011

Dr.VP Dimri, Distinguished Scientist, CSIR-NGRI, Hyderabad, May 11, 2012

Prof. Asis Datta, National Institute of Plant Genome Research, New Delhi, April 9, 2012

डॉ. ओ.सी. हांडा, पुरातत्व विशेषज्ञ, मई 14, 2012

Prof. Deepak Pental, Former Vice Chancellor, Delhi University, June 21, 2012

Prof. Samir K Brahamchari, DG CSIR, New Delhi, June 21, 2012

Dr. BK Mishra, Directror, CSIR-IMMT, Bhubaneswar, June 21, 2012

Prof. Indrapal Singh Aidhen, IIT, Chennai, July 17, 2012

Dr. K Kasturirangan, Hon'ble Member (Science), Planning Commission, Govt. of India, August 14, 2012

Prof.VL Chopra, Chancellor, Central University, Kerala, September 27, 2012

डॉ. एस.के. शर्मा, सलाहकार (आयुर्वेद), आयुष विभाग, स्वास्थ्य एवं परिवार कल्याण मंत्रालय, भारत सरकार, सितंबर 14, 2012

श्री केवल कृष्ण, वरि. तकनीकी निदेशक, राजभाषा विभाग एवं राष्ट्रीय सूचना विज्ञान केन्द्र (एनआईसी), भारत सरकार, सितंबर 17, 2012

Dr. T Ramasami, Secretary to Govt of India, Dept. of Science and Technology, October 7, 2012

Dr. Arvinder Singh, IAS, Secretary, State Information Commission, Punjab, December 18, 2012

Dr. S Natesh, Former Senior Advisor & Head, International Collaboration, Department of Biotechnology, New Delhi, February 28, 2013

GROUP VISITORS

Visitors	No. of Visitors
Students from Educational Institutes	1160
Farmers, NGOs, and Govt. Officials	1079
Total Visitors	2239

IMPORTANT EVENTS

DIRECTOR GENERAL CSIR AT CSIR-IHBT

The institute celebrated its 30th Foundation Day on June 21, 2012. Prof. Deepak Pental, Director, Centre for Genetic Manipulation of Crop Plants, Delhi (Former Vice Chancellor, University of Delhi) delivered the foundation day lecture on ***"Are model species and crop species two different worlds of scientific enquiry?"***. The function was presided over by Prof. Samir K Brahmachari, Director General, CSIR and Secretary, Department of Scientific & Industrial Research, Govt. of India. Prof. BK Mishra, Director, CSIR-IMMT, Bhubaneshwar was also present on the occsssion. Prof. Brahmachari released the annual report 2011-12 of the instiute and laid foundation stone of the Extension & Academic Block. He also inaugurated the Bamboo Museum in CSIR-IHBT.

Dr. Anil Sood, Prof. BK Mishra, Prof. SK Brahmachari, Prof. Deepak Pental and Dr. PS Ahuja (from left to right) on the event of 30th Foundation Day of CSIR-IHBT

Inauguration of the Bamboo Museum by Prof. SK Brahmachari and Prof. Deepak Pental

Prof. SK Brahmachari laid foundation stone of the Extension & Academic Block

DIRECTOR GENERAL ICAR AT CSIR-IHBT

Dr. S Ayyappan, Director General, Indian Council of Agricultural Research (ICAR) discussing with Dr. PS Ahuja, Director, CSIR-IHBT during his visit on June 9, 2012.

National Technology Day

The Institute celebrated the National Technology Day on May 11, 2012 and Dr. RK Khandal, Director, Shriram Institute for Industrial Research, Delhi delivered the key note lecture on ***"Potential of Bioresources for sustainable growth"***. The function was presided over by Dr. Vijay Prasad Dimri, distinguished scientist of Council of Scientific Industrial Research (CSIR) and former director of National Geophysical Research Institute, Hyderabad.

CSIR Foundation Day

CSIR Foundation Day celebration was organized on September 27, 2012. Prof. VL Chopra, Chancellor, Central University, Kerala and Former Member, Planning Commission, Govt. of India delivered the foundation day lecture on ***"Knowledge-based entrepreneurship for plant based enterprise"***.

Dr. RD Singh, Prof. VL Chopra and Dr. Anil Sood (from left to right)

National Science Day

The National Science Day was organized on February 28, 2013 in the institute. Dr. S Natesh, Former Senior Advisor & Head, International Collaboration, Department of Biotechnology, New Delhi delivered the Science Day lecture on "***Plants that changed India and the World***".

Dr. Anil Sood, Dr. S Natesh and Dr. PS Ahuja (from left to right)

Workshops

Workshops on molecular Diagnostics of Fungal and Viral Diseases in Apple was organized during August 7-8, 2012 by Dr. Vipin Hallan and Dr. Gopaljee Jha where ten participants from various R&D institutes in Himachal Pradesh, Uttarakhand and Jammu & Kashmir attended.

Stakeholders Workshop on National Mission for Sustaining the Himalayan Ecosystem (NMSHE) funded by the Department of Science and Technology (DST), Govt. of India was organized during October 6-7, 2012. Dr. T. Ramasami, Secretary, DST was present in the workshop. Dr. SK Uniyal was coordinator of the workshop, 125 stakeholders from various government and non-government organizations of the Indian Himalayan region participated.

Dr. CK Varshneya, Dr. SK Dash, Dr. T Ramasami, Dr. SP Singh, Dr. Ajit Tyagi and Dr. Akhilesh Gupta (from left to right)

INSPIRE

The institute organised INSPIRE Internship-2012 Science Camp from September 24-28, 2012, sponsored by the Department of Science and Technology, Govt. of India. The camp was attended by 98 students.

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- 411021

Dr. S Natesh
Former 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-110044

PERMANENT INVITEE

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

DIRECTOR

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

MEMBER SECRETARY

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

MANAGEMENT COUNCIL

Chairman

Dr. PS Ahuja
Director
CSIR-IHBT, Palampur, HP

Members

Dr. Ram A Vishvakarma
Director
CSIR-IIIM, Jammu, J&K

Dr. Aparna Maitra Pati
Principal Scientist
CSIR-IHBT, Palampur, HP

Dr. Ram Kumar Sharma
Sr. Scientist
CSIR-IHBT, Palampur, HP

Sh. RK Bindal
Principal Technical Officer
CSIR-IHBT, Palampur, HP

Dr. Arvind Gulati
Sr. Principal Scientist
CSIR-IHBT, Palampur, HP

Dr. Markandey Singh
Principal Scientist
CSIR-IHBT, Palampur, HP

Dr. Pralay Das
Scientist
CSIR-IHBT, Palampur, HP

Sh. Sunil Kumr
Finance & Accounts Officer
CSIR-IHBT, Palampur, HP

Member Secretary

Sr. Jaswant Rai
Administrative Officer
CSIR-IHBT, Palampur, HP

STAFF

Scientific

Director
Dr. PS Ahuja

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

Sr. Principal Scientist
Dr. AK Sinha
Dr. Virendra Singh
Dr. Sanjay Kumar
Dr. Madhu Sharma
Sh. D Dhyani
Er. KK Singh
Dr. Ashu Gulati

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

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

Scientist
Dr. Ramesh C Kasana
Dr. Shashi Bhushan
Dr. Gireesh Nadda
Dr. Neeraj Kumar
Dr. Pralay Das
Dr. Vijai Kant Agnihotri
Dr. Ravi Shankar
Dr. Probir Kumar Pal
Dr. Anil Kumar Singh
Dr. Amit Chawla
Dr. SGE Reddy
Dr. Bagler Ganesh B
Dr. Partha Ghosh
Dr. Mahesh Gupta
Dr. Yogendra S Padwad

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

Technical

Principal Tech. Officer
Er. RK Bindal
Dr. Raja Ram

Sr. Technical Officer (3)
Sh. Mukhtiar Singh
Sh. Om Prakash
Sh. RK Tandon

Sr. Technical Officer (2)
Dr. Kiran Kaul
Sh. RS Shekhawat
Sh. Sukhjinder Singh

Sr. Technical Officer (1)
Dr. Avnesh Kumari
Sh. Sandeep Tripathi
Sh. Vikrant Gautam
Sh. Jai Prakash Dwivedi
Dr. Kiran Singh Saini
Sh. Ramdeen Prasad
Sh. JS Bisht

Technical Officer
Sh. Rakesh Kumar
Sh. Anil Kumar
Sh. Vivesh Sood
Sh. Mahesh S
Sh. Ramjeelal Meena
Sh. Sanjay Kumar
Sh. Mohit K Swarnkar

Technical Assistant
Sh. Jasbeer Singh
Sh. Mukesh Gautam
Sh. Om Parkash
Sh. Prashanta K Behera
Ms. Vijay Lata Pathania
Sh. Pabitra Gain
Sh. Shiv Kumar
Ms. Meenakshi
Sh. Arvind Kumar Verma
Sh. Dharmesh Kumar

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

Sr. Technician(1)
Sh. Kewal Chand

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

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

Lab Assistant
Sh. Naresh Kumar
Sh. Prem Parkash

Lab Attendant Gr. I(2)
Sh. Baldev Singh
Ms. Rajni Devi Chettri
Sh. Rakesh Chand

Lab Attendant Gr. I(1)
Sh. Yam Bahadur Chettri
Sh. Uttam Chand
Sh. Balak Ram
Sh. Girja Nand
Sh. Deepak Sood
Sh. Kuldip Singh
Sh. Balwant Raj
Ms. Anupama Saini
Sh. Shamsher Singh

Administration

Finance & Accounts Officer
Sh. Sunil Kumar

Store & Purchase Officer
Sh. Surender Kumar

Section Officer (F&A)
Sh. Inderjit Singh

Senior Hindi Translator
Sh. Sanjay Kumar

Senior Stenographer
Sh. Didar Singh Patial

Assistant (GEN) Gr. I
Sh. Shanti Kumar
Sh. Raj Kumar
Sh. Lakshmi N Pandey

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

Assistant (GEN) Gr. III
Ms. Pooja Awasthi

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

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

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

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

Security Assistant
Sh. Trilok Nath

Coupon Clerk
Sh. Anand Sharma

Staff Car Driver
Sh. Pratap Chand
Sh. Braham Dass

Cook
Sh. Oman Singh
Sh. Karan Singh

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

Tea/Coffee Maker
Sh. Bipan Gurang

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

Newly Joined

Sh. JK Prashar, Administrative Officer, on promotion from the post of P.S. DOJ: 06-03-2013
Sh. SD Rishi, Section Officer (G), on transfer from CSIR-IMT, Chandigarh, DOJ: 03.04.2012
Sh. Anil K Choudhary, Tech. Asstt., on transfer from CSIR-IMT, Chandigarh, DOJ: 16.04.2012

Superannuation

Dr. HP Singh, Sr. Principal Scientist, on 30.11.2012
Dr. RK Ogra, Sr. Tech. Officer (3), on 30.04.2012
Sh. DR Mishra, Assistant (G) Gr.I (MACPs), on 30.11.2012

Resigned

Dr. CS Seth (21-09-2012)
Dr. Gopaljee Jha(31-01-2013)

Transferred to other CSIR Labs :

Sh. Jaswant Rai, Administrative Officer, CSIR-IMT, Chandigarh on 08-03-2013
Sh. Sanjoy Kumar Chanda, Tech. Asstt., CSIR-NEIST, Jorhat on 12-03-2013
Sh. Digvijay S Naruka, Tech. Asstt., CSIR-IMT, Chandigarh on 11-04-2012
Sh. Susheel Kumar, Technician, CSIR-CIMAP, Lucknow on 31-05-2012

PRINCIPAL INVESTIGATORS/SCIENTIST FELLOW/NAM RESEARCH FELLOW/JRFs/SRFs

Principal Investigators

Dr. Tanuja Rana
Dr. Jyoti Bhardwaj
Dr. Lakhmir Singh
Dr. Ugir Hossain SK

Scientist Fellow

Dr. Aditi Saurabh
Dr. Vishal Acharya
Dr. Vikram Patial
Dr. Amitabha Acharya

NAM Research Fellow

Mr. Longue Ekon JP

Sr. Research Fellow

Mr. Himanshu Sharma
Mr. Rahul Kumar
Ms. Archna Thakur
Ms. Richa Salwan
Ms. Ruchi Sharma
Ms. Hena Dhar
Mr. Vivek Dogra
Mr. Vineet Kumar
Ms. Karnika Thakur
Ms. Monika Mahajan
Mr. Sunil Kumar Singh
Ms. Parul Gahlan
Ms. Reenu Kumari
Mr. Dharminder Sharma
Mr. Amit Sharad
Mr. Piar Chand
Mr. Praveen Kumar
Ms. Shammi Bhatti
Mr. Rajesh Kumar
Mr. Rahul Mohan Singh
Ms. Rupali Jandrotia
Mr. Anish Kaachra
Mr. Vishal Kumar
Ms. Prachi Awasthi
Mr. Ram Dhan
Ms. Praveen Guleria
Ms. Amrina Shafi
Ms. Rimpy Diman
Mr. Arun Kumar Shil
Mr. Surender Kumar
Mr. Nitul Ranjan Guha
Mr. Yogesh A Thopate
Ms. Pritu Prathiba
Ms. Mrigaya Mehra
Ms. Sushila Sharma
Mr. AN Hauserao
Mr. Aditya Kulshrehta
Ms. Vandna Chawla
(Inspire Fellow)

Jr. Research Fellows

Mr. Jai Parkash
Mr. Sandeep Kumar
Ms. Shikha (JRF-INSPIRE)
Ms. Parul Goel
Mr. C.Balreddy
Mr. Manoranjan Kumar
Mr. AG Lavekar
Ms. Preeti
Ms. Monika Bhuria
Mr. Ajay Kumar (DBT-JRF)
Mr. Ashish Kumar
Ms. Poonam Roshan
Ms. Indu Gangwar
Ms. Shivalika Pathania,
(JRF-INSPIRE)
Mr. Surender Pal
Ms. Kiran M Rawat
Ms. Madhu Kumari
Ms. Vandna Thakur
Ms. BL Barsain
Mr. Saurabh Sharma
Mr. Vinod Bhatt
Mr. Ashish Verma

Tenure Completed

Mr. Richard Chawlo Mouki (PG Fellow)	04.11.2012
Mr. Vikas, SRF	30.04.2012
Mr. Vikrant Jaryan, SRF	30.04.2012
Ms. Bandna, SRF	30.04.2012
Ms. Abha Chaudhary,SRF	22.04.2012
Mr. Upendra Sharma, SRF	31.07.2012
Ms. Yashika Walia, SRF	10.09.2012
Mr. Sewa Singh, SRF	28.02.2013
Dr. (Mrs.) Alka Kumari, PI	02.08.2012
Mr. Arunava Datta, JRF	14.02.2013
Ms. Pushpinder Kaur, SRF	30.06.2012
Mr. Vinay Kumar, SRF	18.03.2013
Ms. Naina Sharma, SRF	13.04.2012
Ms. Swati Sood, SRF	16.07.2012
Mr. Sandeep Kumar, SRF	03.01.2013

सारांश

शोध एवं विकास गतिविधियां तथा प्रमुख उपलब्धियां

हिमालय जैवसंपदा का लक्षणचित्रण एवं प्रबन्धन

वर्ष 2012–13 के दौरान पश्चिमी हिमालय की पुष्पीय संपदा एवं पादपीय संरक्षण के प्रलेखन के उद्देश्य से प्रदेश के 13 विभिन्न क्षेत्रों के सर्वेक्षण किये गए।

हिमाचल प्रदेश के बिलासपुर जिले में भूमि उपयोग/भूमि आवरण का मानचित्रीकरण

5 फरवरी 2010 के LANDSAT TM उपग्रह चित्र के आधार पर बिलासपुर जिले में भूमि उपयोग/भूमि आवरण का वर्गीकरण किया गया। वर्गीकृत मानचित्र को 7 भागों में (पर्यावास, बंजर भूमि, जलीय भूमि, स्कर्वी, चरागाह, फसली एवं वन भूमि में विभक्त किया गया। बिलासपुर के कुल भूक्षेत्र 29.8% भाग वनों के अन्तर्गत तथा शेष स्कर्वी (23.93%), चारागाह (16.98%), कृषि के अन्तर्गत (15.78%) जलीय भूमि (9.72%) बंजर भूमि (2.86 %) तथा पर्यावास (0.8%) के रूप में है।

डिजिटल वन अग्नि मानचित्र

हिमाचल प्रदेश के धर्मशाला, नूरपूर, पालमपुर और चम्बा वन मण्डल क्षेत्रों का डिजिटल अग्नि मानचित्र सूदूर संवेदी भौगोलिक सूचना प्रणाली (RS GIS) के आधार पर तैयार किया गया। यह मानचित्र वनों में लगी आग की तीव्रता फैलाव और स्थलों की सूचना प्रदान करता है।

प्रजाति का स्थल

एरिमोस्टैकिस सुपरबा रॉयल एक्स बैंथ. (कुल *लैमिएसी*), पश्चिमी हिमालय की एक विलुप्त पौध प्रजाति है। लगभग 75 वर्षों के उपरान्त इस संस्थान ने हिमाचल प्रदेश में इस प्रजाति की पुनः खोज की है। हिमाचल प्रदेश में इस प्रजाति के लगभग 525 पौधों पाए गए।

औषधीय पौधों का व्यापार

नागछतरी हिमाल क्षेत्र का एक स्थानीय पौधा है जो छायादार क्षेत्रों में 2400 से 3800 मीटर की की उंचाई में पाकिस्तान से भुटान तक के क्षेत्रों में पाया जाता है। पिछले 2 वर्षों के दौरान इस प्रजाति के एकत्रण और अनैतिक रूप से व्यापार की खबरें आ रही हैं। इसमें ट्राइलेरिन नामक तत्व पाया जाता है जो स्टीरॉयड और हारमोन तैयार करने के उपयोग में लाया जाता है। धौलाधार वन्यजीव अभ्यारण क्षेत्र में इसको एकत्रित करने वाले 100 व्यक्तियों का पता लगाया गया है। इन लोगों से बातचीत करने पर पता चला कि यह नागछतरी ₹1000 से ₹1500 प्रति किलोग्राम के हिसाब से बिकती है तथा एक व्यक्ति प्रतिदिन 8–10 किलोग्राम ताजे कंद एकत्रित कर लेता है। पौधे के इसी कंदीय भाग का व्यापार में महत्व है।

नृवानस्पतिक ज्ञान का अध्ययन

गद्दी जनजाति के पास पौधों के उपयोग पर परम्परागत ज्ञान को साक्षात्कारों के माध्यम से प्रलेखित किया गया। इसके अन्तर्गत 45 पौधों की जानकारी को जुटाया गया। जिसमें *हिडीचियम, एयुमैक्स, अर्टिका, एसपेरागस, प्लाटांगो, जेरेनियम, फाइटोलाइका, बरबेरिस, फाइकस* और *टेरिस* मुख्य पादप प्रजातियां मुख्यतः पाई जाती हैं।

पश्चिमी हिमालय में टेरेडोफाइट के वनस्थलों का आंकड़ा संचय

पश्चिमी हिमालयी में टेरेडोफाइट के वनस्थलों का आंकड़ा संचय तथा पर्यावास एवं मात्रा जानने के लिए धौलाधार पर्वतीय क्षेत्रों में प्रक्षेत्र सर्वेक्षण किया गया। क्रिप्टोग्रामा स्टालेरी आद्र शैलीय क्षेत्रों से एकत्रित किया गया। टेरेडोफाइट के जीवित पौधों को संस्थान की फर्नरी में लगाने के लिए और पादपालय में रखने हेतु एकत्रित किया गया।

हिमाचल प्रदेश में टेरेडोफाइट के वितरण का मानचित्र

हिमाचल प्रदेश में टेरेडोफाइट के वितरण/मात्रा को जानने के लिए एस्प्लेनियम और डिपलेजियम प्रजातियों की जानकारी प्रकाशित प्रलेखों से एकत्रित की गई तथा भौगोलिक सूचना पद्धति से एक मानचित्र बनाया गया। इस मानचित्र में हिमाचल प्रदेश में *Asplenium* (*A. adiantum-nigrum*, *A. aitchisonii*, *A. alternifolium*, *A. anogrammoides*, *A. ceterach*, *A. dalhousiae*, *A. ensiforme*, *A. fontanum*, *A. indicum*, *A. kukkonenii*, *A. laciniatum*, *A. pekinense*, *A. pun-jabense*, *A. septentrionale*, *A. tenuicaule*, *A. trichomanes*, *A. trichomanes-ramosum*, *A. unilaterale* तथा *A. yunnanense)* and 5 species of *Diplazium* (*D. esculentum*, *D. giganteum*, *D. longifolium*, *D. spectabile* एवं *D. squamigerum*) की 5 प्रजातियों की उपस्थिति देखी गई।

फर्न स्पोरों का लक्षणचित्रण के उद्देश्य से संस्थान में स्पोर रेपोजेटरी स्थापित की गई। इस में 15 फर्न प्रजातियां संरक्षित किया तथा संस्थान के पर्णांगगृह में लगायी गयी। इनमें से 5 पश्चिमी हिमालय क्षेत्र की हैं तथा शेष दक्षिण भारत से हैं।

पादपालय का समृद्धिकरण

पादपालय पौधों के नमूनों को विधि और पद्धतियुक्त संग्रह होता है जो कि संदर्भ एवं शोध के लिए उपयोग में लाए जाते है। लगभग 700 नमूनों (250 टेरेडाफाइट और 450 एन्जियोस्पर्म) को हिमाचल प्रदेश के विभिन्न भागों से एकत्रित किया गया। इनमें से 33 प्रजातियां संस्थान के पादपालय PLP में नई शामिल की गईं हैं।

उच्च तुंगता जीवविज्ञान और जलवायु परिवर्तन

उच्च तुंगता कठोर जलवायु युक्त क्षेत्रों में *केरागाना जुबाटा* उत्तरजीविता के लिए आण्विक उपाय

हिमाचल प्रदेश के लाहौल व स्पीति जिले के शुष्क मरुस्थल स्पीति घाटी के कठोर और प्रतिकूल पर्यावरण को उच्च विकिरण, तापमान और जल की अत्याधिक कमी की दृष्टि से लक्षणचित्रित किया गया। इस क्षेत्र की चिरस्थायी झाड़ी *केरागाना जुबाटा* की उत्तरजीविता को जानने के लिए आण्विक स्तर पर अध्ययन किया गया और जीन की प्रभुता पाई गई।

भारतीय ट्रांस-हिमालय से सूक्ष्मजीवों का विलगन और पहचान

भारतीय ट्रांस –हिमालय स्थित झीलों एवं हिमनदियों से सूक्ष्मजीवों का विश्लेषण विविधता एवं पहचान का कार्य शुरु किया गया है। कुल मिलाकर 1530 बैक्टीरिया, 66 एक्टिनोमाइसिटी एवं 150 फफूंद निकाले गए। 16 sRNA जीन सिक्वेंसिंग के आधार पर बैकटीरिया एवं एक्टीनोमाइसिटी ने अलग–अलग बैक्टीरिया एवं एक्टिनोमाइसिटी के साथ संबन्धता दिखाई। ITS रिजन सिक्वेंसिंग के आधार पर फफूंदों ने एसपरजिलस, कैडोफोरा, कोनियाथीरियम, कीटोमिमम, फ्यूजेरियम, जीयोमाइसीज, पेनिसिलियम एवं जाइलेरिया के साथ संबन्धता दिखाई।

भारतीय ट्रांस-हिमालय से सूक्ष्मजीवों का सूक्ष्मजीव प्रतिरोधी गतिविधि के लिए चयन

कुल मिलाकर 630 सूक्ष्मजीवों में से 82 सूक्ष्मजीवों ने एक या एक से अधिक जीवों के विपरीत सूक्ष्मजीव प्रतिरोधी गतिविधि दिखाई। 30 सूक्ष्मजीवों ने *बैसिलस सबटिलिस* MTCS121 के विपरीत, 18 ने *ई.कोलाई* MTCC 739 के विपरीत, 62 ने *माइक्रोकोकर ल्यूटिसा* MTCC2470 के विपरीत 5 ने *सूडोमोनास* MTCC2453 के विपरीत 42 ने *स्टैफाइलोकोकस ऑरियस* MTCC96 के के विपरीत एवं 11 ने *स्टैफाइलोकोकस ऑरियस* ATCC 43300 के विपरीत गतिविधि दिखाई।

सूक्ष्मजीव एंडोफाइट्स की जैवप्रत्याशा

कुल मिलाकर 55 एन्डोफाइट्स जिनमें 29 वैकटीरिया 5 एक्टिनोमाइसिटी एवं 21 फफूंद चाय की जड़ों से विलगित और लक्षणचित्रित किए गए। 16 sRNA जीन सिक्वेंसिंग के आधार पर बैक्टीरिया एवं एक्टिनोमाइसिटी ने *बैसिलस*,

बैबत्रवीवैसिलस, लाइसनीबैसिलस, पैंन्टिया, डाईला, स्ट्रैप्टोमाइसीज, रोडोकोकस, टैराकोकस एवं *नीकारडिया* से संबन्धता दर्शाई। ITS रीजन सिक्वेंसिंग के अधार पर फफूंदों ने *फ्यूजेरियम, एसपरजिलस, अल्टरनेरिया, जाइलेरिया, थानाटिफोरम, यूरोटियम, पेरिसिलियम, कैडोफोरा* एवं *सोरडेरियोमाइसिट* से संबधता दिखाई।

ट्रईफोलियम रिपेन्स vkj *रयूमेक्स नेपालेसिंस* dh of) vkj ck;kekl mRiknu dh fy, mPp CO_2 vkj rkieku dk iHkko

इसके प्रभावों को जानने और भविष्य की फसल उत्पादन के लिए वर्तमान वैश्विक जलवायु परिवर्तन को समझना आवश्यक हो गया है।

पादप विविधता

अनुकूलन जीवविज्ञान अध्ययन और उपयोगी जैवसक्रियों के लिए औषधीय रूप में महत्वपूर्ण पौधों को समझना तथा दोहन करना

पिन घाटी राष्ट्रीय उद्यान और लाहौल के रिबलिंग चोटी पर दो स्थायी अन्वेक्षण प्रक्षेत्र विकसित किए गए हैं। कुछ चुनी हुई प्रजातियों के घनत्व और विविधता का अध्ययन किया गया है। इस भूमि की उपरी सतह के रसायनिक विशेषताओं का की मूल्यांकन किया गया

जर्मप्लाजम संसाधन केन्द्र की स्थापना

देश के विभिन्न भागों से लक्षणचित्रित जर्मप्लाजम को तैयार करने के जिए लाहौल व स्पीति जिले के तांदी पंचायत में 2 हे. क्षेत्र में *हिफोपी* की राष्ट्रीय स्तर की रिपोजिटरी स्थापित की गई। जर्मप्लाजम संसाधनों के सतत उपयोग के लिए अकारकीय और रसायनिक लक्षणचित्रण युक्त एक विवरणयुक्त डेटाबेस को विकासित किया गया।

पर्यावरण का उपचार

भू–जल से भारी धातुओं को खत्म करना

भू–जल में भारी धातु प्रदूषण विकासशील देशों में चिन्ता का विषय है। सेब का भुक्तशेष एक व्यर्थ पदार्थ है जिससे स्वरस निकालने के बाद त्याग दिया जाता है। इस अध्ययन से यह निष्कर्ष निकला है कि सेब के भुक्तशेष को अवशोषक के रूप में उपयोग में लाकर भू जल में धातुओं के प्रदूषण से बचा जा सकता है।

चाय में सगंध और विषैली धातुओं का अध्ययन चाय की गुणवत्ता और उत्पादन में सतत विकास की प्रयोजना के आकलन में उपयोगी होती है।

एनएचपीसी की मलवायुक्त स्थलों में पुनः हरियाली

एनएचपीसी की मलवायुक्त स्थलों में पुनः हरियाली लाने के कार्य को इस वर्ष भी जारी रखा गया। कुल्लू जिले के मनीकर्ण, गड़सा और सैंज क्षेत्रों में राष्ट्रीय जलविद्युत निगम लि. की 10 मलवायुक्त स्थलों में संस्थान ने पुनः हरियाली ला दी है। तीखी ढाल युक्त इन स्थलों में लोहे की जाली में पत्थर भरक मेड़ लगाई गई ताकि मिट्टी के कटाव को रोका जा सके तथा पौधारोपण किया जा सके। संस्थान ने वहां की जलवायु परिस्थितियों को देखते हुए 11 वृक्ष प्रजातियो, झाड़ियो एवं शाकीय प्रजातियों को लगाया जिसमें से *Aesculus indica*, *Ailanthus excelsa, Alnus nepalensis, Pinus wallichiana, Cedrus deodara, Populus nigra, Robinia pseudoacacia, Salix tetrasperma, Punica granatum*- pomegranate, *Quercus leucotrichophora* व बांस प्रमुख हैं। इन वृक्ष प्रजातियों को बसन्त ऋतु (मार्च–अप्रैल) और बरसात (जुलाई–अगस्त) में लगाया गया। 14370 पौधों को सभी 10 स्थलों में लगाया गया। झाड़ी की एक प्रजाति *Berberis lycium* के बीज शाकीय प्रजाति *Rumex hastatus, R. nepalensis, Tagetes minuta, Trifolium alexandrinum*, व *Plantago ovate* को भी प्राकृतिक रूप से लगाया गया।

ftukfeDl ,oa ikfV;kfeDl

आलू के जीनोम में एनएसी ट्रांसक्रिप्शन फैक्टर परिवार की अभिव्यक्ति रूपरेखा

एनएसी (एनएएमए ATAF1/2 और CUC2 प्रोटीन्स जैविक और अजैविक स्ट्रेस प्रतिक्रिया और हार्मोन संकेतन में महत्वपूर्ण भूमिका निभाते हैं. हमने आलू जीनोम डाटा में 136 एनएसी प्रोटीन को बनाने बाले 110 StNAC जीन की पहचान की। उनके *अरेबिडोप्सिस* और चावल समकक्षों के StNACs की वंशावली विश्लेषण से 18 उपसमूहों में इन प्रोटीनों विभाजित किया गया StNAC072 और StNAC101 सहित StNAC जीनए निर्जलीकरणए के लिए उत्तरदायी पाए गए. यह शोध आलू के StNAC जीन के सुधार में उपयोग के लिए ब्लू प्रिंट उपलब्ध कराएगा।

फफूंद प्रतिरोधी ट्रांसजेनिक आलू का विकास और मूल्यांकन

चाय के पोधे के thaumatin की तरह प्रोटीन (CsTLP) के जीन को ओवर एक्सप्रेस कर के ट्रांसजेनिक आलू के पौधों को विकसित किया गया है. ट्रांसजेनिक आलू की फफूंद प्रतिरोध क्षमता फफूंद रोगजनकों, *Macrophomina phaseolina* और *Phytophthora infestans* के प्रति अधिक पाई गयी.

अकाल के तनाव की प्रतिक्रिया मे कुल्थी के प्रतिलिपि संग्रह व स्मॉल का मूल्यांकन/विश्लेषण (सी.एस. आई.आर.–वाई.एस.ए. परियोजना)

कुल्थी एक फलीदार पौधा है जो कि विकासशील देशों के शाकाहारी आहार मे प्रोटीन का एक महत्वपूर्ण स्त्रोत है। यह एक अकाल सहिष्णु फसल है। इसे ध्यान रखते हुए इस परियोजना का उद्देश्य अकाल के तनाव मे प्रभावी प्रतिलिपियों, स्मॉल आर.एन.ए. मेथलीकरण की पहचान व वर्णन करना है। डी.एन.ए. मेथलीकरण एक पुराअनुवांशिकी रूपांतरण है जो पौधो में पित्रैक व्यक्तिकरण को प्रभावित करता है। कुल्थी (मैक्रोटाइलोमा यूनिफ्लोरम (वैम) वर्दिक) के दो प्राकृतिक वंशवर्गों एच पी के सी–2 (अकाल–संवेदनशील) व एच पी के–4 (अकाल सहिष्णु) में सी.पी.जी. मेथलीकरण की विभिन्नता का अध्ययन किया गया है। दोनों ही वंशवर्गों में सी.पी.जी. मेथलीकरण के स्वरूप का अध्ययन एम.एस. ए.पी. तकनीक द्वारा किया गया है नतीजों से यह ज्ञात होता है कि एच.पी.के.सी.–2(10.1) में एच.पी.के.–4(8.6) की तुलना में अधिक मेथलीकरण है। क्रमिक अनुरूपता यह दर्शाती है कि डी.आर.ई. जिल्द कारक (सी.बी.एफ.–1), पी ओ जेड/बी टी बी प्रोटीन तथा टी वाई–1 कोपिया रेट्रोट्रांसपोजॉन कुल्थी के डी.एन.ए. मेथलीकरण के व्यवहार परिवर्तन के लिये जिम्मेदार है। दोनों वंशवर्गों में डी.एन.ए. मेथलीकरण के स्वरूप की विभिन्नता इनके अकाल–तनाव के प्रति व्यवहार को दर्शाती है।

कुल्थी का जैवरासायनिक व प्रोटियोनिक मूल्यांकन (विज्ञान एवं तकनीकी विभाग, भारत सरकार द्वारा वित्तपोषित)

इसी परियोजना में पहले किये गये कार्य की निरंतरता में मानकीकृत मूललिपि (फिनॉल प्रणाली) द्वारा कुल्थी व अन्य फलीदार एवं फलीरहित पौधों का प्रोटीन निष्कर्षण किया गया व निष्कर्षण प्रोटीन से विभिन्न नमूनों की गुणवत्ता व मात्रा का आंकलन किया गया। यह देखा गया कि चुनी गयी प्रणाली अच्छी प्रकार से प्रोटीन निष्कर्षण में सक्षम है।

मानकीकृत मूललिपि को कुल्थी के अंतिम प्रोटियोमिक परीक्षण से पहले, चार विभिन्न यौगिकों (कैल्शियम क्लोराइड, मेगनीज क्लोराइड, मेगनीशियम क्लोराइड व सोडियम क्लोराइड) को कुल्थी के बीजों से प्रचुर प्रोटीन के निष्कर्षण हेतु प्रयोग किया गया। यह तुल्नात्मक अध्धयन यह दर्शाता है कि मेगनीज क्लोराइड कुल्थी के बीजों से प्रचुर प्रोटीन के निष्कर्षण में सार्वधिक सक्षम है।

प्रचुर प्रोटीन का निष्क्रषीकरण लवण तनाव के अन्तर्गत प्रभावी कम/अपर्याप्त प्रोटीन की पहचान मे सहायक होगें। इन प्रोटीन का लक्षण–वर्णन माल्डी–टॉफ तकनीक द्वारा किया जाएगा।

सी.एस.ए.एन.आर. द्वारा बढाये गये फ्लेवन–3–औल्स की पराउत्पतिमूलक तम्बाकू में अति–अभिव्यक्ति

ऐन्थोसाइनिन्स तथा फ्लेवन–3–औल्स पौधों में विस्तृत रूप मे वितरित रहते है। इनका संश्लेशण एक ही जैविक संश्लेशित पथ द्वारा होता है। ए.एन.आर. इस पथ का शाखा बिन्दु है। यह किण्वक एन्थोसाइनिडिन्स को फ्लेवन–3–औल्स में परिवर्तित करता है। ज्ञात है कि चाय में फ्लेवनॉइडस अधिक मात्रा मे पाये जाते है। अतः एन्थोसाइनिसं तथा

फ्लेवन–3–औल्स के प्रभाव को देखने के लिए चाय के सी.एस.एन.आर. की संयोजक डी.एन.ए. को पराउतपतिमूलक तम्बाकू पौधे में अतिअभिव्यक्त किया गया व पराउत्पतिमूलक तम्बाकू को अनुवांशिकी पी.सी.आर. एवं परापित्रैक की अभिव्यक्ति को अर्ध–परिमाणात्मक पी.सी.आर. के परीक्षण द्वारा प्रमाणित किया गया। रोचक रूप से पराउत्पतिमूलक तम्बाकू के हल्के गुलाबी/सफेद रंग के फूल जंगली तम्बाकू के गहरे रंग के फूलों की तुलना में एन्थोसाइनिन की मात्रा के घटने को दर्शाते है। मापने पर इसे कम पाया गया। जबकि परउत्पत्तिमूलक तम्बाकू की पत्तियों में फ्लेवन–3–औल्स की बढ़त पायी गयी। सी.एस.ए.एन.आर. अतिअभिव्यक्त पराउपतिमूलक तम्बाकू तथा जंगली तम्बाकू के विभिन्न पुश्प भागों (बाह्य दल, पंखुड़ी, पुंकेसर, अण्डप) मे भी अन्य फ्लेवनॉइड जैवसंश्लेशित पौधों के पित्रैकों की अभिव्यक्ति का परिक्षण किया गया। जंगली तम्बाकू की तुलना में सी.एस.ए.एन.आर. पराउत्पतिमूलक तम्बाकू के सभी पुष्प भागों में पी.ए.एल. तथा कैलकोन आइसोमरेज पित्रैकों का प्रतिलिपि स्तर निम्न–नियंत्रित था जबकि कैलकोन सिन्थेज, फ्लेवानोन–3–हाइड्रोक्सीलेज, फ्लोवोनोल सिन्थेज, एन्थोसाइनिन रिडक्टेज–1 व एन्थोसाइनिन रिडक्टेज–2 के पित्रैकों का प्रतिलिपि स्तर उच्च–नियंत्रित था। फूल के विभिन्न भागों में डी.एफ.आर. तथा ए.एन.एस. पित्रैकों का व्यक्तिकरण भी सी.एस.एन.आर. के अति–अभिव्यक्त होने के कारण अपरिवर्तित था। अतः तम्बाकू के फूलों में सी.एस. ए.एन.आर. का अति–अभिव्यक्तिकरण विभिन्न फ्लेवनॉइड जैवसंश्लेशण मार्ग के पित्रैकों के व्यक्तिकरण को ठीक करके उनके फ्लेवन–3–औल्स की मात्रा को बढ़ाता है। व एन्थोसाइनिन को हटाता है। यह बदलाव सम्भवतः सी.एस.ए.एन. आर. पराउत्पत्तिमूलक तम्बाकू में परागण से पहले ही परागकोश में होते हुए भी परागों में परागनली की उपस्थिति के लिए उतरदायी है।

ऑक्सीकरणरोधी के सन्दर्भ में फ्लेवोनोल सिन्थेज साइलेन्सड तम्बाकू का लक्षण-वर्णन

फ्लेवन–3–औल्स (कैटेकिन व एपीकैटेकिन) अजैविक रूप में प्रत्यक्ष मुक्त कणों के संमार्जक के रूप मे जाना जाता है। परन्तु जैविक रूप मे ऑक्सीकरणरोधी किण्वकों के साथ इनकी ऑक्सीकरणरोधी क्षमता का अध्ययन नही हुआ है। तम्बाकू फ्लेवन–3–औल्स के उत्पादन मे सम्मिलित मैटाबोलाइट को निर्देशित करने के लिये फ्लेवोनोल सिन्थेज को कोडित करने वाले पित्रैक को मौन करके फ्लेवनॉइड मार्ग का अभियंत्रण किया गया है। एफ.एल.एस. को शांत करने के पश्चात फ्लेवोनॉल की मात्रा में 17–53 प्रतिशत की कमी पायी गयी जबकि कैटेकिन व एपीकैटेकिन की मात्रा में क्रमशः 51–93 प्रतिशत व 18–27 प्रतिशत की बढ़ोतरी हुई। एफ.एल.एस. मौन श्रेणियों में फ्लेवन–3–औल्स के संचयन का प्रतिलिपि स्तर व आक्सीकरण रोधी किण्वकों के क्रिया स्तर का अध्ययन किया गया, एफ.एल.एस. मौन तम्बाकू में आक्सीकरण रोधी किण्वकों जी.आर., ए.पी.एक्स. कैट का प्रतिलिपि स्तर बढ़ा हुआ था जबकि जी.एस.टी. का स्तर कम था। एफ.एल.एस. मौन तम्बाकू में आक्सीकरण रोधी किण्वकों की अधिक सक्रियता देखी गयी। इसकी पुश्टि के लिए एक प्रयोग किया गया जिसमें तम्बाकू के अंकुरों को कैटेकिन की विभिन्न सान्द्रताओं में रखा गया। कैटेकिन में अनावृत के अंकुरों के आक्सीकरण रोधी किण्वकों के प्रतिलिपियों में वैसी ही प्रवृति देखी गयी जैसी एफ.एल.एस. मौन तम्बाकू के अंकुरों मे देखी गई थी। परिणामों से यह ज्ञात होता है कि संभवतः फ्लेवन–3–औल्स जी.आर., ए.पी. एक्स., कैट के संवाहक आर.एन.ए. स्तर को उन्नत करके उनकी क्रियात्मकता को बढा रहा है। इसलिये यह उपाय कैटकिन की उत्पादकता बढ़ाने के लिए फसलों के जीवन के साथ ही उन्हें जीर्णकारी तनाव के विरूद्ध सहिष्णु बनाने मे सहायक होगा।

तम्बाकू में लवण-तनाव के समय फ्लेवनॉइड जैवसंश्लेषण व ऑक्सीकरणरोधी तन्त्रों के पुराअनुवांशिकी नियंत्रण में अराबिडॉपसिस के रॉस-1 पित्रैक के प्रभाव का मूल्यांकन

यह जानने के लिए कि लवण–तनाव के समय फ्लेवनाइड व ऑक्सीकरणरोधी तन्त्र पुराअनुवांशिकी नियंत्रण में है या नही अरैबिडॉपसिस के रॉस–1 पित्रैक को अतिअभिव्यक्त करने वाले तम्बाकू के पौधे को विकसित किया जाएगा। इाके लिए अरैबिडॉपसिस से रॉस–1 के संयोजक डी.एन.ए. को पृथक कर उसे पी.ई.जी.ए.डी. सदिश में प्रतिरूपित किया गया है। इस पुनर्संयोजक पी.ई.जी.ए.डी–रॉस–एक सदिश को एग्रोबैक्टीरिया मध्यस्थ रूपांतरण द्वारा पराउत्पति मूलक तम्बाकू उत्पन्न करने के लिये प्रयुक्त किया जाता है।

पौधों में प्रोटीन्स की संख्या दोगुनी करने हेतु एक्सप्लोरेटरी अध्ययन

पौधों में प्रोटीन्स की संख्या दोगुनी करने हेतु एक्सप्लोरेटरी अध्ययन : प्रोटीन बनने की प्रक्रिया ATG कोडोन से ही क्यों षुरु होती है। इस जिज्ञासा के अधार पर इस परियोजना के अन्तर्गत ATG कोडोन के अतिरिक्त अन्य किसी कोडोन से प्रोटीन बनाने की प्रारम्भिक प्रक्रिया की संभावना का अध्ययन किया गया।

अन्धेरी परिस्थितियों में पौधों की बचाव, विकास और बहुगुणन हेतु अन्वेषण

इस परियोजना के अन्तर्गत पौधों की प्रकाश पर निर्भरता के विकल्प का अध्ययन किया गया। इसके अन्तर्गत NADPH रसायन द्वारा पौधों के विकास पर सकारात्मक असर पाया गया।

dEI;wVs'kuy thofoKku ,oa lpuk thofoKku

वेंचुरिया इनेइक्यूलिस का संयोजन कंप्यूटेशनल और विश्लेषण की श्रृंखला के बाद किया गया। जीनोमिक सिक्वेंसिस और NSG से miRNA की पहचान करने के लिए सबसे स्टीक सॉफ्टवेयर विकसित किया गया।

ukuk rduhd

क्वेरसेटिन के संतुलित व अनवरत निर्गमन हेतु पौधों के तत्वों द्वारा संश्लेषित पी.एल.ए. नैनो कण-एक हरित प्रस्ताव

धातु नैनों कणों का हरित संश्लेशण पौध–तत्वों द्वारा संचारित होता है। जिनमें स्थिरक/पायस के गुण होते है। यह ऐसा प्रथम अध्ययन है जिसमे पौध–तत्वों को सड़नशील पी.एल.ए. नैनो कणों के उत्पादन में प्रयोग किया गया है। पारम्परिक पद्धतियां जो कि विषाक्त पदार्थों के प्रयोग से सम्पन्न होती है। परन्तु वर्तमान अध्ययन पौध–तत्वों के प्रयास पी.एल.ए. नैनो कणों के निर्माण पर आधारित है। वर्तमान पद्धति से तैयार नैनो कण क्वेरसेटिन के संतुलित निर्गमन मे सहायक है। इनके निर्माण के लिये मुख्यतः पत्ती के तत्वों का प्रयोग किया गया है। पौध तत्वों के मध्यस्थ संश्लेशण पर आधारित इस प्रस्ताव ने प्रावरित दवाईयों/छोटे अणुओं तथा अन्य जैवक्रियात्मक घटकों के सुरक्षित जैववितरण के मार्ग को सहज बना दिया गया है। यह दवाईयों का उपचार क्षमता बढ़ाने में सहायक होंगे। साथ ही अन्य पौधों के अन्वेषण में भी सहायक होंगे।

ikdfrd ikni jklk;fudh

शतावर *(ऐस्पेरेगस रेसिमोसस)*

आयुर्वेद में शतावर को वायुविकास, अल्सर, स्नायु संबन्धी विकार, प्रदाहक, यकृत रोग, अपच, दुग्धस्रावी के उपचार के रूप में किया जाता है। शतावर की जड़ से नये स्टीरायडल सपोनिनस सटावरोसाइड–सी और डाइफिनाइल पेंटाडाइऑल का शुद्धिकरण किया गया। साथ ही पांच ज्ञात यौगिकों का भी शुद्धिकरण किया गया।

गुडुचि *(टिनोस्पोरा कॉर्डिफोलिया)*

यह पौधा अपने प्रतिरक्षा गतिविधि के लिए जाना जाता है। वर्तमान अध्ययन में पालीमॉर्फोन्यूक्लियर ल्यूकोसाइट फंक्सन टेस्ट का प्रयोग करके प्रतिरक्षा गतिविधि के लिए विभिन्न पॉलीसैकेराइड से समृद्ध अंश का निर्माण एवं मूल्यांकन किया गया। जी.सी.एम.एस. द्वारा ज्ञात हुआ कि सक्रिय पॉलीसैकेराइड अंश में ग्लूकोज प्रक्टोज एवं ऐरेबिनोज थे।

पिंक रेन लिली *(जैफिरेन्थीस ग्रैंडिफ्लोरा)*

इस समूह की प्रजातियां ट्यूमर, मधुमेह और विभिन्न थेरेपियोटिक प्रभावों के प्रयुक्त होते हैं। इस वंश के सक्रिय यौगिक एमेराइलिड्सी एल्केलाइड विभिन्न औषधीय गतिविधियों के लिए जिम्मेदार है। *जैफिरेन्थीथ ग्रैंडीफ्लोरा* में बायोएक्टिव एमेराइरीडेसी एक्लेलॉयडस (राइकोरेमीन हेमाइन, हेमानथमीन और टोरटोसीन) के निर्धारण हेतु सरल और विश्वसनीय यूपीएलसी विधि विकसित की गई है।

स्कीमिया *(स्कीमिया लोरिओला)*

स्कीमिया लोरिओला के जल वाष्पीकरण द्वारा निष्कर्षित तेल का विश्लेषण जीसी–एमएस तकनीक से किया गया। इस प्रकार 20 घटकों की उपस्थिति का पता चला जो कुल तेल का 94.6% था।

पिक्रोराइजा *(पिक्रोराइजा कुरूआ)*

इस पौधे के हवाई भाग के एन.–ब्यूटेनॉल रसों से दो यौगिक निकाले गये। इनकी पहचान ल्यूटियोलिन–5 ओ ग्लूकोसाइड और पिसिइन के रूप में की गई। इसके रस, अंश एवं शुद्धिकृत यौगिकों में प्रतिऑक्सीकारक गतिविधि के गुण पाए गए। पिक्रोराइजा कुरुआ की 56 नमूनों का पिक्रोसाइड । व ।। की मात्रा के लिए एचपीएलसी द्वारा विश्लेषण किया गया जो 0.15 से 6.7% मात्रा में पाए गए।

सी-बक-थॉर्न *(हिप्पोफी रेमनाइडिस)*

इस परियोजना के अन्तर्गत हिपोफरेनॉइड के विभिन्न रसों का उनके रेडियो सुरक्षात्मक प्रभाव के लिए जांच की गई। एक रस में सर्वाधिक प्रभाव पाया गया।

यूकेलिप्टस *(यूकेलिप्टस योमानी)*

यूकेलिप्टस की पत्तियों से प्रयोगशाला पैमाने में जल आधारित प्रक्रिया द्वारा रूटीन शुद्धिकरण प्रक्रिया विकसित की गई।

इंडियन हॉर्स चेस्टनट *(एसकुलस इंडिका)*

वनखोड़ से बीटा–एसिन के शुद्धिकरण के लिए प्रयोगशाला पैमाने पर तरल–तरल निष्कर्षण इकाई प्रयोग की गई।

दमस्क गुलाब *(रोजा डेमेसिना)*

दमस्क गुलाब के ताजे फूलों (10580.7 कि.ग्रा.) का वृहद स्तर पर आसवन कर 3.789 लीटर गुलाब तेल निकाला गया तथा 1800 लीटर गुलाब जल का उत्पादन किया गया। पश्चिमी हिमाचलय क्षेत्र के अन्तर्गत *रोजा डेमेसिना* के सगंध तेल की उपज व संघटन पर विभिन्न खाद्य के प्रभाव का अध्ययन करने के लिए एक प्रयोग किया गया जिसमें 90:80:90 किलोग्राम एनपीके प्रति है. के उपयोग से 50 प्रतिशत से अधिक फूलों की मात्रा में वृद्धि पाई गई।

कटाई की तिथि का दमस्क गुलाब के सगंध तेल की मात्रा तथा संरचना पर प्रभाव का अध्ययन करने के लिए 2012 के दौरान एक प्रयोग किया गया जिससे पता चला कि कटाई की तिथि दमस्क गुलाब के फूलों के सगंध तेल की मात्रा तथा संरचना को काफी प्रभावित करती है।

मुस्कबाला *(वेलेरियाना जटामांसी)*

वेलेरियाना जटामांसी की 3 नमूनों का वेलीपोटेरीएट मात्रा के लिए एचपीएलसी द्वारा विश्लेषण किया गया जो कि 0.5 से 2.1 प्रतिशत की सीमा में पाए गए।

चार पौधों से 50 क्रूड निष्कर्षण तैयार किए गए तथा उनका रेडियोन्यूक्लिाइड उदग्रहण के लिए मूल्यांकन किया गया एवं उनमें से केवल 4 निष्कर्षणों के अच्छे परिणाम आए।

पांच विभिन्न फर्न, *एडिएनटम इनासिसम, डिप्लेजियम मैक्जिमम, टैरीडियम इक्वीसिटम* और *डिप्लेजियम एसकुलेन्टम* का मेथेनॉल : जल (80:20) के साथ निष्कर्षण किया गया। इन निष्कर्षणों की कीटनाशक गतिविधियों के लिए जांच की गई जिसमें से डाइप्लेजियम मैक्सिमस में लारवीसाइडल गतिविधि दिखाई दी।

पेक्टिन को 3 विभिन्न विधि से अलग–अलग तापमान, पी.एच. और अम्ल द्वारा उपचार किया गया शुद्ध पेक्टिन के एल्डीटोल एसिटेट व्यूत्पन्न बनाए गए एवं उनका जीसीएमएस द्वारा विश्लेषित किया गया।

सेब खली से निष्कर्षित आहारीय रेशों के लाइफोलाइज नमूने से मेनो सेक्केराइड इकाइयों के व्युतपन्न बनाए गए जिनका जीसीएमएस द्वारा निर्धारण किया गया।

ग्लुकोसिनोलेट के हाइड्रोलिटिक उत्पाद के निष्कर्षण के लिए प्रोटोकॉल मानकीकृत करने के क्रम में *ब्रेसिका जांसिया* एवं *इरुका स्टाइवा* के विभिन्न बीज किस्मों की अलग–अलग विलायकों द्वारा निष्कर्षण किया गया, जिनमें घटकों का जीसी एमएस द्वारा विश्लेषण किया गया।

प्रकृति में उपस्थित लिमोनीन से एल्डोल संघटन व्युत्पन्न गामा–ब्यूटाईरोलेक्टोन संश्लेषण के लिए विधि विकसित की गई जिसमें प्रति ऑक्सीकरक गतिविधि पाई गई।

पीईजी 400 में जिंक थैलोसाइनिक के साथ नाइटोएरीन का अत्याधिक चयनात्मक अपचयन किया गया। जिसमें हाइड्रोजीनहाइड्रेट का उपचापक के रूप में उपयोग किया गया। कार्बनिल यौगिकों का रिडक्टिम अमाइनेशन किया गया जिसमें अमाइन अच्छी मात्रा में प्राप्त हुए, इस विधि से विभिन्न अमाइन के साथ 2–कार्वोऑक्सीबेन्जलडीहाइड का टेन्डम अमीनेशन द्वारा एहाइड्रेजीनहाइटड्रेट आइसोइण्डोलिनोन बनाए गए।

कोबाल्ट थेलोसायनीन का उत्प्रेरक की तरह प्रयोग कर एमीनेसन–एमाइडेसन द्वारा उच्च कैमोसेलेक्रिन और उत्कृष्ट मात्रा के साथ एन–प्रतिस्थापित आइसोइण्डों का संश्लेषण किया गया।

PEG-400 के साथ निकल थैलोसायनीन और हाइड्रोजन स्रोत के रूप में सोडियम बोरोहाइड्राइड का उपयोग कर कार्बनिक यौगिकों की कैमा और रीजिसोएलेक्टिव अपचयन करने के लिए कुशल पुनर्प्रयोजन एवं ग्रीन विधि विकसित की गई।

1,3–डाइमिथाइलीमिडजोलियम हाइड्रोजन कार्बोनेट का एक कुशल आर्गलोक्टैलिस्ट के रूप में उपयोग कर आर्गेनोनाइटाइल का संक्रमण युक्त धातु जलयोजन से एमाइन का मैमोसेलेक्टिव जलयोजन किया गया है।

ठोस सर्पोटड पेलेडियम उत्प्रेरक से नाइटोएरीन का कैमोसेलेक्टिव अपचयन किया गया जिसमें एमीन अच्छी मात्रा में प्राप्त हुएए लीर्गेन्ड मुक्त ठोस सर्पोटड नैनो और सूक्ष्मकणों का विजातीय उत्प्रेरक के रूप में प्रयोग कर कार्बन बिषम परमाणु बन्ध का गठन किया गया। जिसमें नाइटो–प्रतिस्थापित एराइलहैलाइड की आक्सीजन, सल्फर और नाइट्रोजन न्यूक्लियोफाइल के साथ अभिक्रिया में इसी उत्पाद की अच्छी मात्रा प्राप्त हुई।

एकल और बहुपद हैक अभिक्रियाओं को प्रदर्शित करने के लिए ठोस सर्पोटड पैलेडियम नैनो और सूक्ष्मकणों को सक्रिय किया गया।

रोडियम के ठोस नैनो व सूक्ष्म कणों का युग्मन अभिक्रिया के लिए एक लिगेंन्ड युक्त विजातीय उत्प्रेरक के रूप में विस्तृत श्रृंखला के साथ तैयार एवं लागू किया गया।

बहुलक स्थिर गोलाकार रूथीनियम नैनो कणों को तैयार एवं लक्षणचित्रित किया गया। जिसमें आणविक आक्सीजन का प्रयोग बैन्जाइलिन और एलाइलिन एल्कोहल का इसके कार्बोनिल में चयनात्मक आक्सीकरण के लिए एक विजातीय उत्प्रेरक के रूप में कार्य किया गया।

अच्छी मात्रा एवं कम समय में 3–4 डाइहाइड्रोपाइरीनिडीन का मल्टीकम्पोनेन्ट संश्लेषण के लिए अमीनो एसिड आपनिक द्रव्य का ग्रीन उत्पेरक के रूप में प्रयोग किया गया।

बहुतायात में उपलब्ध मेथॉक्सीलेटेड फिनाइल प्रोटीन से सिनेमाइल यौगिकों की श्रृंखला का संश्लेषण किया गया और 14 असरदार बैक्टीरियल और फंगल रोगजनकों के विरुद्ध ब्रोथ माइक्रोडाइल्यूसन विधि द्वारा उनकी रोगाणुरोधी गतिविधि के लिए मूल्यांकन किया गया।

स्टीविया *(स्टीविया रेबाडियाना)*

स्टीविया की उत्पादकता एवं गुणवत्ता पर निपिंग और पत्ते के निषेचन के प्रभाव को देखने के लिए एक प्रयोग किया गया। स्टीविया की शिखर कलियों की निपिंग से गुणवत्ता को प्रभावित किए बिना शाखाओं में वृद्धि हुई और अंत में सूखी पत्ती उपज में नॉन निपिंग की तुलना में 13 से 17% की वृद्धि हुई।

क्लोराफिल सामग्री सूचकांक मूल्य और कुल क्लोरोफिल सामग्री के बीच कुल क्लोरोफिल के गैर प्रभाकारी आकलन के लिए उपयुक्त गणितीय संबन्ध स्थापित करने के लिए प्रयोग शुरु किया गया जिनमें बहुपद प्रतिगमन मॉडल कुल क्लोरोफिल की गैर विनाशकारी आकलन के लिए उपयुक्त है।

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संस्थान के विनियामक अनुंसधान केन्द्र में पश्चिमी हिमालय की जैवसंपदा से उत्पादित अणुओं की पात्रे व जीवे जांच उनके कक्र रोग, मधुमेह, गुर्दे एवं जिगर से संबन्धित रोगों के लिए की जा रही है। उसी के साथ इस केन्द्र में एन अन्न घटकों, सौंदर्य प्रसाधनों तथा औषधीय उत्पादों की विष विद्या संबन्धी परीक्षणों को किया जा रहा है।

868-GFP प्रोत्साहक जाल लाइन के विश्लेषण यह ज्ञात होता है कि बारी जीन (T-DNA) की प्रविश्टि काल्पनिक जीन (AT4G10596) के 461 bP ऊपर हुई है जिसमें रिपोर्टर की अभिव्यक्ति परागकोश विशिष्ट है। *एरोबिडोप्सिस* की जंगली एवं संशोधित जिसमें T-DNA समयुग्मक अवस्था में है में At4G 10596 जीन की अभिव्यक्ति सभी उतकों में तुलनात्मक पाई गई, जबकि GFP रिपोर्टर जीन की अभिव्यक्ति परागकोश विशिष्ट में पाई गई, जिससे यह पता चलता है कि 461bP का टुकड़ा द्विदिशक प्रोत्साहक का काम करता है। अतः, जब दोहरी प्रोत्साहन की क्षमता की जांच हेतु यह टुकड़ा GUS रिपोर्टर जीन के साथ दिशात्मक तरीके से क्लोन किया गया है। दिशात्मक क्लोन के जांच से यह पता चला कि GUS रिपोर्टर जीन की अभिव्यक्ति भी परागकोष विशिष्ट है, जिससे यह प्रमाणित होता है कि 461 bP का टुकडा परागकोष विशिष्ट द्विदिशिक प्रोत्साहन का काम करने में सक्षम है। *एरोब्डिोप्सिस* की जंगली प्रजाति 461 bP के उपर किसी भी ट्रांसक्रिप्ट का न बनना यह दर्शाता है कि यह एक गुप्त प्रोत्साहक है। यह अनुसंधान प्रोत्साहक जाल तकनीक एवं ऐसे प्रोत्साहक को अलग कर बेहतर अनुसंधान करने की महता की ओर प्रकाश डालता है।

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पोडोफाइलम हैक्सैण्ड्रम

पोडोफाइलम हैक्सैण्ड्रम रायल एक लुप्तप्रायः प्रजाति है जिसे मे एप्पल के नाम से भी जाना जाता है। यह हिमालय के उच्च पर्वतीय क्षेत्रों में लदाख से सिक्किम तक 3000–4200 मीटर की ऊंचाई में पाया जाता है। इसकी जड़ें 'पोडोफाइलोटॉक्सीन' नामक लिग्निन का मुख्य स्रोत है जिसमें केंसर रोधी विशेषता होती है।

पोडोफाइलम हैक्सैण्ड्रम रायल में नवीन यूनीजीन युक्त माइक्रोसेटेलाइट चिन्हकों की खोज एवं लक्षणचित्रण

प्रभावी संरक्षण के लिए आनुवांशिक विविधता स्तर और वितरण क्षेत्र के आकलन किया किया गया। परवर्ती डाटा माइनिंग के लिए 1084 FASTA फोरमेटेड EST सिक्वेंसिस को एनसीबीआई से पुनः प्राप्त किया गया।

पोडोफिल्म हैक्सैंडम रायल (वनककड़ी) एवं *एकोनिटम हैटोफिल्म* उच्च पर्वतीय क्षेत्रों में पाए जाने वाले पौधे हैं। इन पौधों का प्रसार पारम्परिक रूप में बीजों द्वारा होता है। परन्तु बीज सुषुप्तावस्था के कारण प्रसार करना कठिन है। वर्तमान अध्ययन में इन दोनो पौधों की बीज संरचनात्मक कायिकी और जैव रासायनिक बाधाओं को बीज अंकुरण के समय प्रोटीन में परिवर्तन के माध्यम से समझाने का प्रयास किया गया है। तुलनात्मक प्रोटीन परिवर्तन विश्लेषण से पता चलता है कि बीज अंकुरण में बाधा पहुंचाने वाले भ्रूणपोष कोशिकाओं के संकलन करने वाले उपयोगी प्रोटीन जैसे कि bi-3 ग्लुकानेस, XET एक्स्पेनासिन जो कि एबासिसिक अम्ल एवं जिब्रेलिक अम्ल जैसे हार्मोन से नियंत्रित होती है, जीव अकरण में निर्णायक भूमिका निभाते हैं।

एकोनिटम हैटरोफिलम

पिछले अध्ययन को जारी रखते हुए एथनोल में उपचारित और अनउपचारित अंकुरित बीजों में तुलनात्मक विश्लेषण प्रोटीन प्रोफाइल में फेस ।। में 40 विभिन्न एक्सप्रैसड प्रोटीन को रिकार्ड किया गया।

ckxkuh Q l y

चाय एक बहुत ही महत्वपूर्ण फसल है क्योंकि इसमें पाए जाने वाले द्वितीयक उत्पाद मुख्यतः केटिकिन और इसके व्युत्पन्न औषधीय गुण रखते हैं। चाय के बहुत महत्वपूर्ण होने के साथ बहुत से जैविक और अजैविक कारक इसके उत्पादन को प्रभावित करते हैं। विभिन्न जैविक कारकों में से ब्लिस्टर ब्लाइट एक बहुत ही महत्वपूर्ण रोग है जो चाय के उत्पादन तथा गुणवता को काफी हद तक कम कर देता है। इसी प्रकार अजैविक कारकों में से अनावृष्टि एक बहुत ही महत्वपूर्ण कारक है जो चाय के उत्पादन को प्रभावित करता है। चाय के आनुवांशिकी के बारे में बहुत अधिक जानकारी न होने के कारण इसकी उत्पादकता को विभिन्न प्रकार के जैविक और अजैविक कारक प्रभावित कर रहे हैं। चाय की आनुवांशिकी, जीन समूह की संरचना तथा नई अच्छी उत्पादकता वाली किस्म को बनाने के लिए हमने ब्लिस्टर बलाइट प्रतिरोधी SA6 और ब्लिस्टर ब्लाइट संवेदनशील आशा पौधों का ट्रांसक्रिप्टोम किया। इस ट्रांसक्रिप्टोम से हमने 973 माइक्रो सेटेलाइट मारकर बनाए। इन 973 चिन्हकों को 30 विभिन्न प्रजातियों पर वेलिडेट किया। ब्लिस्टर ब्लाइट SA6 और ब्लिस्टर ब्लाइट संवेदनशील 'आशा' से उत्पादित 213 की F1 पीढ़ी पर 83 माइक्रोसेटेलाइट मारकर से इनका पृथ्थककरण प्रतिरूप देखा। इसके आधार पर हम चाय का जैनेटिक मानचित्र बनाएंगे जिससे साइटोलाजिकल और फिजिकल मानचित्र बनाने में मदद मिलेगी। इस मानचित्र से पोजिशनल क्लोंनिग का उपयोग करते हुए हम ब्लिस्टर ब्लाइट प्रतिरोधी जीन की पहचान करेंगे। भविश्य में ब्लिस्टर ब्लाईट के लिए संवेदनशील लेकिन अच्छी गुणवत्ता वाले चाय की किस्म में ब्लिस्टर ब्लाइट प्रतिरोधी जीन डालकर हम ब्लिस्टर ब्लाइट संवेदनशील पौधों की गुणवत्ता बढ़ाने की संभावना को बढ़ा सकते हैं। इस प्रकार भारत की वैश्विक अर्थव्यवस्था को बढ़ाने में सहायक होगा।

चाय पौधों के स्पेक्ट्रल व्यवहार को जानने के लिए हाइपरस्पेक्ट्रल डाटा विश्लेषण

चाय के पौधों की गुणवत्ता एवं मात्रा उसकी किस्म, पौधों के काल, वृद्धि स्तर, कांट–छांट स्तर, प्रकाश परिस्थितियों और व्याधि आदि पर निर्भर करती है। हाइपरस्पेक्ट्रल डाटा में यह योग्यता होती है कि वे वनस्पति में स्पेक्ट्रल विविधता का पता लगा लेती है। इसलिए चाय पौधों के स्पेक्ट्रल व्यवहार को जानने के लिए हाइपरस्पेक्ट्रल डाटा विश्लेषण के लिए एक अध्ययन किया गया।

श्रेष्ठ रोपण सामग्री का चयन

कांगड़ा जाट और द्विक्लोन बीज स्कंधों से चयनित मातृ पौधों क्लोनयुक्त पौधों के मूल्याकंन के कार्य को जारी रखा गया। मनचाहे आकार की चाय पत्ती की तुड़ाई के लिए स्किफिंग मशीन की तीसरे वर्ष कार्य निष्पादकता जांची गई तथा वांछित परिणाम पाया गया। परीक्षणों के आधार पर कांगड़ा में चाय की व्यावसायिक खेती के लिए सीइएफ–02 परिग्रहण को 'हिम स्फूर्ति' नाम की एक किस्म को जारी किया गया इससे 37 प्रतिशत अधिक मात्रा में फसल प्राप्त होती है।

हिमस्फूर्ति

संस्थान द्वारा जारी हिमस्फूर्ति की मुख्य विशेषताएं

कांगड़ा चाय की सैंकड़ों वर्ष पुरानी चाय से विकसित की गई। इसका पौधशाला में श्रेष्ठ प्रदर्शन रहा है। इसका स्वाद कांगड़ा जाट, कांगड़ा आशा और उपासी 09 से बेहतर है, तथा यह ब्लिस्टर ब्लाईट से कम प्रभावित होती है।

कांगड़ा की परम्परागत काली चाय के गुणवत्ता पैमाने के त्वरित पहचान के लिए इ-विजन का मानकीकरण

थियाफ्लेविन और थियाविगिल चाय के रंग और चमक को बढ़ाने के लिए दो महत्वपूर्ण रासायनिक यौगिक हैं। सी–डेक द्वारा एक इ–विजन को विकसित किया गया है। इस प्रणाली को परम्परागत काली चाय पर गुणवत्ता के लिए परीक्षित किया गया, जिसके अच्छे परिणाम सामने आए हैं।

बाँस

सूक्ष्मप्रवर्धन और प्रक्षेत्र में हस्तातंरण

गुडुआ एगुस्टिफोलिया

गुडुआ एगुस्टिफोलिया के इन–विट्रो संवर्धों में संदूशणों की पहचान के लिए एक अध्ययन किया गया। यह संवर्ध *पेंटोया एगलोमरनस* और *पी. एनानिटिस* जीवाणुओं से संदूषित पाए गए। इनको 10 दिनों तक केनामिसिन की निर्धरित मात्रा से हटाया गया। फसलस्वरूप स्वस्थ्य और विषाणु रहित अंकुरण प्राप्त हुआ।

आनुवांशिक रूपांतरण

डेंड्रोकेलामस हेमिलटोनाई

पौधों की अनुकूलनशीलता को बढ़ाने के लिए ट्रांसजेनिक पौधों को तैयार करने के लिए एक प्रोटोकाल को विकसित किया गया जिससे कि शुक मरुस्थलों में भी इसके पौधे लगाए जा सकेंगे।

उद्योगों के लिए महत्वपूर्ण रीड बाँस *(आकलेंडरा ट्रैवनकोरिया)*

बॉस की विभिन्न प्रजातियों में *ओकलेंडरा* केरल के पश्चिमी घाट में बहुत अधिक संख्या में फैला हुआ है।

jx ,o jt d

अरनेबिया प्रजातियां

अरनेबिया i tkfr dk fl dkfuu l 'y"k.k eVokyke d fo'k"k lnHk e ryukRed v/;;u (जैवप्रौद्योगिकी विभाग, भारत सरकार द्वारा वित्तपोषित)

अरनेबिया की तीन प्रजातियों को हिमाचल प्रदेश के उच्च जलवायु वाले क्षेत्रों से एकत्रित करके सिकोनिन जैव संश्लेषण के मेटाबोलाम अध्ययन किया गया। *अरनेबिया गुटाटा* को ताबो क्षेत्र (3280 मी.) जिला लाहौल एवं स्पीति हिमाचल प्रदेश तथा *अरनेबिया बैंथमी* को चम्बा जिले के याडा क्षेत्र (3455 मी.) की ऊंचाई से एकत्रित किया गया। RP-HPLC उपाय से 60 नमूनों को विभिन्न सगंध अम्लों सहित सेकेन्डरी मेटावोलाइट के साथ विश्लेषित किया गया।

[kk| ,o elkyk Qly

सेब पोमेस

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

केसर

केसर एक बहुमूल्य फसल है जिसको खाद्य पदार्थों में रंग व सुगंध एवं औषधीय उपयोग के लिए प्रयोग में लाया जाता है। केसर एशिया की फसल है तथा स्पेन और भारत के जम्मू एवं कश्मीर में इसकी खेती की जाती है। शेरे

कश्मीर कृषि विज्ञान एवं प्रौद्योगिकी विश्वविद्यालय, श्रीनगर के केसर अनुसंधान केन्द्र में सितम्बर 2009 को प्रदर्शन खण्ड विकसित किए गए जिसके अच्छे परिणाम आने लगे हैं।

स्टीविया

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

i"i Qly

शोभाकारी गुलाब

प्रजनन

नई पुष्प किस्मों को बनाने के लिए शोभाकारी गुलाबों का प्रजनन किया गया। तेल की गुणवत्ता, फूलों के आकार और पुष्प विविधता के लिए गुलाब के 6 विभिन्न प्रजातियों (*रोजा बौर्बेनियाना, रो. बैंकेसी, रो. ब्रुनोनी, रो. सेंटीफोलिया, रो. रुगोसा* और *रो. चायनेंसिस मिनिमा*) में अंतरजातीय संकरण किया गया जिसके अच्छे परिणाम सामने आने लगे हैं। षोभाकारी गुलाबों के प्रजनन से 76 परागणों से 112 बीज प्राप्त हुए बैक संकरण से 202 परागणों से 93 बीज, दमस्क गुलाब के अतः किस्मों के संकरण से 61 परागणों से 19 बीज तथा अन्तर विशिष्ट संकरणों के 317 परागणों से 981 बीज प्राप्त हुए।

चयनित गुलाब कलियों का मूल्यांकन

गुलाब को फूलों की रानी भी कहा जाता है। इसकी लोकप्रियता का कारण इसकी हर प्रकार की जलवायु और मृदा में अनुकूलनशीलता, लम्बे समय तक खिले रहना है। विदेशज कर्तित प्रजाति फस्ट रेड किस्म की दो कलियों का मूल्यांकन किया गया। इनको बहूगुणित करके शोभाकारी गुलाब की एक नई किस्म को तैयार किया गया है। मध्यम पहाड़ियों में फरवरी माह में फर्स्ट रेड प्रजाति में टी बडिंग में 80% उत्तरजीविता देखी गई।

जरबेरा

प्रजनन

जरबेरा प्रजनन कार्यक्रम के चल रहे कार्य को आगे बढाते हुए *जरबेरा जेमसोनाई* की दो किस्मों में अंतरजातीय संकरण द्वारा फूलों के रंग, आकार आदि में अच्छे परिणाम पाए गए।

कार्नेशन

कार्नेशन एक बहुत ही महत्वपूर्ण कर्तित पुष्प फसल है जिसकी मोहकता और तरोताजगी के लिए अधिक मांग है। अध्ययन में पाया गया है कि इसकी खेती अधिक लाभ देने वाली है। मानकित कार्नेशन की 5 कृषोपजातियों को पालीहाउस में बहुगुणन के लिए लगाया गया है।

लिलियम

व्यावसायिक रूप से एशियाटिक संकर लिलि प्रजाति बहुत ही लोकप्रिय है। लिलियम उगाने वाली क्यारियों में खाद उवर्रक और मल्चिंग को मानकित करने के लिए कार्य शुरु किया गया। नोवसेंटो प्रजाति में सबसे ज्यादा कंद संख्या (5.93) तथा आकार (71.66 ग्रा.) पाए जब 250 पीपीएम फोलियर छिड़काव और उवर्रक 19:19:19 का प्रयोग किया

गया। लिलियम के पुष्प की सुन्दरता, आकर्षण, चमकदार व विभिन्न रंगों में उपलब्धता, तुड़ाई के उपरान्त ज्यादा दिनों तक तरोताजा बने रहने की क्षमता, सरलता से उगाए जाने तथा कुछ किस्मों में मनमोहक सुगंध पाए जाने के कारण यह विश्व के सर्वोच्च 10 कर्तित पुष्पों की श्रेणी में आता है। लाहौल एवं स्पीति में व्यावसायिक रूप से एशियाटिक संकर लिलि प्रजाति के कंदो के आकार के मानकीकरण में नोवसेंटो, पोलियाना और पराटो प्रजाति में अधिकतम कंद (14.33 से.मी. प्रति प्ररोह) तथा अधिकतम पुष्प लम्बाई (165 सेमी.) नोवसेंटों में पाया गया।

लिजिएंथस *(यूस्टोमा ग्रेन्डीफ्लोरम)*

लिजिएंथस जेंटिएसी कुल का पौधा है और यह मध्यम और उत्तरी अमेरिका का मूल पौधा है। इसको कर्तित पुश्प, बागानों में एकदम सामने लगाए जाने वाले पौधे और पॉट प्लांट के रुप में उगाया जाता है। इसकी आदर्शतम उत्पादन पाने के लिए प्रयोग चल रहा है।

आक्रिड

सीम्बिडियम गाइजैंनटीयम और *रिन्कीस्टाइलिस रेटूजा* में PLBs का पुनर्जनन क्षमता को परख गया एवं 60 दिनों के संरोपण के बाद *सीम्बिडियम गाइजैंनटीयम* क्लंप में शत–प्रतिशत पुनर्जनन पाया गया। एक अलग अध्ययन में *सीम्बिडियम गाइजैंनटीयम* पौध के सतह/नीचे के भाग में PLBs के गुच्छे में बनते हैं। यह PLBs पहले गहरे हरे हुए और बाद में पूरे पौध बन गए।

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माइक्रोबियल एंजाइम

प्रोटीएस उत्पादन के लिए सकारात्मक चौदह बैक्टीरियल आइसोलेटस की 16S rRNA जीन अनुक्रमण के आधार पर पहचान की गई हैए और ये जीन्स चराईसोबैक्टीरियम, सूडोमोनास और बैसीलस के साथ संबद्ध रखते हें। पहले से पहचान किये हुऐ प्रोटीएस उत्पादन करने वाले 22 बैक्टीरियल आइसोलेटस को कैसिइन–जाईमोग्राम पर आइसोज़ाइम बदलाव के लिए परखा गया। इस में कुल 15 आइसोफोर्म थे और उनमें से अधिकांश की सीरिन प्रकार के रूप में पहचान की गई। सभी आइसोलेटस से क्रूड प्रोटीएस कम तापमान और क्षारीय पीएच में सक्रिय थे। ऐसिनेटोबेक्टर से क्षारीय सीरिन प्रोटीएस जीन को *ई. कोलाई* में क्लोन और व्यक्त किया गया। प्रोटीएस सबटीलिसिन परिवार (S8) के सदस्यों के साथ अनुक्रम समानता का प्रदर्शन करता है। एक होनहार पीनिबैसीलस से तीन एंडोग्लूकानेस जीन को *ई. कोलाई* में क्लोन और व्यक्त किया गया। एक क्लोन से 63 किलो डाल्टन सक्रिय पुनः संयोजक एंडोग्लूकानेस को आयन एक्सचेंज क्रोमैटोग्राफी का उपयोग करके षुद्ध किया गया।

कीटों का सर्वेक्षण :

चाय की फसल पर लगने वाले कीट तथा माईट जानने के लिए पालमपुर के चाय बागानों का सर्वेक्षण किया गया। इक्टठे किए गऐ कीटों को 70% एल्कोहल में संरक्षित किया गया। स्केल कीट एफिड और थ्रिप्स चाय पर पाऐ जाने वाले सबसे ज्यादा कीट थे। स्केल कीट के एडल्ट और क्रॉलर तने शाखा, पत्तों और कलियों से रस चूसते है, जिससे पत्तियां पीली, सूख और गिर जाती है हांलाकि चाय पर लीफ फोल्डर, लीफ माइनर तथा ग्रास होपर भी कम मात्रा मे पाए गए।

एक दूसरे अध्ययन मे FACE और FATE फैसिलीटी मे वैलैरियाना जटामानसी नामक औशधीय पौधे पर एफिड, *ट्राइफोलियम रिपेन्स* पर *स्पोडोपटैरा लीटूरा* तथा *रूमैक्स* घास पर नीला बीटल पाया गया। एफिड को *वैलोरियना जटामांसी* के पत्तों और फूलों का रस चूसते हुए और *स्पोडोपटैरा लीटूरा* तथा नीले बीटल के *रूमैक्स* और ट्राइफोलियम के पत्ते खाते हुऐ पाया गया।

पौधों से बने कीटनाशियों की जांच

पौधों से बने कीटनाशी के विकास के लिए टैरोडोफइट के 6 एक्सट्रेक्ट *प्लूटैला जाइलोस्टैला, स्पोडोपटैरा लीटूरा,* एफिड और माइट कोटों को नियंत्रण करने के लिए परीक्षण किए गए और उनमें से सबसे अच्छे परिणाम IHB-PED-M001 ने दिखाए। इस नमूने ने 48 घण्टे के बाद 90%, 60%, 47% परिणाम 2.0%, 1.5%, और 1.0% सांद्रता पर दिखाए।

जैंथोझाइलम से बने अलग–अलग एक्सटैक्टस, *प्लूटैला जाइलोस्टैला* को नियंत्रण करने के लिए लगाए गए जिनमें से द–हैक्सैन का सारसत्व ने सबसे अच्छे परिणाम दिखाए जबकि क्लोरोफॉर्म मे बना सारसत्व सबसे कम आंका गया। द–हैक्सैन का जब GC-MS किया गया तो इसमे 22 तरह के तत्व पाये गए।

कोस्टस स्पेसियोसस नामक पौधे के भुमि के अन्दर के भाग का इथैनोइक सारसत्व भी *प्लूटैला जाइलोस्टैला* नामक कीट के लिए 20,000 और 15000 ppm पर सक्रिय पाया गया।

क्षेत्र प्रयोग

सेब की माइट को नियंत्रित करने के लिए अलग–अलग अकैरिसाइड को फील्ड मे जांचा गया। नए कीटनाशी जैसे स्पाइरोमैसीफेन, क्लोरफैनपाइर, फैनपाईरोक्सीमैट, हैक्सीथाइजोक्स एवामैकटिन, नीम और परंपरागत कीटनाशी जैसे फैनजक्वीन और डाइकोफोल कुल्लू जिला के नग्गर तथा मढी में सेब की माइट को नियंत्रित करने के लिए बगीचों में टैस्ट किया। होर्टिकलचर मिनरल ऑयल और नीम को छोडकर बाकी सभी के 28 दिनों के बाद तक अच्छे परिणाम आए।

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सीएसआईआर–आईएचबीटी भारत के ग्रामीण एवं छोटे कस्बों के लोगों के जीवन को सुधारने तथ उनके अजीविका के लिए एक नेटवक्र मोड में कार्य कर रहा है। संस्थान के मुख्य लाभार्थी जिला जलागम विकास एजेंसी, शिमला के साथ–साथ हिमाचल प्रदेश सरकार के कृषि बागवानी, वन, ग्रामीण विकास और आयुर्वेद विभाग हैं। चाय बोर्ड, राष्ट्रीय बॉस उपयोग मिशन भारत भी इस संस्थान से जुड़े हुए हैं। वर्ष के दौरान लगभग 1100 किसानों, विस्तार अधिकारियों, उद्यमियों और विद्यार्थियों ने इस संस्थान के बागान अनुसंधान प्रक्षेत्र और व्यावसायिक दृष्टि से महत्वपूर्ण कर्तित पुष्प के प्रदर्शन प्रक्षेत्रों , औषधीय एवं सगंध पौधों, वानस्पतिक और जैवविविधता उद्यान, बॉस पौधशाला और संग्रहालय का दौरा किया। इससे व्यक्तियों को उन्नत खेती पद्धति और वैकल्पिक उपयों के बारें में पता चला जिससे उत्पादकता, गुणवत्ता एवं आय उपार्जन हुआ। संस्थान के वैज्ञानिकों तथा तकनीकी स्टाफ ने प्रशिक्षण, प्रदर्शन द्वारा ज्ञान को आगे पहुंचाया है। चाय, बांस पौधारोपण, व्यावसायिक पुष्पविज्ञान, बागवानी और औषधीय एवं सगंध पौधों के उत्पादन और मूल्यवर्धन के लिए सामाजिक विकास गतिविधियों को शुरु किया गया। गुणवत्तायुक्त रोपण सामग्री, पौघशाला एवं पौध तैयारी, स्थल पर जाकर ही व्यावहारिक प्रशिक्षण, प्रक्रमण प्रदर्शन, जागरुकता भ्रमण, तकनीकी बुलेटिन तैयार एवं वितरित करना, टेलीविजन एवं रेडियो कार्यक्रम प्रस्तुति, वेबसाइट में सामग्री और संस्थान द्वारा विकसित प्रौद्योगिकी पर ज्ञान का आदान–प्रदान जैसी कई गतिविधियां ग्रामीण विकास कार्यक्रम का हिस्सा हैं।

किसान, ग्रामीण समुदाय, सगंध तेल एवं पादप रसायन उद्योग, आयुर्वेद क्षेत्र, जैवसंपदा संरक्षण में लगे लोग और ग्राहक आदि इस परियोजना से सीधे तौर पर लाभान्वित हो रहे हैं। जैवप्रौद्योगिकी, बागवानी, वन विभाग और जिला ग्रामीण विकास अभिकरणों को ज्ञान, तकनीक के साथ–साथ रोपण सामग्री भी प्रदान की जाती है।

संस्थान अपने ज्ञान को प्रैस व मीडिया के माध्यम से भी प्रचारित और प्रसारित कर रहा है। दूरदर्शन के शिमला, जालंधर और दिल्ली केन्द्रों के साथ–साथ निजी चैनलों में कार्यक्रय प्रसारित हुए हैं। अकाशवाणी के धर्मशाला केन्द्र से भी वार्ताएं प्रसारित हो रही हैं। इसके अतिरिक्त पत्रिकाओं, समाचारपत्रों में भी समय–समय पर लेख जानकारी आदि प्रकाशित होते रहते हैं।

प्रशिक्षण

हिमाचल प्रदेश के कांगड़ा जिलें के विभिन्न क्षेत्र प्रशिक्षणार्थियों को चाय कृषि पद्धति और पौधशाला प्रबन्धन पर प्रशिक्षण दिया गया।

बड़ी इलाइची की खेती को बढ़ावा देने के लिए उपयुक्त स्थलों का चयन कर अच्छी प्रजाति के 200 कंदों को कांगड़ा जिले के 6 इच्छुक किसानों को उपलब्ध कराया गया। इसकी खेती की तकनीक से संबन्धित प्रशिक्षण भी उपलब्ध कराए गए।

कार्यशाला का आयोजन

कांगड़ा चाय की विशेषताओं पर एक कार्यशला 6 अप्रैल 2012 को संस्थान परिसर में आयोजित की गई। इसमें 74 प्रतिभागियों ने प्रतिभागिता की जिसमें से 1 इंगलैंड व 2 इथोपिया से थे।

चाय बागानों का दौरा

चाय बोर्ड, भारत के श्री एमजीवीके भानु, अध्यक्ष, सुश्री रोशनी सेन, उपाध्यक्ष और श्री बी बोरिया, निदेशक, चाय विकास ने संस्थान के बनूरी स्थित चाय परीक्षण फार्म का दिनांक 4 अगस्त 2012 को दौरा किया तथा संस्थान द्वारा चाय के क्षेत्र में किए जा रहे शोध एवं विकास और विस्तार कार्यों को देखा।

कर्तित पुष्प उत्पादन तकनीक का हस्तातंरण

संस्थान इस पहाड़ी राज्य में व्यावसायिक पुष्प खेती के लिए एक उत्प्रेरक की भूमिका को निभा रहा है। परामर्श यात्राओं, प्रशिक्षणों, प्रदशर्नो और रोपण सामग्री को उपलब्ध करा कर किसानों को प्रेरित कर रहे हैं जिससे कि संस्थान को व्यावसायिक पुष्प खेती के अन्तर्गत हिमाचल प्रदेश व साथ लगते राज्यों में इसके क्षेत्र में विस्तार में सफलता मिली है। इससे उनके सामाजिक–आर्थिक स्थिति में परिवर्तन आया है। इसके प्रभाव का इस बात से पता चलता है कि अकेले लाहौल स्पीति जिले से वर्ष 2012–13 के दौरान 60 लाख रुपये के कर्तित पुष्पों का व्यापार हुआ।

मै. नेवा प्लांटेशन प्रा. लि. गोपालपुर, जिला कांगड़ा को लिलियम के कन्दों के उत्पादन की खेती और फसलोपरांत तकनीक पर ग्राहकों की संतुष्टि के अनुरूप परामर्श सेवाएं प्रदान की गईं।

प्रदर्शन प्रक्षेत्र

संस्थान परिसर एवं किसानों के खेतों में क्रिसेंथिमम, जरबेरा, लिलियम, बर्ड–आफ–पेराडाइज और गेंदे के प्रदर्शन प्रक्षेत्रों को स्थापित किया गया।

रोपण सामग्री का बहुगुणन और वितरण

क्रिसेंथिमम, लिलियम, जरबेरा, एल्सट्रोमेरिया, बर्ड–आफ–पेराडाइज, ग्लोडियोलस, एगपेन्थस और गेंदे जैसे कर्तित पुष्पों की रोपण सामग्री को बहुगुणित किया गया तथा किसानों में वितरित किया गया और इस वर्ष के दौरान 14.5 है. के लगभग क्षेत्र को व्यावसायिक पुष्प खेती के अन्तर्गत विस्तारित किया गया। लिलियम की विषाणु परीक्षित विभिन्न कृषोपजातियों की प्रत्येक प्रजाति के 12 हजार कन्दों को उगाया गया ताकि इसका आकार एक समान हो। जरबेरा की जफोना प्रजाति का बहु संख्या में उतक संवर्धन तकनीक से प्रवर्धन किया गया तथा इसका दृढ़ीकरण किया गया। इसी जफोना प्रजाति की 10 सवर्धों को मै. रजत वायोटेक, धुमार्वी को बहुगुणित करने के लिए सामग्री हस्तांतरण समझौते के अन्तर्गत प्रदान की गईं।

समय–समय पर व्यावसायिक दृष्टि से महत्वपूर्ण कर्तित पुष्पों की कृषि एवं फसलोपरांत तकनीक पर विभिन्न प्रकार के प्रदर्शन एवं प्रशिक्षण कार्यक्रमों का आयोजन किया गया। जिनमें से कुछ संस्थान परिसर में तथा कुछ अन्य स्थलों पर आयोजित किए गए।

प्रदर्शनी में प्रतिभागिता

संस्थान ने राज्य सरकार के अन्य विभागों के साथ मिलकर 25 सितम्बर 2012 को लाहौल स्पीति जिले में आयोजित 'हि.प्र. के लाहौल स्पीति जिले बागवानी एवं औषधीय फसलों की संभावनाएं' विषय पर आयोजित बैठक में प्रतिभागिता की तथा एक प्रदर्शनी भी लगाई।

इसी प्रकार संस्थान ने राज्य सरकार के अन्य विभागों के साथ मिलकर 31 मई 2012 को जिला ग्रामीण विकास अभिकरण, कांगड़ा द्वारा फ्लावर फेडरेशन, दरंग के साथ एक बैठक की।

संस्थान ने सीएसआईआर के अन्य संस्थानों के साथ मिलकर 24–27 जनवरी 2013 के दौरान नागपुर में आयोजित एग्रोविजन 2013 में प्रतिभागिता की। लगभग 800 किसानों ने इस प्रदर्शनी में सीएसआईआर के स्टाल में यात्रा की तथा स्टीविया, दमस्क गुलाब, जरबेरा, ग्लेडियलस, क्रिसेंथिमम और लिलियम की व्यावसायिक खेती में अपनी अभिरुचि व्यक्त की।

संस्थान ने 17 मार्च के जम्मू में आयोजित किसान मेले में प्रतिभागिता की। इसके अतिरिक्त संस्थान ने पालमपुर के प्रगति मैदान में होली मेले के दौरा भी अपने स्टाल लगाए। बड़ी संख्या में लोगों ने स्टाल में आकर संस्थान द्वारा किए जा रहे कार्यों में रुचि दिखाई।

औषधीय, सगंध और पाककला के हर्ब्स का बहुगुणन और वितरण

संस्थान ने रोजमैरी (2 लाख), लैवेन्डर (1.5 लाख) दमस्क गुलाब (50 हजार), जिंको (20 हजार) और स्टीविया (25 हजार) के पौधों का प्रवर्धन किया ताकि यह पौधे उत्पादकों को आंबटित किए जा सके। अश्वगंधा, बकोपा, चमेली, टेक्सस, जिन्को, एलोए, मुस्कबाला, लेमनग्रास, वायोला, ओरिगेनो, सफेदा आदि के मदर स्टॉक को प्रतिपादित किया और प्रवर्धित कर उत्पादकों को इसकी आपूर्ति की। यह सामग्री 15 है. के लगभग क्षेत्र के लिए पर्याप्त है।

विशेष प्रशिक्षण

जिला जलागम विकास एजेंसी, जिला शिमला द्वारा प्रायोजित जिले के थियोग, रामपुर और बसंतपुर विकास खंडो के 10 समूहों को वर्ष के दौरान प्रशिक्षण एवं प्रदर्शन कार्यशालाओं का आयोजन किया गया इसमें कुल 202 प्रतिभागियों ने भाग लिया।

इसके अतिरिक्त वर्ष के दौरान सैंकड़ों किसानों और उत्पादकों ने संस्थान के औषधीय एवं सगंध पौधों के प्रदर्शन प्रक्षेत्रों का दौरा भी किया।

हि. प्र. के कांगड़ा जिले के उत्पादकों की मांग के आधार पर प्रक्षेत्र परामर्श सेवाएं भी प्रदान की गई।

पंजाब के गुरदासपुर में औषधीय, सगंध एवं पुष्पीय फसलों के प्रदर्शन प्रक्षेत्र किसान की भूमि में स्थापित किया गया। इसमें 12 फसलों को उगाया जाएगा।

14–16 अगस्त के दौरान संस्थान के वार्षिक जनजातीय मेले में प्रदर्शनी का आयोजन किया गया। इस दौरान संस्थान द्वारा बक व्हीट द्वारा तैयार दो उत्पादों को भी प्रदर्शित एवं जारी किया। लिलियम, जरबेरा, ग्लेडियोलस की विभिन्न किस्मों, और औषधीय एवं सगंध पौधों की गुलाब, लेवेन्डर, आर्टिमीसिया, जिन्को आदि को भी प्रदर्शित किया गया तथा वहां के लोगों को इन फसलों के उगाने पर होने वाले लाभ के बारे में भी बताया गया। केसर और अन्य व्यावसायिक दृष्टि से उपयोगी फसलों के रोगरहित रोपण सामग्री का भी प्रदर्शन किया गया। सीएसआईआर–उच्च जलवायु जीवविज्ञान केन्द्र, तांदी, जिला लाहौल व स्पीति के लक्ष्यों और वर्तमान गतिविधियों को स्थानीय लोगों को बताया गया।

बाँस को बढ़ावा देना एवं उपयोग

वर्ष के दौरान बाँस की विभिन्न प्रजातियों के पौधों को उत्पादकों, वन विभाग, हि.प्र. व अरुणाचल प्रदेश तथा हिमाचल प्रदेश एवं साथ लगते राज्यों के किसानों को वितरित किए गए। जिससे बाँस को लगभग 30 है. क्षेत्र के अन्तर्गत लाया गया। हिमाचल प्रदेश के मंडी में चीन की मोसो बाँस किस्म को 10 हैक्टेयर क्षेत्र में लगाया गया।

2.5 लाख पौधों को पौधशालाओं में प्रवर्धित किया गया। इसमें से 11777 पौधों को विभिन्न भागों में वितरित किया गया।

महिलाओं को बाँस से बनने वाले खाद्य पदार्थों जैसे केन्डी, बड़िया, केक, डोनट, सिरप और पापड़ आदि बनाने का प्रशिक्षण प्रदान किया। इसी प्रकार कए कार्यक्रम वन विभाग के अधिकारियों के लिए आयोजित किया गया जिसमें बाँस से चारकोल और केंडी आदि बनाने का प्रशिक्षण दिया गया।

18 सितम्बर 2012 को संस्थान परिसर में विश्व बाँस दिवस का आयोजन किया गया।

इंजीनियरिंग सेवा प्रभाग

जोगिन्द्रनगर में हिमाचल प्रदेश सरकार के आयुर्वेद विभाग के लिए एक प्रयोगशाला का निर्माण, टेप, टिम और ग्रामीण विकास केन्द्र का निर्माण

योजना, परियोजना, अन्वेक्षण और मूल्यांकन इकाई

12वीं पंचवर्षीय योजना को तैयार किया। सी.एस.आई.आर. तथा आई.एच.बी.टी. के वार्षिक प्रतिवेदन के लिए सूचना को एकत्रित किया। इन्टरनेट तथा इन्ट्रानेट पर सामग्री को अद्यतन किया। एनएबीएल के लिए वेब आधारित सिस्टम को विकसित किया। सीएसआईआर–युआरआईडीपी, पुणे की 350 से ज्यादा एंटरी को दर्ज किया गया। पूरी हुई 12 परियोजनाओं की सूचना का संकलित किया। अब 151 परियोजनाओं की जानकारी उपलब्ध है। 48वीं अनुसंधान परिषद बैठक का आयोजन। संस्थान परिसर में विभिनन संस्थानों के 202 छात्रों को परियोजना प्रशिक्षण हेतु जबाव दिया तथा 47 छात्रों को प्रशिक्षण दिलाया गया। संस्थान की गतिविधियों को बताने के लिए तथा स्कूली छात्रों में विज्ञान के लोकप्रियकरण के लिए समय–समय पर संस्थान में शैक्षणिक भ्रमण कराया गया। इन्सपायर इन्टरशिप केम्प का आयोजन किया गया। विभिन्न सी.एस.आई.आर. स्थापना दिवस, आई.एच.बी.टी. स्थापना दिवस, राष्ट्रीय विज्ञान दिवस, राष्ट्रीय प्रौद्योगिकी दिवस सहित कई प्रकार के समारोहों का आयोजन किया। संस्थान में चल रही परियोजनाओं का मूल्यांकन किया। प्रकाशन, पेटेंट आदि से संबन्धित जानकारियों को संग्रहित किया। भण्डार, वित्त एवं प्रशासन के साथ मिलकर एक–सीएसआईआर के लिए सामग्री का संकलन किया।

dEI;wVj bdkbZ

300 से अधिक कम्प्यूटरों को फाइबर बैकबोन एवं वाई–फाई नेटवक्र, वीडियोकान्फ्रेंसिंग सुविधा, एच.पी., आई.बी.एम. सरवर के माध्यम से प्रदान की गयीं हैं। राष्ट्रीय ज्ञान नेटवक्र के अन्तर्गत सारे संस्थान परिसर में 1Gbp लीज्ड लाइन की सुविधा प्रदान की गई है। नेटवक्र सिक्योरिटी के लिए यूनिफाइड थ्रेट मैनेजमेंट सिस्टम, आईडीएस, आइपीएस, सेंट्रलाइज नेटवक्र सिक्योरिटी सिस्टम, एन्टीवायरस आन क्लाइंट सरवर मोडम तथा एसएमटीपी स्पेम/वायरस प्रोटेक्शन सॉफ्टवेयर को संस्थान के इ रिसोर्सस को संरक्षित करने के लिए लगाया गया। डोमेन नेम सरवर, डीएनएस, वेब, इमेल प्रोक्सी आफलिनेक्स को प्रबन्धित किया गया।

vkb-,p-ch-Vh- Kku l;kl/ku dsUnz

आई.एच.बी.टी. का ज्ञान संसाधन केन्द्र संस्थान के वैज्ञानिकों तथा तकनीकी कर्मियों तथा पालमपुर के आस–पास के शैक्षणिक केन्द्रों को लगातार सेवाएं प्रदान कर रहा है। वैज्ञानिकों तथा तकनीकी स्टाफ के लिए साइटेशन रिपोर्ट को एकत्रित किया गया तथा विषय विशेष पर बिविलियोग्राफी उपलब्ध कराई गई। प्रत्येक सप्ताह केन्द्र में आने वाले नवीततम पुस्तकों, पत्रिकाओं आदि की जानकारी सभी को उपलब्ध कराई जाती है। 4500 से अधिक इ–जर्नल और डेटाबेस को देखा जा सकता है। इसके साथ ही 155 प्रकाशित जर्नल भी उपलब्ध हैं। 6044 उपयोगकर्ताओं ने केन्द्र की सेवाओं का लाभ उठाया। 1159 पुस्तकें इस वर्ष पाठकों को जारी की गई। 5.2 लाख से अधिक पृष्ठों की फोटोकापी प्रदान की गई। ऑनलाइन जर्नल को देखने के लिए पाठकों को प्रशिक्षण भी प्रदान किया गया।

QkVkxzkQh ;wfuV

फोटोग्राफी युनिट ने विभिन्न समारोहों, कार्यशालाओं, प्रशिक्षण आदि की कवरेज के अतिरिक्त शोध एवं विकास से संबन्धित विषयों पर भी फोटोग्राफी की।

iVsaV

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

प्रकाशन

वर्ष के दौरान संस्थान ने स्तरीय जर्नल में 142 शोध पत्र प्रकाशित कराए। चार लोकप्रिय विज्ञान लेख विज्ञान प्रगति में प्रकाशित हुए। पुस्तकों में 19 लेख/पाठ प्रकाशित हुए। चार पुस्तकें प्रकाशित हुईं जिनमें से 2 अंग्रेजी में तथा 2 हिंदी में हैं।

संगोष्ठी/सेमिनार में प्रतिभागिता

संस्थान के वैज्ञानिकों ने 26 संगोष्ठियों तथा 23 बैठकों में प्रतिभागिता की।

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

व्याख्यान

संस्थान के वैज्ञानिकों ने 27 स्थानों में व्याख्यान दिए।

संस्थान में 5 आंमत्रित व्याख्यान आयोजित किए गए।

दूरदर्शन कार्यक्रम

संस्थान के वैज्ञानिकों ने वर्ष के दौरान 10 दूरदर्शन कार्यक्रम दिए तथा 4 कार्यक्रम अन्य चैनलों से प्रसारित हुए। अकाशवाणी के धर्मशाला केन्द्र से 2 वार्ताएं भी प्रसारित हुए।

विदेश यात्रा

वर्ष के दौरान संस्थान के 8 वैज्ञानिकों 1 तकनीकी कर्मचारी तथा दो शोध छात्रों ने विदेश दौरा किया

छात्रों को प्रशिक्षण

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

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

इस वर्ष संस्थान के 12 शोध छात्रों ने पी. एचडी., 39 छात्रों ने स्नातकोत्तर तथा 14 ने बी.टेक. डिग्री के लिए शोध–प्रबन्ध विभिन्न विश्वविद्यालयों में जमा किए।

अनुबन्ध

संस्थान ने अपनी प्रौद्योगिकी के ज्ञान के प्रसार के लिए 10 संस्थानों से अनुबन्ध किए।

विशिष्ट अतिथि

इस वर्ष 15 विशिष्ट अतिथियों ने संस्थान में यात्रा की।

संस्थान का शैक्षणिक भ्रमण

शैक्षणिक संस्थानों से छात्र	1160
किसान, स्वयंसेवी संस्थाएं तथा सरकारी अधिकारी	1079

OBITUARY

Sh. Shyam Lal, Lab Attendant 1
(10.03.1955 – 13.10.2012)

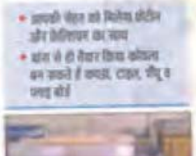
Sh. Shyam Lal was born on March 10, 1955 in Village- Punner Kaswa, Palampur (HP). He joined CSIR-IHBT on January 12, 1994 as Helper with temporary status, and was absorbed on December 26, 2002 under the Casual Workers Absorption Scheme of CSIR, 1990 & 1995. He contributed significantly in Engineering Service Unit (ESU) of the Institute and catered to routine electrical maintenance activities of the Institute. He will be remembered for his dedication and diligence. He departed for his heavenly abode on October 10, 2012. He is survived by his wife Ms. Veena Devi and daughter Ms. Nisha Devi, Ms. Reeta Devi and son Sh. Shubham Sharma.

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

Central University signs MoU with Palampur IHBT

खोज : आइएचबीटी के वैज्ञानिकों ने हासिल की कामयाबी

अब खाइए बांस के पापड़-नूडल्स



फूलों की खेती से पहले हासिल करें जानकारी

NATIONAL SCIENCE DAY OBSERVED

HT Correspondent

DHARAMSALA: The Institute of Himalayan Bioresource Technology (IHBT) on Thursday celebrated the National Science Day at Palampur. The day is observed in commemoration of Nobel laureate CV Raman's discovery – Raman's effect.

The IHBT informed students of surrounding schools about the research activities being undertaken by the institute. S Natesh, senior adviser to the department of bioresource, government of India, who was chief guest on the occasion, delivered a lecture on "The plants which transformed the world".

He elaborated on plants which have impact on the history, society, environment and economy. Natesh talked about

विज्ञान को बनाएं कैरियर

आई.एच.बी.टी. ने सी.एस.आई.आर स्थापना दिवस समारोह मनाया

भटियात की तिजोरी भरेंगे फूल

पर्वतीय क्षेत्र के लिए वरदान बना आइएचबीटी

रंगों से चुनें फूलों की किस्में

भटियात में डा. परमवीर सिंह ने किसानों को दिए टिप्स

पुष्प उत्पादन पर प्रशिक्षण शिविर शुरू

बागवानों से आह्वान

हिमाचल में 47 वन्य औषधियां संकटग्रस्त घोषित

▸ वन मंत्री ने की खेती द्वारा तैयार औषधियों को ट्रांजिट पास फीस से मुक्त करने की वकालत

योल में गृहकर बढ़ाने का

कहा–गरीब परिवारों पर

Workshop on sustaining Himalayan ecosystem

OUR CORRESPONDENT

KANGRA, OCTOBER 7

A two-day stakeholders' workshop on "National Mission for Sustaining Himalayan Ecosystem" was ...

He also explained the aims of the mission for sustaining the ecosystem. The experts discussed various issues which included climate change vulnerability and impact, meteorology, glaciology and hydrol...

Garhwal University; and Dr Ajit Tyagi, former Director-General, Indian Meteorological Department, also contributed in this workshop.

The outcome of the workshop was focused on having constructive results as stake...s, institutions enrol... the national mission, ...ication of knowledge in climate change ...h and development ...filment, identify pos... knowledge networks ... search and develop... rojects, besides state ... ments', Central min... role in the mission, ... rces added.

Anti-ageing enzyme gene isolated

Plant which produces superoxide dismutase discovered

ASHOK RANA

KANGRA, AUGUST 2

Scientists at the CSIR Institute of Himalayan Bioresource ...

Dr Kumar, senior principal scientist, biotechnology division, said the enzyme was found in all plants, animals and human beings, but was a critical enzyme, associated with controlling oxygen toxicity arising from oxidative stress in any living system, in this plant.

He said the enzyme, isolated from the plant, was engineered by mutation of a single amino-acid. It was functional from sub-zero temperature to above 50°C, survived autoclaving (heating at 121°C with a pressure of 1.1 kg per square cm for 20 minutes) and was resistant to proteolysis, Dr Ahuja said.

He said a systematical analysis was carried out and the enzyme identified. He said three or four US patents had been awarded to the IHBT for unique properties of this enzyme and cloning its gene.

Dr Kumar said they did experiments to enhance the shelf life of fruits and ...

Dr Sanjay Kumar searches for the plant in the higher reaches of the Himalayas.

...gery and transplant of heart, kidney, skin, liver, lung and pancreas.

ी से बदलें की दकदीर

'फूलों की किस्म का चुनाव जरूरी'

हिमालय जैवसंपदा प्रौद्योगिकी संस्थान में पुष्पों के विकास पर प्रशिक्षण कार्यक्रम

फूलों की घाटी बनेगा भटियात

वीरवार को किसानों को बताए गए फूलों की खेती के गुर

Scientists vouch for genetically-modified crops

LALIT MOHAN
TRIBUNE NEWS SERVICE

DHARAMSALA, JULY 3

Scientists from the Centre for Scientific and Industrial Research (CSIR) have advocated the use of genetically ...

New variety of tea released

'HIM SPHURTI', a new variety of tea developed from the original Kangra tea plantations was also released on the occasion. The scientists who developed the variety said new variety of tea ...

... considerably, he said.

He also alleged that though certain sections were laying stress on organic crops, but studies have shown that such crops are 40 per cent costlier than other crops.

PS Ahuja, the director of the IHBT, listed the achievements of the institute over the past one year. He said scientists of the IHBT have developed technology to revive plantations over 10 ...

Braving the Attitude of Altitude: *Caragana jubata* at Work in Cold Desert of Himalaya