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वार्षिक प्रतिवेदन
Annual Report
2014 -15

Moving Towards
Sustainable Bioeconomy

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CSIR-Institute of Himalayan Bioresource Technology
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Palampur-Himachal Pradesh

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वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद्
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Annual Report
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With Best Compliments from :

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MISSION

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

Thrust areas

- High altitude biology and plant conservation
- Adaptation biology and climate change
- Biotechnology, nanobiology and bioinformatics
- Natural products chemistry and process development
- Agrotechnology and plant improvement
- Plant protection
- Food and nutraceuticals
- Regulatory research

FROM THE DIRECTOR'S DESK

Himalay in India covers an area of 537 thousand km^2 and harbours rich and unique biodiversity. The region accounts for approximately 50% of the total flowering plants of the country, 30% of which are endemic. Rich biodiversity in the Indian Himalayan region offers immense opportunities to be the focal point of bioeconomy, which requires fresh approach for sustainable and innovative use of bioresources for developing economies around medicinal and aromatic plants, food, feed, fiber, and energy. Accordingly, various teams were organized into functional units encompassing Agrotechnology & Plant Improvement, Plant Protection, Food Nutraceuticals & Quality Control, Natural Product Chemistry & Process Development, Adaptation Biology & Climate Change, Biotechnology, and High Altitude Biology & Plant Conservation. Integration of various teams to achieve the research target is the hallmark of the institute.

Advancing in the direction of bioeconomy, a gluten free-antioxidant rich food products utilizing *Fagopyrum esculentum* was developed. Peel of *Punica granatum*, a waste of processed fruit, was utilized for development of polyphenol rich functional foods. It helped in prevention of isoproternol-induced myocardial infarction by modulating nitric oxide signaling pathway. Technology for production of catechins, an anitoxidant having high global demand, was successfully demonstrated to the industry for outreach of laboratory products to the market.

Apple (*Malus domestica)* is one of the most important commercial fruit crops of the state and its productivity and quality is under serious threat by virus infestation. Our team developed virus-free quality planting material of apple rootstock, and the knowhow was transferred to biotechnology-based industry to meet the national demand. A blueprint for improvement of disease-resistant varieties in apple has been developed by integrating multiple expertises across disciplines.

The institute has been utilizing traditional knowledge of medicine to identify important biomolecules. Quercitin is one such commercially important biomolecule which was nano-encapsulated for improving its efficacy in animal system. Efforts are underway to develop nanoparticle-based molecular imaging probes for ease of disease diagnosis. The flowers and leaves of *Callistemon citrinus* were found to have anticancer activities against brain and lung cancer cell lines.

A complete technology, from discovery to product, of a unique thermostable enzyme superoxide dismutase (SOD) and its successful commercialization is one of the major contributions of this institute. Working in this direction, other source of unique SOD was also identified and a process

was developed to improve the stability of the enzyme upon multiple cycles of exposure to >100C. Apart from industrial use of the enzyme, the gene was evaluated in arabidopsis along with *ascorbate peroxidase* using transgenic approach and the combination of two genes modulated the levels of active species of oxygen, which in turn affected the gene networks associated with lignin biosynthesis. We envisage transferring these genes into crops of choice to improve stress tolerance against abiotic stresses.

Issues in basic sciences continue to be of interest since these lay the bases of emergence of new technologies. One of such issues in plant science was, "Why a few tree species show evergreen habit whereas others exhibit deciduous behaviour?". The work propounded a detailed gene network and the processes that evidently highlighted the importance of cell wall degrading enzymes such as cellulase and polygalacturonase and their regulatory processes in controlling leaf abscission.

Institute took lead in deciphering the processes through transcriptome sequencing of selected plant species of commercial importance such as *Picrorrhiza kurroa*, *Sinopodophyllum hexandrum*, tea and apple. Besides this, a miRNAs controlled epigenetic regulatory network model was propounded for the first time in plant system. Our efforts on molecular fingerprinting of *S. hexandrum* populations of Indian Himalay have confirmed the existence of two genetic populations irrespective of the geographical locations, which suggested that *S. hexandrum* evolved well in response to the changing environment. These findings will assist to devise conservation strategies and improve sustainable bioeconomy by selecting elite germplasm of this prized medicinal plant.

Further on, an abundantly available alkaloid vasicine in the leaves of *Adhatoda vasica* was discovered as an organocatalyst for C-H activation and reduction reactions. New generation supportive nano-catalysts were also developed and applied in cascade approach for polyphenols, vinyl triazoles and the most challenging reverse esterification reactions. Erucin, an isothiocyanate, was isolated from *Eruca stavia* and used as a precursor molecule for the synthesis of benzazole and thiourea derivatives. These molecules are widely used as pharmaceuticals and have high economical and industrial potential.

Our team developed green technology for the production of steviol glycosides from *Stevia rebaudiana* and selected a rebaudioside A enriched genotype of *S. rebaudiana*. Efforts have been intensified to transfer stevia-based technologies to multiple entrepreneurs.

In order to boost commercial floriculture, novel 'Him Glow' and 'Him Peace' cvs. of gerbera were released. Also, 16 novel hybrids of carnation and calla lily were procured and their agrotechnologies were standardized. In addition, our continuous efforts led to rediscovery of *Jasminum parkeri* Dunn. from Chamba region after a gap of ~100 years. *J. parkeri* has a huge potential to be developed as an ornamental.

Efforts for promotion of tea farm mechanization are continuing. A series of trainings imparted to farmers and small scale entrepreneurs significantly contributed to the social and economic objectives of our nation to uplift life of a common man. Conscious efforts were made to assess the

impact of the training and technology transfer with proper follow ups. Also, appropriate MoUs and liasions were established to extend the technologies developed by the institute for societal, industrial and environmental benefits.

The Centre for High Altitude Biology at Ribling (Lahaul & Spiti district) successfully introduced high value crops such as ginseng and lilium in the region. *Artemesia maritima*, a local speices, was successfully utilised to extract high value oil. The locals were empowered through trainings on preservation of their farm produce. The Centre is emerging as an important hub of upliftment of societies in the remote region of the state.

Dedicated research and innovation teams are relentlessly striving to make national and international marks through fundamental research and development of new technologies. For bioresource rich Himalay, bioeconomy strategy is set to provide "green" solutions for several environmental and societal challenges including natural resource management and energy security. Research towards bioeconomy is a step towards CSIR's commitment to evolve India into "Samarth Bharat" (competent India) and "Sashakt Bharat" (strong India).

Sanjay Kumar

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भारत में हिमालय 537 हजार वर्ग कि.मी. क्षेत्र में फैला है, जो अपनी समृद्ध और अनूठी जैवविविधता से भरपूर है। देश के कुल पुष्पणयुक्त पौधों के लगभग 50 प्रतिशत पौधे इसी क्षेत्र से प्राप्त होते हैं जिनमें से 30 प्रतिशत स्थानिक हैं। भारतीय हिमालय क्षेत्र की समृद्ध जैवविविधता जैवआर्थिकी (बायोइकोनॉमी) के क्षेत्र में अपार अवसर प्रदान करती है जिसके लिए खाद्य, चारा, औषध, सुगंध एवं ऊर्जा के क्षेत्र में सतत एवं आर्थिक विकास हेतु नवीन दृष्टिकोण से शोध की आवश्यकता हैं। तदनुसार, कृषि प्रौद्योगिकी एवं पादप सुधार, पादप रक्षण, खाद्य न्यूट्रास्यूटिक्ल एवं गुणवत्ता नियंत्रण, प्राकृतिक रसायनिकी एवं प्रक्रम विकास अनुकूलन जीविज्ञान एवं जलवायु परिवर्तन, जैवप्रौद्योगिकी तथा उच्च तुंगता जीवविज्ञान एवं पादप संरक्षण जैसी कार्यात्मक नई टीमों का गठन किया गया है। अपने शोध लक्ष्यों को प्राप्त करने के लिए विभिन्न टीमों का आपस में मिलकर काम करने की क्षमता ही हमारे संस्थान की पहचान है।

जैवआर्थिकी (बायोइकोनॉमी) की दिशा में अग्रसर होते हुए, फेगोपाइरम एसकुलेन्टम के उपयोग से ग्लूटोनमुक्त, एंटीऑक्सीडेंट से प्रचूर खाद्य उत्पाद विकसित किया गया है। अनार (प्यूनिका ग्रेनेटम) के फल प्रसंस्करण के बाद व्यर्थ छिलकों से पॉलीफिनॉल समृद्ध वृतिमूलक खाद्य विकसित किया गया। यह आइसोप्रोटेरनॉल द्वारा प्रेरित मध्य हृदयविकार को नाइट्रिक ऑक्साइड संकेतन पथ में सुधार करके रोकता है। केटेचिन, जो कि एक एंटीऑक्सीडेंड है, को बनाने की पद्धति को विकसित किया है, जिसकी विश्व में अत्याधिक मांग है, इसको सफलतापूर्वक उद्योगों को प्रदर्शित किया गया ताकि प्रयोगशाला के उत्पाद बाजारों तक पंहुच सकें।

सेब जो कि प्रदेश का व्यावसायिक फलों की फसल है, इसकी उत्पादकता तथा गुणवत्ता को विषाणु रोगों से काफी खतरा है। हमारी टीम ने सेब के विषाणुमुक्त गुणवत्ता वाले मूलकांड/रुट–स्टॉक बनाए हैं और इस जानकारी को जैवप्रौद्योगिकी आधारित उद्योग को हस्तांतरित किया ताकि देश में इसकी मांग को पूरा किया जा सके। सेबों में रोग प्रतिरोधक किस्मों के सुधार के लिए विभिन्न विभागों की बहुविशेषताओं को इस्तेमाल करके एक खाका तैयार कर लिया गया है।

संस्थान औषधि के परम्परागत ज्ञान को महत्वपूर्ण जैवअणुओं की पहचान के लिए उपयोग में ला रहा है। क्वेरसिटिन एक ऐसा महत्वपूर्ण व्यावसायिक पादप अणु है जिसको नेनो प्रावरण में परिवर्तित किया गया ताकि प्राणितन्त्र में इसकी दक्षता में सुधार हो। रोगों की पहचान के लिए नेनो कणों पर आधारित आण्विक इमेजिंग जांच को विकसित करने के प्रयास चल रहे हैं। इसके अतिरिक्त केलिस्टिमोन सिट्रिनस के फूलों व पत्तों में मस्तिष्क और फेफड़ों के कैंसर के लिए प्रतिरोधक क्षमता पाई गई।

थर्मोस्टेबल एन्जाइम, सुपर ऑक्साइड डिस्म्यूटेज (SOD) की खोज व इसकी प्रौद्योगिकी का विकास तथा सफलतापूर्वक व्यावसायीकरण इस संस्थान के महत्वपूर्ण योगदानों में से एक है। इस दिशा में काम करते हुए अनुठे एन्जाइम (SOD) के अन्य स्रोतों की पहचान की गई है तथा 100 डिग्री से अधिक तापमान पर अनेकों बार गर्म करने के पश्चात भी एन्जाइम की स्थिरता के सुधार के लिए प्रक्रिया को विकसित कर लिया गया है। इस एन्जाइम के औद्योगिक उपयोग के अतिरिक्त ट्रांसजेनिक विधि का प्रयोग करते हुए एरोबिडोप्सिस पौधे में इस जीन का एसकोरबेट परॉक्सीडेज़ जीन के साथ मूल्यांकन किया गया। इन दोनों जीनों ने संयुक्त रूप से क्रियाशील आक्सीजनों का वर्धन किया जिससे लिग्निन संश्लेषण से संबन्धित जीन नेटवर्क प्रभावित हुए। संस्थान

अजैविक तनावों की वजह से होने वाले तनाब सहनशीलता के सुधार के लिए फसलों में इन जीनों के हस्तांतरण करने की संभावना पर विचार किया जा रहा है।

आधारभूत विज्ञान के मूद्दे लगातार रुचियुक्त होते है क्योंकि इससे ही नई प्रौद्यागिकी के विकास के लिए आधार तैयार होता है। पादप विज्ञान में एक महत्वपूर्ण मुद्दा है कि 'क्यों कुछ पेड़ों की प्रजातियां हमेशा सदाबहार होतीं हैं जबकि कुछ अन्य पर्णपाती व्यवहार का प्रदर्शन करती हैं ? इस क्षेत्र में कार्य से एक विस्तृत जीन नेटवर्क और प्रक्रियाओं का पता चला जिससे कोशिका भित्तियों का अवस्तरण करने वाले एन्जाइमों जैसे सेलुलेज व पॉलीगेलक्टोयुरोनेज के महत्व दर्शित हुए तथा पत्तियों के अलगाव के नियंत्रण में इनकी भूमिका का पता लगा।

संस्थान ने पिक्रोराइजा कुरुआ, सिनोपोडोफिलम हैक्सेड्रम, चाय और सेब जैसी व्यावसायिक दृष्टि से महत्वपूर्ण चुनी हुई पादप प्रजातियों के ट्रांसक्रिप्टोम अनुक्रमण के द्वारा प्रक्रियाएं स्पष्ट करने में पहल की है। इसके अतिरिक्त पहली बार पादप निकायों miRNA नियंत्रित एपिजेनेटिक रेगुलेटरी नेटवर्क मॉडल को स्थापित किया गया है। समस्त भारतीय हिमालय क्षेत्र में सिनोपोडोफिलम हैक्सेड्रम समष्टियों के आण्विक फिंगरप्रिंटिंग में हमारे प्रयासों से किसी भी भौगोलिक क्षेत्र से परे इसके दो आनुवांशिक समष्टियों की पुष्टि हुई है। जिससे यह पता चलता है कि बदलते पर्यावरण में भी सी. हैक्सेंड्रम ने अपने आपको अच्छी प्रकार से स्थापित कर लिया है। इस खोज से मूल्यवान औषधीय पौधों के श्रेष्ठ जर्मप्लाजम के चयन द्वारा संरक्षण पद्धति को सुनिश्चित करने और सतत जैवआर्थिकी के सुधार में सहायता मिलेगी।

एड्होटोडा वेसिका की पत्तियों में बहुतायत में उपलब्ध एल्कालॉयड वेसिसिन को C-H सक्रियण और अपचयन क्रियाओं में ओर्गेनोकेटलिस्ट के रूप में खोज की गई। नई पीढ़ी के सहायक नेनोउत्प्रेरकों को भी विकसित किया गया जिनका प्रयोग पॉलीफिनॉल, विनायल ट्राईजॉल के संश्लेशण व चुनौतीपूर्ण रिवर्स एस्टरीफिकेशन क्रियाओं में किया गया। इरुका स्टाइवा से प्राप्त एक आइसोथायोसायनेट इरुसिन को अग्रगामी यौगिक की तरह प्रयोग कर बेंजाजॉल व थायोयुरिया व्यूत्पन्न बनाए गए। ये यौगिक फार्मास्यूटिक्ल में व्यापक रूप से प्रयुक्त हो रहे हैं तथा इसकी आर्थिक और औद्योगिक संभावना बहुत उच्च है।

हमारी टीम ने स्टीविया रेबोडियाना से स्टीवियोल ग्लाइकोसाइड के उत्पादन के लिए एक हरित प्रौद्योगिकी विकसित की है तथा इस पौधे के रिबॉडियोसाइड–ए से प्रचूरित जीन प्रारुप का चयन किया है। स्टीविया आधारित प्रौद्योगिकी को बहुआयामी उद्यमों को हस्तातंरित करने के प्रयास किए जा रहे हैं।

व्यावसायिक पुष्पखेती को बढ़ावा देने के लिए जरबेरा की नवीन 'हिम ग्लो' तथा 'हिम पीस' किस्में जारी की गई। कारनेशन और कैला लिलि के 16 संकरों को एकत्रित करके उनकी कृषि तकनीक को मानकित किया जा रहा है। इसके अतिरिक्त हमारे लगातार प्रयासों से चम्बा क्षेत्र से 100 वर्षों के अन्तर के बाद जेसमिन परकेरी की पुनः खोज की गई है। इसको आभूषक पौधे के रूप में प्रस्तुत करने में अपार संभावनाएं हैं।

चाय बागानों के मशीनीकरण को बढ़ावा देने के प्रयास लगातार जारी हैं। राष्ट्र के सामाजिक और आर्थिक उद्देश्यों की पूर्ति हेतु किसानों और लघु उद्यमियों को लगातार प्रशिक्षण से हम आम आदमी के जीवन के उत्थान के लिए महत्वपूर्ण योगदान कर रहे हैं। इन प्रशिक्षणों और प्रौद्योगिकी हस्तातंरण के प्रभाव को जानने के लिए उचित प्रकार से लगातार प्रयास किए जा रहे हैं। साथ ही संस्थान द्वारा सामाजिक, औद्योगिक और पर्यावरणीय लाभ के लिए विकसित प्रौद्योगिकी को आगे पंहुचाने के लिए उपयुक्त अनुबंध और संपर्क स्थापित किए जा रहे हैं।

रिबलिंग (लाहौल एवं स्पीति जिला) में स्थित उच्च तुंगता जीवविज्ञान केन्द्र ने इस क्षेत्र में जिनसेंग और लिलियम जैसी उच्च मूल्यवान फसलों को सफलतापूर्वक स्थापित किया गया है। स्थानीय प्रजाति आर्टिमिजिया मेरिटिमा से उच्च मूल्यवान तेल का निष्कर्षण किया है और स्थानीय वासियों को स्थानीय उत्पादों के संरक्षण के लिए प्रशिक्षित किया है। यह केन्द्र राज्य के दूरदराज क्षेत्रों में समाज के उत्थान के लिए महत्वूपर्ण बिन्दु के रूप में उभर रहा है।

हमारी शोध और नवोन्मेषी समर्पित टीमें मौलिक शोध एवं नई प्रौद्योगिकी के विकास के माध्यम से राष्ट्रीय और अन्तर्राष्ट्रीय स्तर पर एक पहचान बनाने में प्रयासरत है। जैविक संसाधनों से समृद्ध हिमालय के लिए प्राकृतिक संसाधन प्रबन्ध एवं ऊर्जा सुरक्षा सहित विविध पर्यावरणीय और समाजिक चुनौतियों के लिए हरित उपाय प्रस्तुत करने के लिए जैव आर्थिकी पद्धति को स्थापित किया जा रहा है। जैवआर्थिकी की दिशा में हमारे शोध भारत को 'समर्थ भारत' और 'सशक्त भारत' बनाने की सीएसआईआर की प्रतिबद्धता को पूर्ण करने हेतु एक महत्वपूर्ण कदम है।

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CONTENTS

Adaptation Biology
and
Climate Change

- **Documenting species and ecosystem responses to climate change**
- **Identifying and characterizing genes involved in plant stress tolerance**
- **Mapping and classifying bioresources**
- **Developing online information systems on plants**

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Research area: Adaptive biology and climate change research

Developing indices for native plant species response to elevated CO_2 concentration (550 ±50 µmol mol^{-1}) in Himalaya: How would plant species respond to increased levels of atmospheric CO_2 and temperature that is likely to affect photosynthesis and subsequently the related metabolism?, continue to interest research workers around the world. Free air CO_2 enrichment (FACE) is currently the best technique to study plant responses under near natural environmental conditions and to develop indices for predictive models. The technique has extensively been used to study behaviour of crop and native plants in the developed nations but data from diverse ecosystems and different geographical regions of the world (mostly from areas inhabited by under-developed or developing countries) continue to remain scarce. At CSIR-IHBT, species native to Himalaya like, *Hypericum perforatum*, *Picrorhiza kurrooa, Taraxacum officinale* (low and high altitude population), *Valeriana jatamansi* are being studied at periodic intervals (growth stages, seasonal) under the FACE environment.

Is the shift in photosynthetic response triggered by low partial pressure of CO_2 (at high altitude) comparable to that at low concentration of Co_2? (within Elongated Chamber; EC): Our earlier work showed that some plants at high altitude exhibited adaptive strategies by undergoing a photosynthetic shift whereby activities of ribulose 1-5, bisphosphate carboxylase-oxygenase (Rubisco), PEPCase, aspartate aminotransferase (AspAT) and glutamine synthetase (GS) increased to contribute to plants enhanced efficiency of CO_2 uptake, apparently to overcome the reduced partial pressure of CO_2. The current study aimed to evaluate the response under low concentration of CO_2. To develop atmosphere of low CO_2 concentration, EC facility was developed at CSIR-IHBT. It is a sixty meter long enclosed space constituted by ten interconnected chambers (each of 10 m length) wherein plants (currently altitudinal populations *Rumex nepalensis* and *Trifolium repens* representing 1300m and 3800m) were grown. $CO_2$is fixed by plants continuously in each chamber and its concentration drops in the next chamber, as air from first chamber is made to flow to second and likewise series of subsequent chambers, before finally exiting through last. Atmosphere of declining CO_2concentrations is thus created, and CO_2 concentration of 260 (± 20) µmol $mol^{-1}$was achieved in the tenth chamber in the current experiment.

The low as well as high altitudinal populations of *R. nepalensis* and *T. repens* exhibited enhanced photosynthetic and stomatal conductance (g_s) response thus suggesting acclimation to low concentration of CO_2. This stomatal acclimation was supported by greater stomatal size than their number per unit area. All high altitude populations showed greater g_s response, while species-wise, greater g_s response was observed for *R. nepalensis.* Enzymatic data suggested that photosynthetic acclimation was supported by enhanced enzyme activities of Rubisco, PEPCase, AspAT and GS.

Does phenotypic plasticity alone support wide altitudinal (800 - 4000m) distribution of *R. nepalensis* in Himalaya? Many plant species in high mountains, such as Himalaya, have either narrow or wide altitudinal range of distribution. Plants in the latter category are often exposed to contrasting set of environmental variables (partial pressure of CO_2, temperature, light etc.) at their extreme ends of inhabitation. An area of great interest therefore is to know basis of their adaptive behaviour along the wide altitudinal range to understand i) as to how they optimize growth and performance under the changing environmental variables, and ii) vulnerability of altitudinal ecotype if any, under the climate change scenario. To answer the above, *in situ* studies and *ex-situ* performance of seed raised populations of *R. nepalensis* representing altitudes of 800m, 1300m, 2200m & 4000m were studied under greenhouse conditions. Our result showed that both, phenotypic plasticity and ecotypic differentiation contributed for the wide altitudinal spread (800-4000m) of *R. nepalensis* in Himalaya. The alpine population of the species germinated faster at low temperature, exhibited a compressed phenophase cycle and retained efficient photosynthetic behaviour. These traits which were of adaptive significance under 'harsh' conditions of alpine environment were retained by the ecotype under ex-situ conditions. However, under climate change scenario, the species could face a renewed intra-specific competition that could redefine advantage associated with functional and phenological behaviour of alpine ecotype of *R. nepalensis.*

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Research area: Biodiversity, ecology and resource use documentation

Floral surveys and species richness: The main objective behind surveys is to provide a comprehensive information on the floral resources of HP and prioritize them for further studies. Based on the analyses of primary and secondary information, we found that after the publication of Flora of HP (1984), estimates of species in HP have increased by 14.85%, of genera by 10.46% and of families by 9.60%. Of all the species additions, more than 40% are accounted for by families viz., Asteraceae, Leguminosae, Poaceae. Scrophulariaceae, Orchidaceae, Rosaceae, Brassicaceae, Caryophyllaceae, Cyperaceae, Euphorbiaceae and Lamiaceae (Fig. 1).With respect to localities, trans-Himalayan region of the state requires further explorations as most of the new species have been discovered from this region.

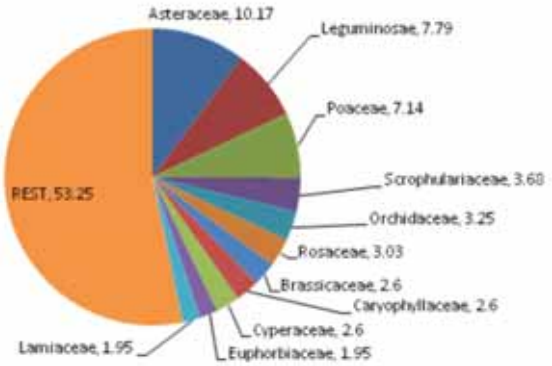

Fig. 1 Addition of species in different families (number after family name represent %)

Studies on plant phenology: Phenology refers to the temporal patterns of biological events such as leafing, flowering, fruiting, etc, occurring in a species. Argued to be amongst the best indicators of changing climatic conditions, documenting plant phenology is a contemporary issue. The group, therefore, initiated and prepared a phenological calendar of *Sapium sebiferum,* an invasive tree species in the Himalaya, using as Biologische Bundesanstalt, Bundessortenamt and CHemical industry (BBCH) scale. Eight principal growth stages that can be further divided into 24 secondary growth stages were identified for the species (Fig. 2). These growth stages started with bud development (stage 01) in the month of March and ended with leaf fall (stage 97) in the month of December. Automated phenological documentation using repeat photography has also been initiated.

Fig. 2 Phenological stages of *Sapium sebiferum* identified based on BBCH scale

Litter decomposition studies: Litter refers to the dead material of plant origin that has been shed onto the ground. Litter fall and its decomposition are important for nutrient re-cycling. High litter fall and its rapid decomposition is a key trait of invasive species. Litter fall and its decay in *Sapium sebiferum* revealed high litter fall during November (1.16 Mg ha^{-1} y^{-1} in under-canopy and 0.38 Mg ha^{-1} y^{-1} in canopy gap). The decay rate of the same was found to be 0.46% day^{-1} in under-canopy and 0.48% day^{-1} in canopy gaps.

Developing online databases on floral resources of HP: The need for timely and seamless sharing of information has resulted in coming up of online information systems. Our group is engaged in designing and developing a Bioresource Information System for the flora of HP. During the current year, information on ~500 alien plant species has been entered in this MySql database. The database in addition to taxonomy has information about the nativity, time of probable introduction, mode of introduction and status of the alien species

Long term ecological research plots: Documenting patterns of changing climatic conditions on the forest ecosystem is a priority research area. During this year our group established a network of 12 permanent plots along an altitudinal gradient in western Himalaya. In all these plots data loggers have been installed.

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- Ahmad M, Choudhary I, Jaryan V and Uniyal SK (2014) Vegetation and soil characteristics of plantations in a part of western Himalaya. *Indian Journal of Forestry,* 37: 57-66
- Kumar A, Singh KN, Lal B, Chawla A, Uniyal SK, Kaushal R, Singh RD and Ahuja PS (2014) Regenerat\ion pattern of tree species in forested landscapes of Himachal Pradesh, western Himalayan region, India. *Proceedings of the National Academy of Sciences, India Section B: Biological* Sciences, 84(3):695–707.
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Research area: Geospatial mapping and database development on bioresources in western Himalaya

Our endeavor is to generate geospatial information on bioresources of western Himalayan region for their effective conservation and management. The Remote Sensing (RS) satellite images provide latest, timely and accurate information on ground conditions. These data when accompanied with field surveys provide primary information on forested landscapes, while already published data is known as secondary information. The Geographic Information System (GIS) is capable of handling and analyzing such multilayered spatial and collateral primary and secondary information leading to formulation of strategies or action plans on bioresources.

This year our focus was on following activities:

Field Surveys

Reconnaissance surveys were conducted in Kothi-Koher region of Kangra district in June 2014 and Chanshal area of Shimla district in August 2014 to find out possible sites for long term ecological research. The Chansal pass was visited again in October 2014 for establishment of permanent plots. The ground truthing was done in Bankhandi, Haripur and Nagrota Surian and surrounding localities of Kangra district in March 2015 for collection of training sets for land use/land cover mapping.Literature surveys were carried out to know the distribution of fern species in HP. The locations of their occurrence were plotted in GIS environment. These activities resulted in maps depicting spatial distribution of 60 targeted ferns species belonging to six genera in HP (Fig.1).

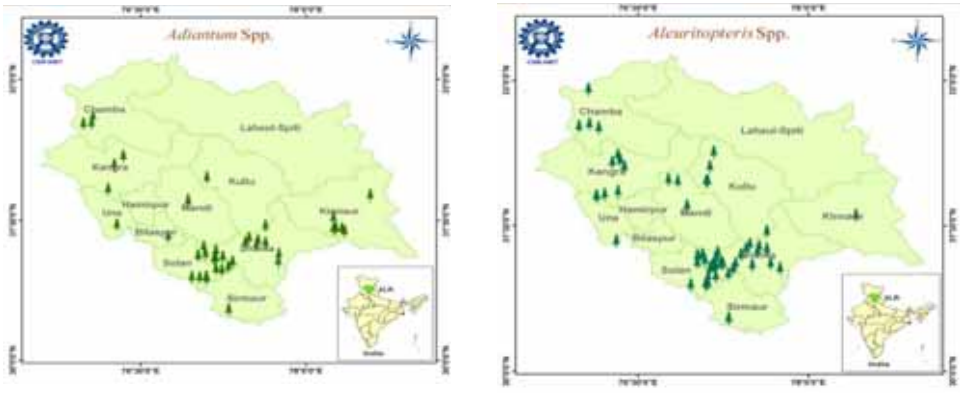

Fig. 1 Maps depicting geographical distribution of some of the targeted fern species in HP

Study on regeneration pattern of tree species in HP

The regeneration pattern of tree species in four agro-climatic zones (I, II, III and IV) was studied by way of stratified random quadrat sampling at 58 forest locations. These localities were observed to be dominated by 18 tree species representing 23 forest landscape elements (LSEs). The zone I in general had poor to no regeneration pattern while other zones generally had fair regeneration of trees.

Estimation of soil erosion in Kangra Disrict (HP)

The sheet/reel soil erosion in Kangra region was estimated using revised universal soil loss equation (RUSLE) modelling. The overall rate of soil depletion in the district was estimated at 25.63 t/ha/yr (Fig. 2).

Establishment of HIMADRI sites for climate change studies

Under Himalayan Alpine Dynamics Research Initiative (HIMADRI) initiative of Indian Space Research Organisation (ISRO), permanent plots were established at Chansal pass region of Rohru district at upper alpine (3900 m), lower alpine (3770 m) and tree line (3600 m) regions (Fig. 3). The similar HIMADRI sites have also been marked in Jammu & Kashmir, Uttarakhand, Sikkim and Arunachal Pradesh by other network organisations. Ecological data recorded from these sites will serve as baseline information for climate change research in Himalayan region.

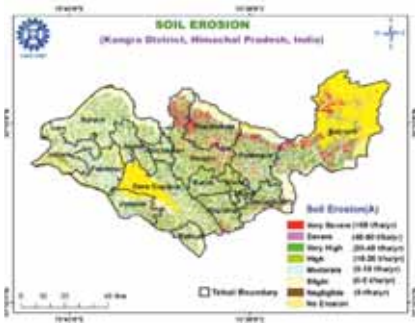

Fig. 2 Maps depicting soil erosion in Kangra District

Fig. 3 HIMADRI permanent plots for long term ecological research

A digital directory of floral resources of Himachal Pradesh, namely 'him-Padap-Sankalan', was prepared using ASP.net and MS-Access (Fig. 4). This information have been compiled from published sources, primarily from the 'Flora of HP: Analysis' (Chowdhery and Wadhwa, 1984). The nomenclature, taxonomic classification, local name(s), trade name(s) and uses of 3348 plants along with maps showing their spatial distribution can be retrieved using its user friendly graphic user interface.

Fig. 4 Graphic User Interface of 'him-Padap-Sanklan'
(Source: Computational Ecology and Software, 2014, 4(3): 183-192)

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- Kumar A and Dhiman R (2014) Manual and automated delineation of watershed boundaries– a case study from Kangra region of western Himalaya, India. *International Journal of Environmental Sciences*, 5(1):16-22.
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Research area: Plant functional genomics

Deciphering the mechanism of higher lignification in transgenic *Arabidopsis thaliana* overexpressing *PaSOD* and *RaAPX* genes from high altitude plants *Potentilla atrosanguinea* and *Rheum australe*, respectively

Abiotic stresses leads to accumulation of reactive oxygen species (ROS), such as hydrogen peroxide (H_2O_2) in plants. Antioxidant machinery maintains optimum level of H_2O_2 that acts as signalling molecule, which regulate plant adaptation against salinity stress. Genes encoding PaSOD and RaAPX cloned from *P. atrosanguinea* and *R. australe*, respectively were overexpressed individually as well as in combination in *Arabidopsis thaliana.* The cotyledonary explants of PaSOD overexpressing transgenic Arabidopsis exhibit early callus induction and high shoot regenerative capacity than wild type (WT) explants. Transgenic plants also performed better in terms of growth, total biomass and yield under salt stress w.r.t WT plants. Intriguingly, *PaSOD* and dual transgenic plants were found to exhibit higher lignin accumulation in their vascular bundles under salt stress. In order to understand the mechanism of enhanced lignification RNA-seq analysis of transgenic as well as of WT was performed under control and salt stress conditions. RNA-seq analysis showed that expression of lignin biosynthesis genes and transcription factors (NACs, MYBs, C3Hs and WRKY) was upregulated in *PaSOD* overexpressing single and dual transgenics plants, that led to higher accumulation of lignin in vascular tissues. Our results suggest that ROS generated during salt stress gets converted into H_2O_2 by SOD and optimum level of H_2O_2 was maintained by APX. This H_2O_2 acts as secondary messenger for transcriptional activation of lignin biosynthesis, which provides mechanical strength to plants to withstand adverse effects of salt stress. These findings reveal an important role of SOD and APX in enhancing salt tolerance of transgenic *Arabidopsis.*

Identification of a senescence associated gene cathepsin B cysteine protease in *Picrorhiza kurrooa*

Picrorhiza (*Picrorhiza kurrooa* Royle ex Benth) is a medicinally important herb of western Himalayan region, which falls under endangered species in Red Data Book. It was observed that in addition to rhizome and roots, leaves are also a good source of picrosides, the main medicinally active compounds. However, the picroside content reduces sharply during the senescence phase. Therefore, a better understanding of leaf senescence in *Picrorhiza* will help in devising molecular strategies for delaying leaf senescence. A senescence associated gene Pk-cbcp encoding cathepsin B cysteine protease was identified and cloned from *Picrorhiza*. Expression analysis revealed upregulation of Pk-cbcp during senescence compared to that

of pre-senescence stage. Application of phytohormones abscisic acid, jasmonic acid and cytokinin influenced the temporal expression status of Pk-cbcp. Abscisic acid and jasmonic acid increased the expression level whereas cytokinin reduced the expression. The findings suggest the role of Pk-cbcp in leaf senescence in *Picrorhiza* which may be differentially regulated through phytohormones.

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- Shafi A, Gill T, Sreenivasulu Y, Kumar S, Ahuja PS and Singh AK (2015) Improved callus induction, shoot regeneration, and salt stress tolerance in Arabidopsis overexpressing superoxide dismutase from Potentilla atrosanguinea. *Protoplasma*, 252:41-51.
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Participants: Parul Goel, Monika Bhuria, Gulshan Kumar, Vishal Sharma, Usha Kumari Ratan, Khushboo Gupta, Rakesh Kumar Singh, Mamta, Robin Joshi and Mohit Kumar Swarnkar.

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Research area: Crop modeling and carbon dynamics

Carbon density of tea: Recent projections of climatic change have focused on a great deal of scientific attention on carbon (C) dynamics, particularly the factors that determine whether an ecosystem is a net source or sink of atmospheric carbon dioxide. The study of C dynamics for any ecosystem represents the different pools and fluxes of carbon in different component. Therefore, quantifying C density of any vegetation system is a vital effort for assessing the C pool for that ecosystem. Tea (*Camellia sinensis*) is an important mandate crop of our institute, which has greater magnitude to store long term C in different component *viz.* soil, litter and plant because of its long life span. In India, tea industry is more than 170 years old and approximately 5,79,000 ha area are under the cultivation and the indigenous varieties of this plant have covered a large part of the area. In this study, C density of soil as well as different components of tea plant *viz.* leaf, stem, litter and root of tea were estimated. The study was conducted at Banuri Tea Experimental Farm of the CSIR-IHBT located at 32°7'N latitude and 76°32'E longitude and altitude of 1219 meters above mean sea level. The soil organic C density up to 10 cm depth in tea field was 24.4 t ha^{-1}. In comparison to soil, tea plant sequestered 4.05 % less carbon per hectare. The greatest percentage of total C measured in tea plants was allocated within the stem (48%), followed by roots (37.1%) and foliage (13.1%). The C density of tea crop was found higher than the cereals crops of agricultural ecosystems and lower than that of the forests.

Agrotechnology and Plant Improvement

Agrotechnology and plant improvement for enhanced crop productivity

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Research area: Agronomy- plantation crops

Crop improvement: Crop yield evaluation of the tea germplasm raised from selected mother bushes of Kangra Jat and biclonal seed stocks with initial productivity of over 1,500 KMTH (Made tea kg/ha) was continued so that elite planting material could be developed. The accessions CEF-01 and CEF-03 among China hybrid tea and SST-09 and SST-02 the Assam type tea selections among the biclonal seed stock populations in Germplasm Block-G showed better productivity as in the previous years. In Germplasm Block-F, contrary to the mean yield of past four years, productivity of the China hybrid accession BGP-156 in 2014 was better than the control clone UPASI-9.

Large cardamom (*Amomum subulatum*) is low volume, high value and environment friendly cash crop, requiring low inputs for sustenance. Mid-hill areas in Himachal Pradesh including parts of Kangra, Chamba, Mandi, Hamirpur, Bilaspur and Sirmour have been found to be suitable for large cardamom cultivation. In the previous years, CSIR-IHBT has demonstrated its successful cultivation by using suitable cultivars and management practices and provided the nucleus planting material to the growers. This year also 480 vegetative propagated nursery plants of suitable cultivars were supplied to the growers of the region. Two trainings were arranged to the interested growers on cultivation techniques of this crop.

One of the most demanded and marketable floriculture crops in this region is marigold. Being a multipurpose flower for every-occasion decoration and for worship in the nearby temple, growers find it an easy to sell crop. Four demonstration plots of ornamental marigold cultivar 'Pusa Narangi' were established in and around of Gopalpur area.

Rural empowerment: In a pursuit of strengthening livelihood of the rural masses, empowerment of the rural youth, women and farmers, this institute has been actively involved under the aegis of CSIR Rural Development Programme.Considering the potential of mushrooms for income enhancement of the rural women in this region, mushroom cultivation was introduced in Gopalpur-Chachian region. Regular need based advisory was extended to these growers throughout the season through an expert.

Rural development activities were also pursued through AcSIR students under CSIR-800, where focus wason a cluster of villages in and around Gopalpur-Chachian region in Kangra district. Activities undertaken includes surveillance and water quality monitoring, assessment of prevalence of anemia among women, scenario of polyhouse cultivation, socio-economic survey and development plan for the selected gram panchayats, survey of incidence of disease of important vegetable crops and analysis of state road network system.

For popularization of the Institute's technologies relevant to the farming community, coordinated telecast of 10 programmes on Doordarshan Kendra Shimla viz., important plant bioresources and medicinal crops, newly released cultivars of stevia and gerbera, value added products from bamboo and hand card making. A talk on Tea Farm Mechanization was also delivered on local cable network channel.

For promotion of innovation in individuals, start-ups and MSMEs (PRISM, a programme of DSIR, New

Delhi), the activities were undertaken as a coordinator of the Centre at the Institute include designing a website (www.ihbt.res.in/PRISM) containing all details of the scheme and application forms and linked it to DSIR website, wide publicity in print and electronic media through news and advertisement for inviting proposals, interaction with industries, academic and research institutes in the region.

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Book chapter:

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Research area: Plant breeding

Breeding Gerberas: Gerbera (*Gerbera jamesonii*) is an important commercial cut flower crop due to its numerous colours, shapes and prolonged vase life. There is an increasing demand of quality gerbera cut flowers, planting material and new types of varieties. Gerbera is out crossing in nature and the possibility of genotype fixation by clonal propagation unfolds a large potential for novel cultivar development. We focused on field performance of two promising gerbera genotypes (IHBT-Gr-23-1 and IHBT-Gr-E-3) developed through hybridization program having improved floral traits (Fig. 1; Table 1) under polyhouse conditions over two consecutive years in comparison to parental genotypes.

Fig.1 Flowers of gerbera genotypes IHBT-Gr-23-1 and IHBT-Gr-E-3 (left and right, respectively)

Table 1. Salient features of gerbera genotypes IHBT-Gr-23-1 and IHBT-Gr-E-3

Salient Features	IHBT-Gr-23-1	IHBT-Gr-E-3
Stem length (cm)	41.2	33.1
Flower head type	Double	Double
Flower diameter (cm)	10.8	7.9
No. of flowers per plant in a year	23.5	18.8
No. of flowers per square meter in a year	210	170
Colour of leaves	Dark green	Dark green
Outer colour of petals	Yellow orange (RHS 16C)	White (RHS 155D)
Inner colour of petals	Yellow orange (RHS 16C)	White (RHS 155D)
Disc colour	Green	Green
Diameter of Inner ray florets (cm)	6.7	5.6
Flower type	Standard	Dwarf

Based on mean performance of hybrid gerbera genotypes with the respective parents, E-3 was superior to at least one parental genotype for traits plant spread in a year, leaf length and width (cm), while it was *at par* to parental genotypes for the other traits. In case of 23-1, the genotype was superior to at least one parental genotype for leaf width (cm), number of flowers per plant in a year and scape length.

***In vitro* mass multiplication of gerbera genotypes:** Vegetative propagation of gerbera genotypes can be done through clump division, but rate of multiplication is too slow for commercial purposes. *In vitro* culturing is an important tool to produce disease free plants on large scale. The protocol for shoot regeneration, multiplication and root induction is being used at the Institute for mass multiplication of gerbera plants (Fig. 2). A large number of *in vitro* rooted plantlets of gerbera were successfully hardened in plastic trays containing sand, and covered with plastic bag to maintain humidity. After about three weeks of acclimatization they were transplanted in sleeves for further cultivation in soil. The new gerbera hybrid genotypes showed high growth response to *in vitro* proliferation as compared to other gerbera genotypes and have good potential for commercialization.

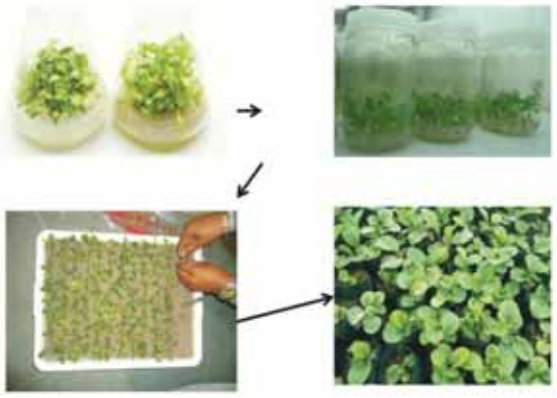

Fig. 2 *In vitro* propagation, root induction and hardening of tissue culture raised gerbera plantlets and their maintenance in nursery

Participants: Somu Koundal, Akhil Sharma, Jyoti Sharma and Balwant Raj.

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Research area: Agronomy, medicinal and aromatic plants, climate change

Development of agrotechnologies for medicinal and aromatic plants: Our group is involved in development of production technologies of medicinal, aromatic plants and industrial crops *viz*., damask rose (*Rosa damascena* Mill.), stevia (*Stevia rebaudiana* Bertoni), saffron (*Crocus sativus* L) and vacha (*Acorus calamus*) etc. Focus is on studying crop weather relationship of damask rose, growth and phenology of selected Himalayan species under elevated CO_2 and temperature conditions. A hypothesis was developed that the chemical constituents of damask rose essential oil are eluted at different times during the hydrodistillation process and vary with flower to water ratios, resulting in oils with different composition. While studying the effect of flower to water ratio (1:2; 1:3; 1.4 and 1:5) and distillation time (3, 4 and 5 h) on essential oil content and composition of damask rose, it was concluded that damask rose flowers should be distilled with flower to water ratio of 1:2 for 3 h distillation for high yield.

Studies on the effect of mulch (no mulch, white polythene mulch, black polythene mulch) and growth regulating factors (no pinching, manual pinching, maleic hydrazide @750 ppm, maleic hydrazide @1500 ppm) on stevia (*Stevia rebaudiana* Bertoni) revelaed that black polythene mulch and pinching treatment produced significantly higher dry leaf biomass yield. Black polythene mulch recorded 57.3% and 21.0% higher dry leaf biomass as compared to control (without mulch) in 2013 and 2014, respectively. On other hand manual pinching of stevia plants also produced 25.2% and 14.0% higher dry leaf biomass yield in 2013 and 2014 as compared to control. It was also observed that steviol glycosides accumulation changed with different harvesting dates. Harvesting stevia during second fortnight of July produced higher steviol glycoside, leaf biomass and stem biomass under western Himalayan conditions.

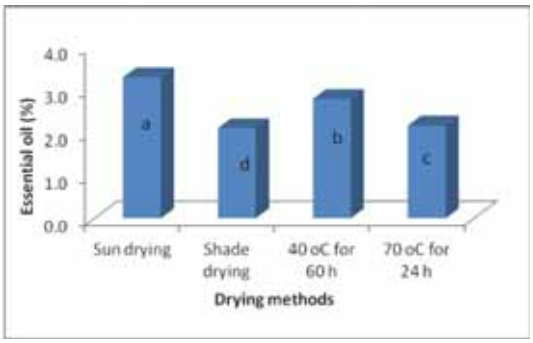

Fig. 1 Effect of drying methods on essential oil (%) of *Acorus calamus*

Effect of different drying methods (sun drying, shade drying, oven drying at 40 °C for 60 h and 70 °C for 24 h) on essential oil content and composition of *Acorus calamus* rhizomes revealed that sun drying had significantly higher essential oil content as compared to other methods (Fig.1). However, β-asarone

(53.9±0.1%), which is not desired in higher concentration was low in oven drying at 40 °C for 60 h as compared to other drying methods (Table 1).

Table 1. Effect of drying conditions on major compounds of *Acorus calamus*.

Compounds	RI Lit.	RI Expt.	Drying conditions			
			Sun drying	Shade drying	Oven drying at 40 °C for 60 h	Oven drying at 70 °C for 24 h
β-Asarone	1622	1637	67.2±2.9	59.5±0.6	53.9±0.1	58.6±1.2
α-Asarone	1679	1694	5.0±0.6	6.3±0.0	8.1±0.0	7.1±0.1

RI: Retention index; data represent means ± standard deviation of duplicate samples.

Effect of elevated CO_2 and temperature on phenology and dry matter accumulation in plants: Response of elevated CO_2 and temperature under FACE and FATI were studied on two medicinal plants *viz*., *Hypericum perforatum and Valeriana jatamansi*. Total dry biomass of *H. perforatum* was also not affected at 6 months after exposure (MAE), however significantly higher biomass in FACE at 8 MAE as compared to FATI but remained at par with ambient conditions (Fig. 2). Flower initiations of *H. perforatum* were significantly enhanced by elevated temperature as compared to ambient and FACE .

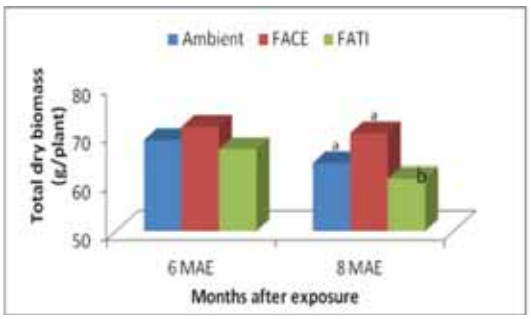

Fig. 2 Effect of elevated CO_2 and temperature on total dry biomass (g/plant) of *H. perforatum*

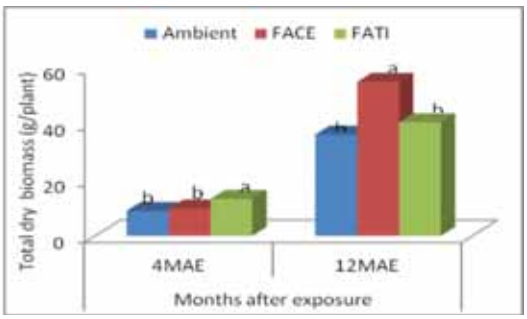

Fig. 3 Effect of elevated CO_2 and temerature on total dry biomass of *V. jatamansi*

Elevated temperature (FATI) recorded significantly higher total dry biomass of *Valeriana jatamansi* at 4 months after exposure as compared to FACE and ambient**.** However, FACE recorded significantly higher biomass at 12 MAE as compared to FATI and ambient (Fig. 3). Flower initiation was also significantly enhanced by elevated temperature.

Publications:

- Kumar R, Sharma S and Sood S (2014) Yield components, light interception and marker compound accumulation of stevia (*Stevia rebaudiana* Bertoni) affected by planting material and plant density under western Himalayas. *Archives of Agronomy and Soil Science*, 60(12): 1731-1745.
- Kumar R, Sharma S, Ramesh K, Pathania V and Prasad R (2014) Irradiance stress and plant spacing effect on growth, biomass and quality of wild marigold (*Tagetes minuta* L.)- an industrial crop of western Himalaya. *Journal of Essential Oil Research*, 26(5): 348-358.

- Kumar R, Sharma S, Sood S, Agnihotri VK, Singh V and Singh B (2014) Evaluation of several *Rosa damascena* varieties and *Rosa bourboniana* accession for essential oil content and composition in western Himalayas. *Journal of Essential Oil Research*, 26(3): 147-152.
- Kumar R, Sood S, Sharma S, Kasana RC, Pathania VL, Singh B and Singh RD (2014) Effect of plant spacing and organic mulch on growth, yield and quality of natural sweetener- *Stevia rebaudiana* Bertoni and soil fertility in western Himalayas. *International Journal of Plant Production*, 8(3): 311-334.
- Kumar R, Sharma S and Sharma M (2014) Growth and yield of natural sweetener plant stevia as affected by pinching. *Indian Journal of Plant Physiology*, 19(2): 119-126.

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Research area: Standardization of agro-technology practices

Standardization of agronomic practices of different medicinal and aromatic plants *Stevia rebaudiana*: The leaf biomass of stevia and accumulation of steviol glycosides in leaves generally depends on growing conditions and agronomic practices. Among the agronomic practices, the optimum plant population with proper crop geometry is an important factor for higher leaf yield. Thus, a field experiment was conducted at CSIR-IHBT Palampur and Punjab Agricultural University (PAU), Ludhiana to standardize the plant population and crop geometry for higher yield. Results revealed that, dry leaf yield of stevia was not significantly ($P \leq 0.05$) affected by the planting geometry at both the locations. On the other hand, in annual cropping system, irrespective of planting geometry, dense population (111100 plant ha^{-1}) significantly ($P \leq 0.05$) increased dry leaf yield (t ha^{-1}) by about 94 and 78% compared with thin population (40000 plant ha^{-1}) at CSIR-IHBT and PAU conditions, respectively (Fig. 1). The accumulation of steviol glycosides (stevioside and rebaudioside-A) was not considerably affected by planting geometry and plant population.

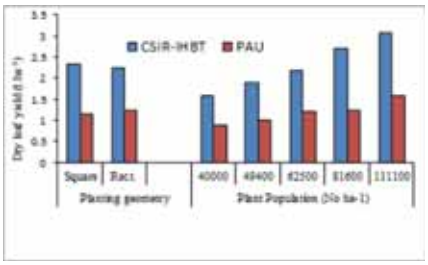
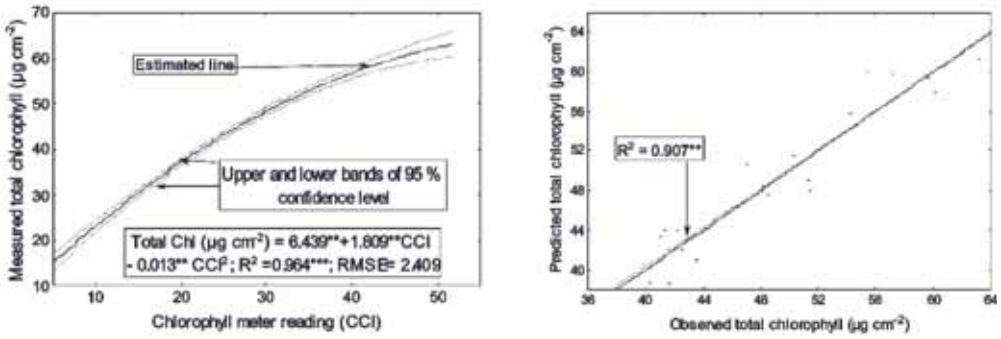


Fig. 1. Effect of planting geometry and plant population on dry leaf yield of stevia

***Rosa damascena*:** The interactive effects of foliar application of plant nutrients and kinetin and its time of application on yield and secondary metabolites profile of *Rosa damascena* under acidic conditions are still unclear. Therefore, a field experiment comprising two different times of spray and five foliar (water spray (control), KNO_3, $CuSO_4$, Kinetin and Ca $(NO_3)_2$) spray treatments was conducted. Results showed that, the foliar spray at flower bud appearance stage (S_2) significantly ($P \leq 0.05$) increased flower yield by 10% as compared to foliar application at axillary bud development stage (S_1), regardless of plant nutrients. Among the foliar spray treatments, irrespective of time of application, kinetin @ 0.20 gL^{-1} registered about 23-39% higher flower yield compared to water spray; however, remained statistically at par ($P \leq 0.05$) with $Ca(NO_3)_2$ @ 4.06 gL^{-1}. However, the essential oil content (%) in flowers was not significantly ($P \geq 0.05$) influenced by the time of foliar spray and different concentrations of plant nutrients and plant hormone.

Valeriana jatamansi: Our group is also interested to develop the method for chlorophyll estimation in a nondestructive mode. The conventional methods for estimating the chlorophyll (Chl) content in leaves are analytical based destructive and time consuming, and these methods do not allow for studying the same sample over time. To resolve this problem, an experiment was conducted to ascertain whether the CCM-200, a hand-held Chl meter, could be effectively used to estimate Chl content of *V. jatamansi* in a non-destructive manner. The regression equations between CCM-200 reading and laboratory analyzed Chl values were developed for three accessions of *V. jatamansi* grown under two different conditions. In the present data-sets, second-degree polynomial regression model has been proven to be the best model with higher R^2 (R^2 = 0.852-0.964, $P \leq 0.01$) and lower Akaike Criterion Information (ACI) values (94.47-171.78) for all the cases (except poly house grown accession-3). The best result was found with accession-5 under open field conditions, with R^2 indicating that about 96% ($P \leq 0.01$) of the variation was explained by a second-degree polynomial model (Fig. 2a). The model predicted values of total Chl were also very close to traditionally measured values with an RMSE*v*< 2.50 µg cm^{-2} (Fig. 2b).



(a) (b)

Fig. 2 Relationship between (a) extracted total chlorophyll and CCM-200 readings, and (b) model predicted chlorophyll vs observed chlorophyll.

Publications:

- Mann TS, Agnihotri VK, Kumar D, Pal PK, Koundal R, Kumar A and Padwad YS (2014) In-vitro cytotoxic activity guided essential oil composition of flowering twigs of Stevia rebaudiana. *Natural Product Communications*, 9(5): 715-718.
- Pal PK, Agnihotri VK, Gopichand and Singh RD (2014) Impact of level and timing of pruning on flower yield and secondary metabolites profile of *Rosa damascene* under western Himalayan. *Industrial Crops and Products*, 52: 219-227.
- Pal PK, Kumar R, Guleria V, Mahajan M, Prasad R, Pathania V, Gill BS, Singh D, Gopichand, Singh B, Singh RD and Ahuja PS (2015) Crop-ecology and nutritional variability influence growth and secondary metabolites of *Stevia rebaudiana* Bertoni. *BMC Plant Biology*, 15:67 doi:10.1186/s12870-015-0457-x.

- Pal PK, Mahajan M, Prasad R and Pathania V, Singh B and Ahuja PS (2014) Harvesting regimes to optimize yield and quality in annual and perennial *Stevia rebaudiana* under sub-temperate conditions. *Industrial Crops and Products*, 65: 556-564.

Book chapter:

- Singh RD, Sud RK and Pal PK (2014) Integrated weed management in plantation crops. *In*: *Recent Advances in Weed Management* (Eds. Bhagirath Singh Chauhan and Gulshan Mahajan). Springer, New York.

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Research area: Plant breeding

Stevia: A clonal genotype (CSIR-IHBT-ST-01) of *Stevia rebaudiana* has been identified with a desirable glycoside profile. It has higher rebaudioside-A content as compared to check (Table 1 and Fig. 1) and has a potential to yield 3.68 t/ha of dry leaves during the second year of production (Table 2). It has high total glycoside content of 14.49% (on dry weight basis) at Palampur location. The selection performed consistently and is vigorous in growth as evaluated in field trials over a period of two years at Palampur location and has excellent nursery performance with respect to rooting and early establishment. It has compact stature and dark green leaves (Fig. 2).

Table 1. Steviol glycoside profile of genotype CSIR-IHBT-ST-01 (U-22-5-1)

Compounds (on dry leaf weight basis)	CSIR-IHBT-ST-01 (U-22-5-1)		Check (Canada-2-3-1)	
	2012-13	2013-14	2012-13	2013-14
Stevioside content (%)	5.72	5.87	7	6.6
Rebaudioside-A (%)	7.18	7.34	2.1	2.4
Rebaudioside-B (%)	-	-	0.07	0.05
Rebaudioside-C (%)	0.83	0.96	0.61	0.7
Rebaudioside-F (%)	0.28	0.21	0.12	0.15
Rubusoside (%)	0.03	0.04	0.21	0.16
Steviolbioside (%)	-	-	0.14	0.21
Dulcoside-A (%)	0.12	0.07	0.17	0.14
Total SGs content (%)	14.16	14.49	10.42	10.41

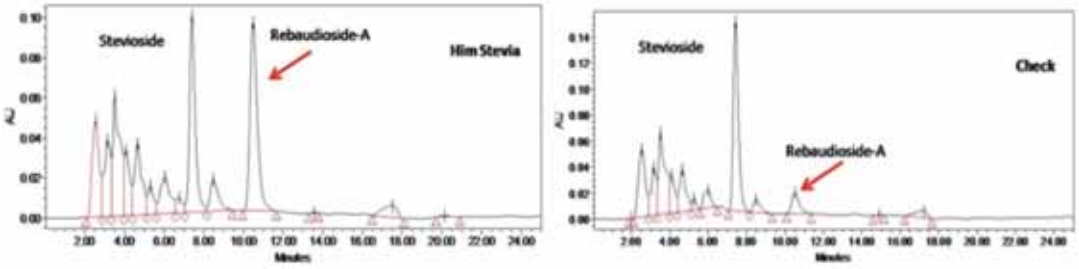

Fig. 1 Representative HPLC chromatogram of leaf samples of genotype CSIR-IHBT-ST-01 (U-22-5-1) in comparison to check

Fig. 2 Morphological features of genotype CSIR-IHBT-ST-01 (U-22-5-1)

Table 2 Morphological features of genotype CSIR-IHBT-ST-01 (U-22-5-1) in comparison to check

Character	CSIR-IHBT-ST-01 (U-22-5-1)		Check (Canada-2-3-1)	
	2012-13	2013-14	2012-13	2013-14
Morphological trait				
Plant height (cm)	95.90	104.20	105.50	112.30
Branches/plant (no.)	12.00	22.00	8.00	18.00
Stem thickness (mm)	6.38	5.26	6.41	5.42
Internode length (cm)	2.90	3.40	3.10	3.80
Max. leaf length (cm)	12.20	9.54	6.80	6.84
Max. leaf width (cm)	4.83	4.24	3.80	3.52
Agronomic trait				
Fresh leaf yield (t/ha)	7.14	12.95	6.23	9.28
Dry leaf yield (t/ha)	2.04	3.68	1.78	2.65
Harvest index (HI)	0.42	0.43	0.39	0.42

Identification of stevia mutant CSIR-IHBT-ST-02 (G-7-5-3) with delayed flowering: A solid mutant CSIR-IHBT-ST-02 (G-7-5-3) for delayed flowering (prolonged vegetative phase) was identified in stevia population treated with 5kR gamma irradiation. The mutant CSIR-IHBT-ST-02 (G-7-5-3) forms flower buds during the 1st week of January compared to 1st week of September as in case of control at Palampur location. This prolonged vegetative phase can increase number of harvests resulting in higher foliage yield (Fig. 3).

Fig. 3 Mutant plant CSIR-IHBT-ST-02 (G-7-5-3) of stevia with delayed flowering

Table 3 Flower bud initiation and Steviol glycoside profile of Mutant CSIR-IHBT-ST-02 (G-7-5-3) at Palampur location.

	Mutant CSIR-IHBT-ST-02 (G-7-5-3)			Check (Canada-2-3-1)	
Year	Flower bud initiation	Stevioside (%)	Rebaudioside-A (%)	Flower bud initiation	Stevioside (%)
2009-10	2nd January	5.3	0.01	1st September	5.8
2010-11	5th January	7.4	0.1	6th September	6.7
2011-12	5th January	7.7	0.8	2nd September	6.7
2012-13	7th January	3.5	0.01	5th September	7.0
2013-14	6th January	8.6	0.1	5th September	6.6

Table 4 Morphological features of Mutant CSIR-IHBT-ST-02 (G-7-5-3) in comparison to check at Palampur location

Character	Mutant CSIR-IHBT-ST-02 (G-7-5-3)		Check (Canada-2-3-1)	
	2012-13	2013-14	2012-13	2013-14
Flower bud initiation	5th January	7th January	2nd September	5th September
Plant height (cm)	85.90	89.20	105.50	112.30
Branches/plant (no.)	4.00	10.00	8.00	18.00
Stem thickness (mm)	6.12	5.23	6.41	5.42
Internode length (cm)	2.60	3.10	3.10	3.80
Max. leaf length (cm)	9.24	8.67	6.80	6.84
Max. leaf width (cm)	4.64	4.08	3.80	3.52

Genome size estimation: The estimation of nuclear DNA content of stevia was done with an aim to study functional and structural genomic aspects. Relative fluorescence intensity of stained nuclei was determined using fluorescence-activated cell sorting (FACS) station. The genome size of *S. rebaudiana* (2C value) was estimated to be 2.72 pg or 2660 Mbp (Fig. 4).

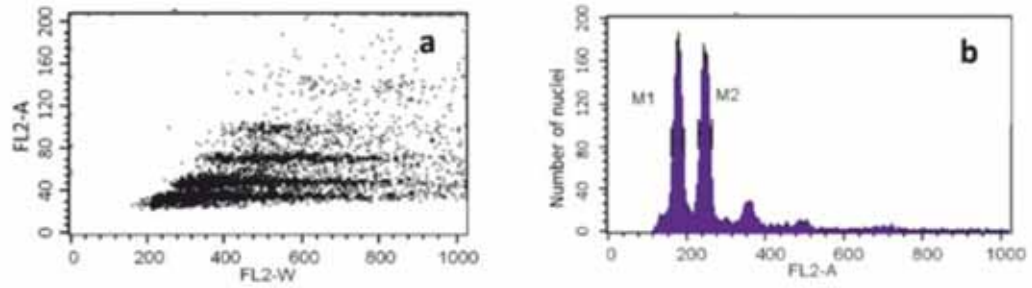

Fig. 4 a) Scattergram and b) flow cytometry histograms showing relative florescence area (FL2-A) of tomato (*Lycopersicon esculentum*) 'Stupicke' as the internal reference standard (M1) and diploid *Stevia rebaudiana* (M2)

Publications:

- Yadav AK, Singh S and Bhardwaj G (2014) Nuclear DNA content and genome size estimation of *Stevia rebaudiana* using flow cytometry. *Minerva Biotechnologica*, 25(3):1-6.

Bhavya Bhargava

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Research area: Protected cultivation of ornamental crops

Protected cultivation of carnation, *Dianthus caryophyllus* L: Carnation is one of the commercially important cut flowers of the world due to its wide range of forms, colours and ability to withstand long distance transportation. In this direction, we collected 16 germplasms viz., Rubisco, Pink Dover, Dover, Tasman, Liberty, Victoria, Pirandello, Yellow Star, Kiro, Master, IIHRP-1, Tikar, Light Star, Baltico, White Wedding and Domingo from Dr. Y S Parmar University of Horticulture and Forestry, Nauni, Solan (H.P.) for its multiplication and evaluation.

Protected cultivation of calla lily, *Zantedeschia aethiopica* (L.) Spreng.: Calla lily is a perennial, rhizomatous plant, grown as cut flower. Our main focus is to study its performance in poly house, shade net and open field condition. Further, we are concentrating on its propagation, nutritional requirements, flowering behavior, insect pest and post harvest management.

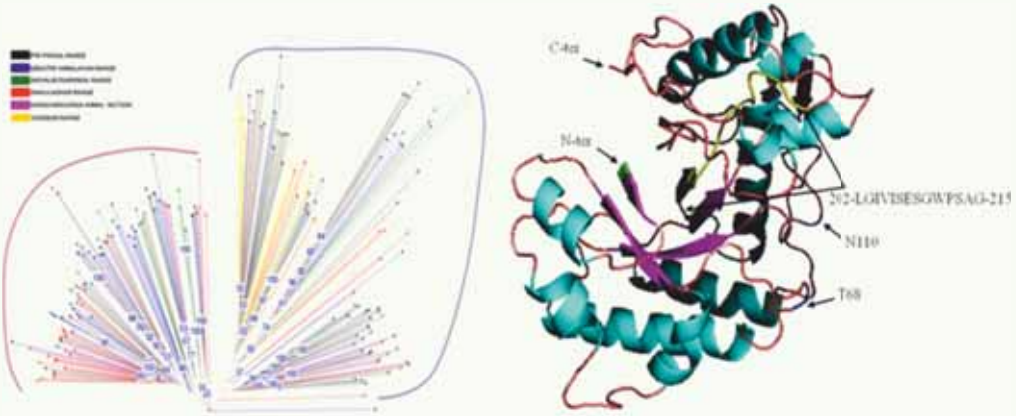
Publication:

- Gupta YC and Bhargava B (2015) Protected cultivation of flowers in hilly region. In: National seminar on Hi tech Horticulture for enhancing productivity, quality and rural prosperity, Organized by Indian Society of Seed Science, Ajmer and Indian Society for protected cultivation. Jan. 19-20, ICAR-National Research Centre on Seed Spices, Tabiji, Ajmer, Rajasthan, pp. 23-28

Participants: Balwant Raj, Sanjay Kuamr and Raja Ram

Dr. Bhavya Bhargava's group

Biotechnology



- Developing efficient micro-macro propagation systems
- Identification of genome wide makers, metabolic engineering and Nanobiology
- Next-Gen and Third Generation high throughput whole genome and transcriptome sequencing for understanding evolutionary mechanism
- Dissecting abiotic and biotic stresses
- Identification and characterization of novel enzymes/ genes for basic and applied research

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Research area: Plant adaptation and high altitude biology

Western Himalayas present immense opportunities to study microbial, plant and ecosystem biology, which are central to bioeconomy. One of the major emphases of our group is on enzyme prospection. We discovered and engineered a unique superoxide dismutase (SOD) enzyme that could be autoclaved and functioned at sub-zero temperature to >50°C. The enzyme was isolated from a high altitude plant species *Potentilla atrosanguinea* and the technology for production of this enzyme was licensed to M/s. Phyto Biotech Pvt. Ltd., Kolkatta. Apart from utilizing the enzyme to improve stress tolerance in plants, our group mutated glutamic acid to alanine at 151 position to improve kinetic flexibility of the enzyme. Concomitantly, screening of plants of the region yielded a kinetically stable SOD from *Cucrcuma aromatica*. The enzyme had a K_m of 0.047 ± 0.008 µM and V_{max} of 1250 ± 24 units/mg of protein. The enzyme functioned across a wide temperature and pH ranges and tolerated varying concentrations of reductants, denaturating agents, inhibitors, and proteases; and had midpoint of thermal transition (T_m) of 70.45°C. These traits suggested the utility of this SOD for use in industries. Similarly, Himalayan bioresources continue to be the source of other industrial enzymes.

Another interest of the group is on understanding plant adaption at varying altitudes and identifying the traits of ecological and economical importance. During previous year, the group discovered a unique carbon fixation pathway that leads to higher photosynthesis rate and nitrogen conservation. It was revealed that C3 plants at high altitude used ribulose-1, 5-bisphosphate carboxylase/oxygenase as well as phosphoenolpyruvate carboxylase (PEPCase) to fix CO_2; carbon fixed by PEPCase was channelized towards amino acid biosynthesis using ammonia that is generated through several metabolic reactions. A construct harboring multiple genes was developed and pathway transplantation in arabidopsis proved its utility to improve carbon and nitrogen status with concomitant increase in photosynthetic rate and yield. Hence, the developed construct can be of immense importance especially in agriculture and will be utilized to improve the yield of crop plants.

The molecular mechanism that confers adaptive capacity and fitness to plants at high altitude was also demonstrated and our work answered a long standing question on “Why the plant species of low altitude can't thrive in the “harsh” environment of high altitude?". Our group cloned a large number of genes, promoters and transcription factors from high altitude flora that impart tolerance to plants against biotic and abiotic stresses. Several of these genes were validated and used to generate stress tolerant *Arabidopsis*, potato and tea lines.

Tea, an important crop of the region experiences dormancy during winters and drought stress during summer that obstructs yield realization. Our group deciphered the gene networks operating during winter dormancy and drought stress and discovered that the down-regulation of genes involved in cell cycle/cell division and up-regulation of stress-inducible genes including those encoding chaperons during winter dormancy can mitigate the stress effects. This work laid the foundation to develop tea with reduced period of winter dormancy and improved tolerance to stresses. Another important contribution of our group was on unraveling the mechanism of non-deciduous habit of tree. The work deciphered "Why evergreen tea does not shed its leaves during winters as compared to deciduous *Populus tremula*"?

Several of the Himalayan plants are rich in secondary metabolites that have implications in human health management. Our contributions towards understanding the molecular basis of biosynthesis of secondary metabolites includes unraveling the molecular regulation of catechins biosynthesis in *Camellia sinensis* (tea), picrosides in *Picrorhiza kurrooa*, steviosides in *Stevia rebaudiana*, shikonins in *Arnebia euchroma* and podophyllotoxin in *Sinopodophyllum hexandrum*. Our work on promoter analysis identified the novel *cis*-acting elements responsible for light mediated gene regulation in *P. kurrooa* (Fig. 1), and also ascertained important elements regulating expression of genes of steviosides

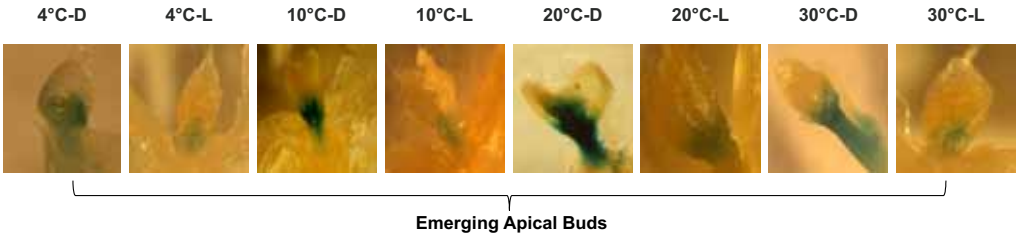

Fig. 1 Expression control HMGR promoter (*Picrorhiza kurrooa*) in arabidopsis under light and darkness at different temperature

biosynthesis in *S. rebaudiana*. These leads have potential implications in the metabolic engineering of plant secondary metabolism and synthetic biology.

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Research area: Conservation and improvement of commercially important and medicinal plants of western Himalaya using plant tissue culture techniques

Micropropagation: The western Himalaya is the abode of several high value medicinal plants that have become rare, threatened, endangered or critically endangered; and many of these figure in the IUCN Red Data Book. In an attempt to conserve these plants by replenishing the dwindling populations, the plant tissue culture group has been actively engaged in the micropropagation of several medicinal plants of western Himalaya since the past few decades. Micropropagation of *Picrorhiza kurroa, Podophyllum hexandrum, Aconitum heterophyllum* and *Dactylorhiza hatagirea* is the present focus of the group.

With an aim to cater to industrial requirements, the group is also involved in the micropropagation of commercially important plants such as apple (scion, Lal Ambri and the rootstocks, Budagovsky 9 and Malling Merton 106), *Amomum subulatum, Camellia sinensis, Coleus forskohlii*, *Crocus sativus, Dendrocalamus hamiltonii, Lavendula officinalis* etc. Efficient micropropagation protocols for bamboo, potato, scented rose, tea, orchids, liliums, gladioli and ferns such as *Adiantum* spp., *Polypodium* sp. and *Diplazium maximum* are presently available with the group. In an effort to develop cost effective micropropagation systems, liquid culture methods for propagating apple rootstocks, scented rose and tea cultivars have been developed.

Early prediction of flowering in bamboos to prevent dwindling of natural populations due to gregarious flowering: Identification of specifiers/markers of floral transition in bamboos is urgently required because their natural stands are threatened by gregarious flowering. During the phenomenon, all physiologically mature clonal individuals flower simultaneously and die, irrespective of geographical locations. While the age of most bamboo plants are unknown, there are no methods available for predicting which natural stands will flower and die. Therefore, a simple and reproducible system of *in vitro* flowering was developed for the maggar bamboo, *Dendrocalamus hamiltonii* in order to facilitate easy monitoring and sampling at each stage of floral transition.

The 40 years long juvenile phase of *D. hamiltonii* was also compressed to 28 days. When the system was used for morphological and biochemical investigations, the findings correlated well with proteomic and transcriptomic data (Fig. 1). Several repressors and specifiers of floral transition involved in dicot plants were identified. Many of these were homologous to those in rice and maize, the close relatives of bamboo.

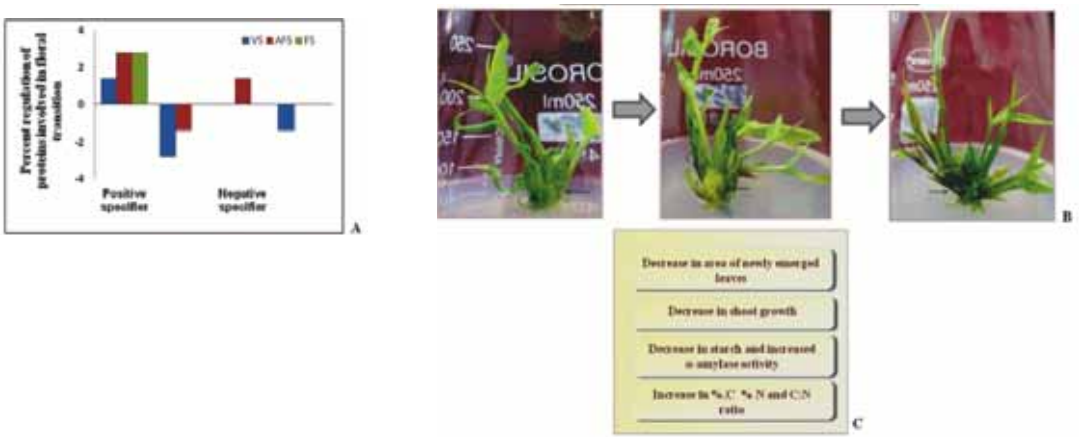

Fig. 1 Changes associated with floral transition in *D. hamiltonii* (A) Protein specifiers (B) *In vitro* development (C) Morphological and biochemical characteristics

Alternative systems for secondary metabolite production: Cell/ callus cultures and also recurrent somatic embryos are often used as alternative systems for secondary metabolite production. These systems are effective in preventing the uprooting and destruction of target plants for extraction of secondary metabolites and are popularly used for *ex situ* conservation of RET plants. In this regard, the plants being targeted include *Nardostachys jatamansi* for jatamansone, *Dactylorhiza hatagirea* for dactylorhins and dactyloses, *Podophyllum hexandrum* for podophyllotoxins, *Coleus forskohlii* for forskolin, *Dendrocalamus hamiltonii* somatic embryos for natural waxes and *Gloriosa superba* for colchicosides and colchicine.

Crop improvement: Improvement of commercially important crops by the biolistic gun as well as *Agrobacterium tumefaciens* mediated genetic transformation has been the major focus of the group. Transgenic Kangra tea, maggar bamboo and apple rootstocks, Budagovsky 9 and MM 106 were developed by the biolistic gun method. Stress tolerant transgenic tea plants expressing the *osmotin* gene of tobacco and *chitinase* gene of rice were developed and are growing successfully in the contained polyhouse of the Institute.

Agrobacterium tumefaciens mediated transformation of these and other crops such as saffron and *Picrorhiza kurrooa* was also attempted. *A. tumefaciens* being a soil phytopathogen, many of these are resistant to it. Therefore, the barriers of these non-host crops were first identified and then removed for successful transgene transfer. Presently, the group is involved in the genetic transformation of *P. kurrooa* for secondary metabolite production.

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Research area: Molecular genetics and genomics

Genetic diversity characterization and genomic resource creation in endangered medicinal plants to enhance conservation efforts

According to the World Health Organization (WHO), as many as 80 % of the world's population depend on traditional medicine for their primary health-care needs. In the present era, unprecedented growth in global population has led to subsequent increase in human demands and overexploitation of the earth's plant resources. Most plausible scenarios today suggest that we are likely to lose a large part of our traditional wealth of medicinal plants in the near future if critical steps are not taken to conserve them. Currently, a large number of medicinally important plant resources are facing serious threats of extinction and severe genetic loss, but detailed information is lacking. For most of these endangered medicinal plant species, effective conservation plans are minimal and very little material is available in gene banks. Our current efforts are to exploit NextGen Sequencing technologies for identification of genome wide molecular markers and high throughput genotyping studies in targeted plant species of western Himalayan region. Intraspecific genetic variation in natural population governs their potential to overcome challenging ecological and environmental conditions. Found in the Himalayas, *Podophyllum hexandrum* is an endangered high elevation plant species that has great medicinal importance. We report genetic diversity analysis of 24 *P. hexandrum* population (209 individuals), representing the whole of the Indian Himalayas. Amplified fragment length polymorphism (AFLP) maker based analysis generated 1677 fragments, of which 866 were found to be polymorphic. Neighbour joining clustering, principal coordinate analysis and STRUCTURE analysis clustered 209 individuals from 24 population of the Indian Himalayan mountains into two major groups with a significant amount of gene flow (Nm=2.13) and moderate genetic differentiation, Fst (0.196),Gst (0.20). This suggests that, regardless of geographical location, all of the population from the Indian Himalayas are intermixed; and are composed broadly of two types of genetic population (Fig.1).

High variance partitioned within population (80 %) suggests that most of the diversity is restricted to the within-population level. These results suggest two possibilities about the ancient population structure of *P. hexandrum*: either all of the population in the geographical region of the Indian Himalayas are remnants of a once widespread ancient population, or they originated from two types of genetic population, which coexisted a long time ago, but subsequently separated as a result of long-distance dispersal and natural

selection. High variance partitioned within the population indicates that these have evolved in response to their respective environments over time, but low levels of heterozygosity suggest the presence of historical population bottlenecks. Inferences derived from the current study will help to guide management and conservation policies.

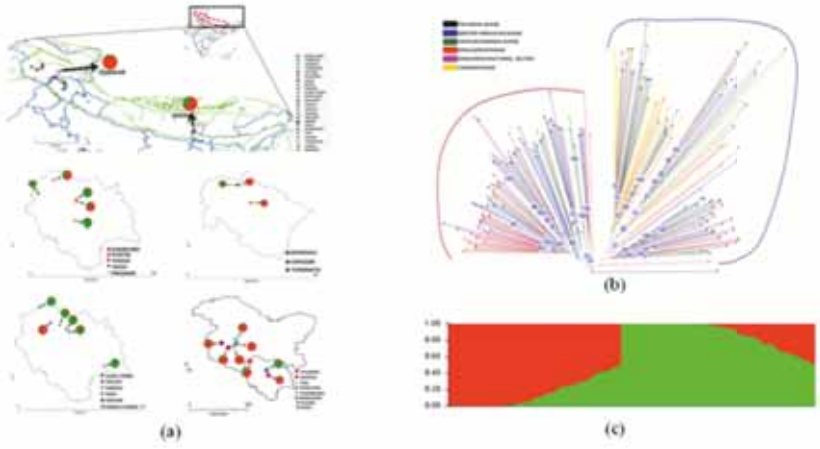

Fig.1 AFLP based Genetic diversity inferences of *P. hexandrum* (a) Geographic distribution of sampled population with pie charts representing the percentages of the two genetic pools from each of the population, (b) Neighbour-joining tree based on genetic distances of 209 individuals, (c) STRUCTURE analysis bar plot represents individuals arranged according to its most likely ancestry

Similar efforts were done in endangered *Aquilaria malaccensis*, an important plant with high economic values. Considering important repositories of biological diversity, the genetic relationships of 127 *A. malaccensis* accessions from ten home gardens of three states of Northeast India were assessed using amplified fragment length polymorphism (AFLP). Of the 1153 fragments amplified with four AFLP primer combinations, 916 (79.4%) were found to be polymorphic. High gene flow (Nm: 3.37), low genetic differentiation (FST: 0.069) and high within-population genetic variation (93 %) suggests that most of the genetic diversity is restricted to within-population. Based on the various diversity inferences, five diverse populations (Jorhat, NEIST, Halflong, Dhemji, Itanagar) were identified. These can be potentially exploited to develop conservation strategies for *A. malaccensis*.

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Research area: Transgenics, plant developmental biology

Functional validation of stress related cDNAs from high altitude plants in *Arabidopsis thaliana:* Antioxidant enzymes play a significant role in eliminating toxic levels of reactive oxygen species (ROS), generated during stress from living cells. It was found that the transgenic *Arabidopsis* plants over-expressing two different antioxidant enzymes namely copper-zinc superoxide dismutase (*PaSOD*) and ascorbate peroxidase (*RaAPX*) were more tolerant to cold stress than either of the single gene expressing transgenic plants during growth and development. In both single (*PaSOD*, *RaAPX*) and double (*PaSOD* + *RaAPX*) transgenic plants, during cold stress (4°C) (Fig. 1), higher levels of total antioxidant enzyme activities, chlorophyll content, total soluble sugars, proline content and lower levels of ROS, ion leakage were recorded when compared with WT, besides increase in yield. It was concluded that the cold stress tolerance of these transgenic plants might be because of the peroxide induced up-regulation of lignin by antioxidant genes mediated triggering.

Fig. 1 Transgenic *Arabidopsis* plants under cold stress conditions (WT1, WT2: Wild type; S26, S15: *PaSOD*; A18, A20: *RaAPX*; 18O, 19C are the double transgenic lines)

In vitro flowering associated protein changes in *Dendrocalamus hamiltonii:* In *D. hamiltonii*, conversion of vegetative meristem to a floral meristem was successfully achieved on flower induction medium. Two-DE and subsequent proteomic analysis suggested that the interactive effects of metabolism related proteins, heat stress, flowering, ethylene biosynthesis, calcium related, phyto-hormone related, and phytochrome regulation related proteins might be the possible major regulators of floral transition in this bamboo (Fig. 2).

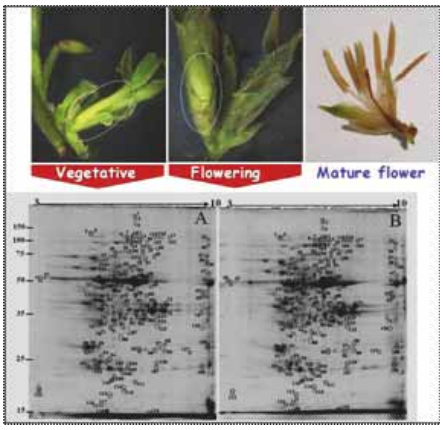

Fig. 2 Different stages of flowering in bamboo and 2-D PAGE gel photographs of vegetative and flowering shoots

Seed Biology of high altitude plants: A novel ß-1, 3-glucanase cDNA was cloned from the germinating seeds of *Podophyllum* (Ph-glucanase). Analysis of the cloned nucleotide sequence revealed that the Ph-glucanase is with an open reading frame of 852 bp encoding a protein of 283 amino acids with a molecular mass of 31 kDa and pI of 4.39 (Fig. 3). Seeds from the transgenic *Arabidopsis* plants over-expressing Ph-glucanase showed better germination performance against a wide range of temperatures and abscisic acid (ABA) stress. This can be attributed to the accumulation of Ph-glucanase at both transcript and protein levels during the seed germination in transgenic *Arabidopsis*. This novel seed specific glucanase from a cold desert plant, *Podophyllum* could be used for the manipulation of seed germination problems of different plant species against various harsh conditions.

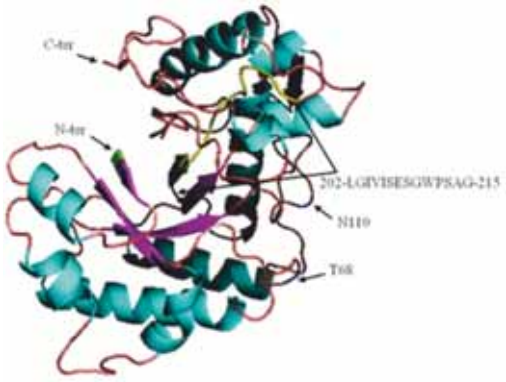

Fig. 3 Predicted tertiary protein structure of the Ph-glucanase

Isolation and characterization of novel genes / promoters specific to reproductive and seed development in *Arabidopsis:* Seeds are the important food resource for the living organisms including humans. Seed development starts with the specification of micro and megaspore mother cells (MMCs) and completes with the subsequent gametophyte development, fertilization, embryo development and maturation. These processes were regulated by the expression of a number of genes and their interactions. What these programs are and how they are integrated into unique regulatory networks to form a mature seed within the plant genome remain major unanswered questions. Identification and understanding the function of novel genes may permit us to plan novel approaches to breed and engineer seeds with new agronomic traits. In a screening of in-house developed promoter trap population of *Arabidopsis*, a number of seed development mutants and promoter trap lines showing the reporter gene expression in and around the male and female gametophytes were identified.

Identification and characterization of gametophyte specific promoters from *Arabidopsis:* In a screening of promoter trap populations, we identified a promoter trap line showing reporter gene expression in the female gametophyte. From this we cloned and characterized a 672-bp fragment which shows bi-

directional promoter activity (Fig.4). This novel bidirectional promoter drives gene expression specifically in the female gametophyte.

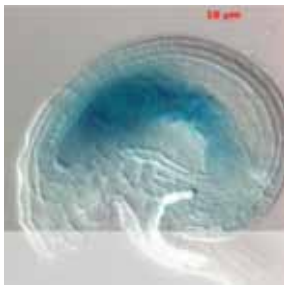

Fig. 4 *Arabidopsis* mature embryo sac showing the expression of the cloned bi-directional female gametophyte specific promoter

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Research area: Plant metabolic engineering, epigenetics and nanobiology

Plant Metabolic Engineering

Over-expressing of SrKA13H from stevia in *Arabidopsis* induced dwarfism: Ectopic over-expression of *SrKA13H* (*ent*-kaurenoic acid-13 hydroxylase) cDNA from *Stevia rebaudiana* revealed significant accumulation of steviol in transgenic *Arabidopsis*. They possessed phenotypic similarity to gibberellin-deficient mutants. The reduction in endogenous gibberellin content was found responsible for dwarfism in these transgenics. Exogenous application of GA_3 could rescue the transgenics from dwarfism. Hypocotyl, rosette area and stem length was considerably reduced in transgenics. A noteworthy decrease in pollen viability was noticed and likewise, retardation in pollen germination rate was observed. The exogenous application of steviol did not influence the pollen germination efficiency. This suggested that *in planta* formation of steviol was not responsible for the observed changes in transgenic *Arabidopsis*, while significant reduction in endogenous gibberellins seems to be responsible for the dwarfism, and abnormal behavior of pollen germination and seed set.

Over-expression of a tea flavanone 3-hydroxylase gene confers tolerance to salt stress and *Alternaria solani* in transgenic tobacco: Flavan-3-ols are the major flavonoids present in tea (*Camellia sinensis*) leaves. These are known to have antioxidant and free radical scavenging properties *in vitro*. Flavanone 3-hydroxylase is considered to be an important enzyme of flavonoid pathway leading to accumulation of flavan-3-ols in tea. Expression analysis revealed the up-regulation in transcript levels of *Camellia sinensis* flavanone 3-hydroxylase encoding gene *CsF3H* under salt stress. In this study, the biotechnological potential of *CsF3H* was evaluated by gene over-expression in tobacco (*Nicotiana tabacum* cv Xanthi). Over-expression of *CsF3H* cDNA increased the content of flavan-3-ols in tobacco and conferred tolerance to salt stress and the fungus, *Alternaria solani* infection. Transgenic plants produced higher degree of pectin methyl esterification *via* decreasing pectin methyl esterase.

Evaluating the effect of *Arabidopsis* ROS1 on epigenetic regulation of flavonoid biosynthetic and antioxidant systems during salt stress in *N. tabacum*: The aim was to unravel whether genes encoding enzymes of flavonoid biosynthetic and antioxidant pathways are under epigenetic regulation particularly DNA methylation during salt stress. For this, ROS1 a repressor of silencing from Arabidopsis (*AtROS1*) was over-expressed in transgenic tobacco. The generated transgenics were evaluated for the influence of *AtROS1* on methylation status of promoters as well as coding regions of genes encoding enzymes of flavonoids biosynthesis and antioxidant pathways. Data suggested the epigenetic regulation of flavonoid biosynthetic and antioxidant pathways during salt stress exposure of plants.

Nanomaterials:

Applications and impact on safety, health and environment (NanoSHE)

Strong antibacterial activity of silver nanoparticles synthesized using plant extracts: Three plants

Populus alba, *Hibiscus arboreus* and *Lantana camara* were explored for the synthesis of SNPs. The synthesis rate of SNPs was highest with LE of *L. camara* followed by *H. arboreus* and *P. alba*. *L. camara* LE showed maximum potential of smaller size SNPs synthesis, while bigger particles were formed by *H. arboreous* LE. TEM analysis revealed the formation of SNPs of average size 17±9.5 nm with 5% LE of *L. camara.* The SNPs synthesized by LE of *L. camara* showed strong antibacterial activity against *E. coli* and could be potential candidate for biomedical applications.

Novel nanocomposite of cellulose nanocrystals and silver bionanoparticles for enhanced wound repair: An improved combination of chemical and mechanical methods was employed to isolate plant cellulose nanocrystals. A novel and innovative greener line of action has been put forward for *in situ* impregnation of silver bio-nanoparticles (AgNPs) into CNCs matrix, leading to formation of nanocomposites (Ncs). CNCs and NCs were characterized with zeta potential measurements, UV-Vis spectroscopy, SEM, TEM, FTIR and XRD. The high water uptake capacity of CNCs was found to be liable for producing effective wound dressing material and its utility was further enhanced by the incorporation of antimicrobial AgNPs. Results suggested the potential use of developed NCs as novel wound dressing biomaterials for accelerating wound repair.

Betulin encapsulated PLA nanoparticles: Betulin (BT) is an abundant triterpene found predominantly in the bark of Himalayan birch. It is difficult to deliver this molecule *in vivo* because of its low aqueous solubility. To improve its solubility, bioavailability and therapeutic efficacy, BT nanoformulation of poly-D, L-lactide nanoparticles (PLA NPs) was synthesized using polyvinylalcohol (PVA) and *Lonicera japonica* leaf extract (LEs) as stabiliser. Developed BT NPs showed better biocompatibility, excellent stability and enhanced release characteristics.

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Research area: Value addition of western Himalayan bioresources

***In vitro* production of plant secondary metabolites**

Plants produce varieties of natural compounds having immense importance in healthcare, food, cosmetics and pharmaceutical industries. However, their continuous extraction from natural resources has resulted in overexploitation and even most of them are on the verge of extinction. In this regard, plant cell culture technology has proved to be a useful biotechnological tool with commercial successes in production of secondary metabolites like shikonin derivatives, taxol, berberine, ubiquinone-10 etc. At CSIR-IHBT, we are working on micro-propagation of medicinal and aromatic plants, *in vitro* production of secondary metabolites through cell culture and scale up in bioreactors. It includes the optimization & standardization of *in vitro* protocols, characterization & quantification of secondary metabolites and manipulation of secondary metabolism through various biotechnological approaches for high metabolite production. Presently, our focus is on natural pigment (shikonin derivatives) production using *Arnebia* species cell culture (Fig. 1). Continuous efforts are going on for screening of high pigment production cell line and biosynthetic regulation of secondary metabolism at cellular level to increase the metabolite yield.

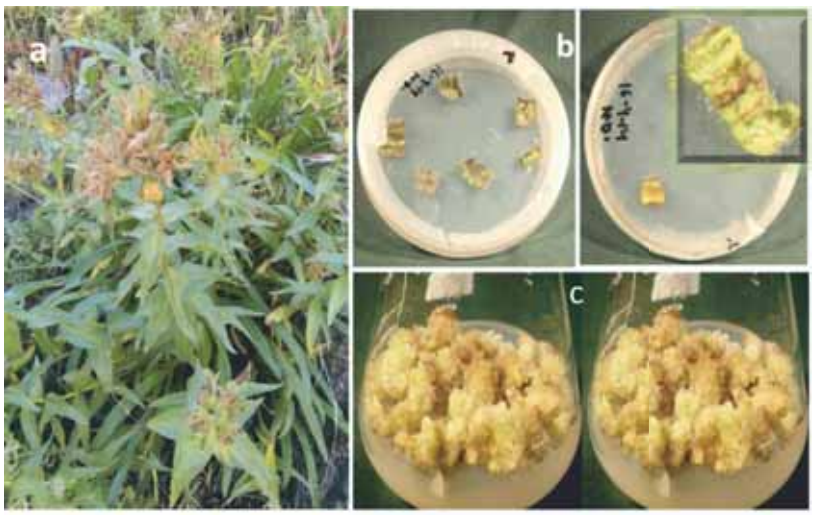

Fig. 1 a) *Arnebia euchroma*, b) Callus induction, & c) Callus proliferation

Evaluation of bioactive compounds as functional ingredient

In addition, we are also exploring the traditionally employed resources for healthcare system by local inhabitant of western Himalayan region. Our aim is to provide scientific validation, documentation and their value addition through development of dietary supplement (s) or nutraceuticals. In an new initiative to develop biopreservatives based on western Himalayan plant resources at CSIR-IHBT, *Clematis gouriana* referred as 'Bakarbail' locally (Fig. 2), collected from Thural area, District Kangra, Himachal Pradesh, India. It not only helps in meeting the growing consumer demand of natural ingredients, but will also assist or support the government efforts in conservation of valuable endangered western Himalayan bioresources.

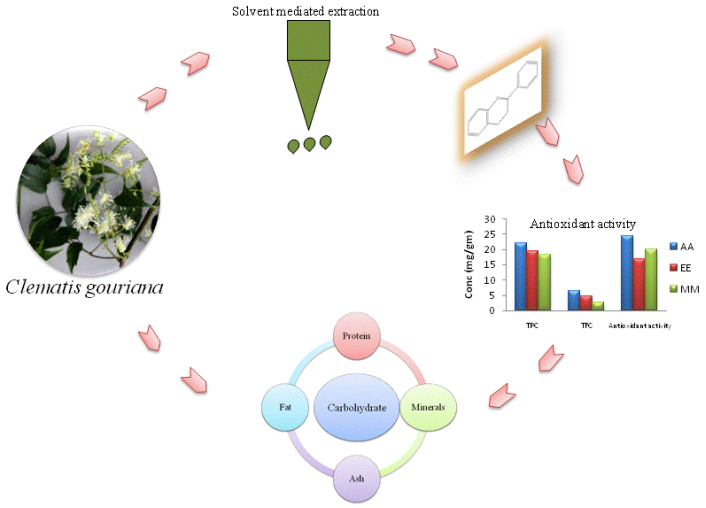

Fig. 2 Screening of bioactives in *Clematis gouriana* leaves

Publications:

- Malik S, Bhushan S, Sharma M and Ahuja PS (2014) Biotechnological approaches to the production of shikonins: a critical review with recent updates. *Critical Reviews in Biotechnology.* DOI:10.3109/07388551.2014.961003.
- Rana S, Rawat K, Mahendru M, Padwad YS, Pakade YB, Lal B and Bhushan Shashi (2015) Screening of bioconstituents and in vitro cytotoxicity of *Clematis gouriana* leaves. *Natural Product Research*, DOI:10.1080/14786419.2014.1000891.
- Rana S, Rana A, Gulati A, and Bhushan S (2014) RP-HPLC-DAD determination of phenolics in industrial apple pomace. *Food Analytical Methods*, 7:1424–1432 DOI 10.1007/s12161-013-9765-7.

• Walia M, Rawat K, Bhushan S, Padwad YS and Singh B (2014) Fatty acid composition, physico-chemical properties, antioxidant and cytotoxic activity of apple seed oil obtained from apple pomace. *Journal of the Science of Food and Agriculture*, 94:929–934.

Participants: Shalika Rana, Sumita, Preeti Katoch, Jyoti Pathania, Roshan and Rishi.

Dr. Shashi Bhushan's group

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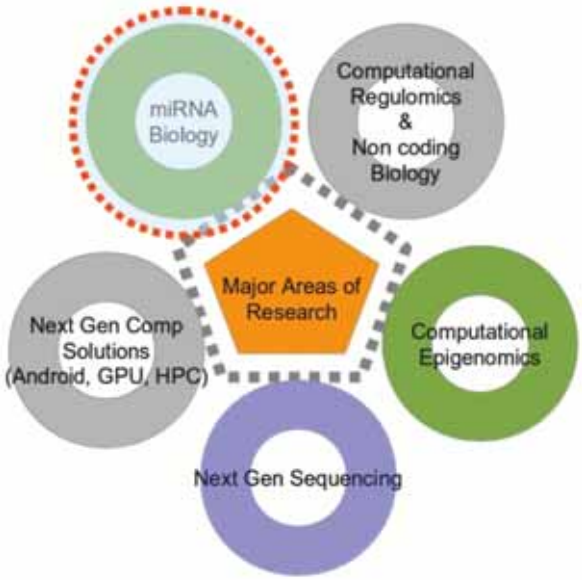
Research area: Computational biology & bioinformatics

Computational research in next generation sequencing, noncoding genomics and regulomics:

There was an era where reductionist approach hovered only around protein coding regions of the genome, and only those regions were called genes and everything else were called non-coding elements, a majority of which tagged as "Junk". With time, science matured and thus the definition of the gene and junk! Genes expanded and junks shrunk. Non-coding elements have gathered new found respectability as the king makers of genome and microRNAs fit the bill very well. We are studying the regulatory roles of sRNA and how these sRNAs fit the modular system. The project aims to develop software to improve micorRNA target prediction, propose new theories and algorithms and finally develop a closely knitted system to put forward regulatory modules of various cell systems. Also research is being done in order to emphasize that the present concept of miRNAs needs change and it is very possible that a huge amount of regulation is being done by sRNA compared. Besides this, other non-coding elements and repetitive elements are being studies extensively, as these elements have high potential to work as major regulatory contributors.

In present couple of years many studies have proved that genome and proteome sequencing alone don't give enough information to elucidate the behavior of cell and development. Here comes the epigenetic control, which does not change nucleotide but methylation and related modification in DNA and histones determine the chromatin and DNA response to binding proteins. A combination of regulatory forces of TFBS, Epigenetic modifications and post transcriptional regulation by sRNAs and RBPs have major stake in the cell system's fate. In order to understand this combinatorial regulatory control, the Studio is pursuing research in this direction, too.



Next generation sequencing approaches are changing the face of science in strong way. The dream of fast & affordable journey towards the paths of genome is achievable with this technology. It gives huge amount of reads in very short time, giving high confidence for those covered areas producing the reads, minimizing the level of sequencing errors. Same time new challenges have emerged with these technologies regarding their de-novo assembling, scaffolding and new sequence generation. The Studio has initiated its project in this direction to standardize the process of de-novo sequence assembling and generate high confidence assembled sequence out of short reads. Besides this, the lab can be easily counted among the pioneer labs in Next Gen Sequencing in this nation which has resolved several plant's transcriptomes using Illumina sequencing. The lab heavily relies and works in this area for its research in vast domains. Details can be found at http://scbb.ihbt.res.in

Publications

- Paul A, Jha A, Bhardwaj S, Singh S, Shankar R and Kumar S (2014) RNA-seq-mediated transcriptome analysis of actively growing and winter dormant shoots identifies non-deciduous habit of evergreen tree tea during winters. *Scientific Reports*, 4, doi:10.1038/srep05932.
- Jha A and Shankar R (2014) miRNAting control of DNA methylation. *Journal of Biosciences*, 39: 365-380.
- Kumari A, Singh HR, Jha A, Swarnkar MK, Shankar R and Kumar S (2014). Transcriptome sequencing of rhizome tissue of *Sinopodophyllum hexandrum* at two temperatures. *BMC Genomics*, 15 (1): 871.

Participants: Mrigaya, Pallavi, Indu, Vandna Karmani and Vandana Chawala
Ashwani, Rajnish, Pankaj, Ganesh and Rohit.

Dr. Ravi Shankar's group

Amitabha Acharya

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Research area: Synthesis of functional nanomaterials for diverse applications, nanoparticle based detection of biomolecules

Our group is actively involved in developing novel hybrid nanomaterials, which can be used for bioimaging and sensing applications. With the development of nanoparticle based molecular imaging probes, substantial improvement of the specificity and sensitivity of disease diagnosis has been achieved. Again, the use of nanosensors is expected to increase the precision and limit of detection of the target analyte.

Biopolymer coated nanocomposites as molecular imaging probe: The group has synthesized and characterized chitosan encapsulated nanocomposites using different spectroscopy and microscopy techniques. The size of the synthesized nanoparticles was found to be ~ 20 to 50 nm. The presence of different metal ions was confirmed by AAS studies. Cellular studies were carried out with three different cancer cell lines *viz.*, human oral cancer (KB), rat glioma (C6) and human lung adenocarcinoma epithelial (A549) cells to confirm the utility of these nanocomposites. Positive fluorescence response was observed for KB and C6, whereas A549 did not respond. Further Perl's prussian blue test confirm the presence of Fe inside KB intracellular environment. The SRB assay confirmed that these nanocomposites showed less cytotoxicity compared to their bare nanoformulation.

Fluorescent nanoparticles for pesticide detection: Glutathione coated CdS nanoparticles were synthesized and characterized. The TEM results of GSH-NPs suggested mostly monodispersed spherical particles, with size in the range of 11.5±1 nm. The prepared fluorescent nanoparticles were found to selectively recognize dicofol among all the other pesticides studied, by increasing the fluorescence intensity of the nanoparticles ~ 2.5 times. Similar studies carried out with dimethoate, which did not result in any change in the fluorescence intensity. Further studies carried out with commercially available pesticide solutions, also confirmed similar results. The TEM, SEM and DLS studies suggested aggregation of the nanoparticles in presence of dicofol. Control experiments suggested possible role of both amine and carboxylic acid functional groups of glutathione in the recognition of dicofol.

Publications:

- Walia S and Acharya A (2014) Fluorescent cadmium sulfide nanoparticles for selective and sensitive detection of toxic pesticides in aqueous medium. *Journal of Nanoparticle Research*, 16: 2778-2887.
- Walia S and Acharya A (2015) Silica Micro/Nanospheres for Theranostics: From Bimodal MRI and Fluorescent Imaging Probes to Cancer Therapy. *Beilstein Journal of Nanotechnology*, 6(1): 546-558.

Patent:

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Participants: Shanka Walia and Avnesh Kumari

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Research area: Computational functional genomics & system biology

Genome-wide characterisation of disease resistance genes: Our research includes developing software as well as applying statistical machine learning, biomolecular simulation and information retrieval to analyze and mine all kinds of biological data, including nucleotide sequences, protein sequences and structures, microarray as well as next generation sequencing (NGS) data for the purpose of facilitating biology discovery. A number of recent studies have been carried out to identify and characterize disease-resistance (Nucleotide binding site-leucine rich repeat) (NBS-LRR) gene families in many important plant species. In this study, we have identified NBS-LRR gene family in one of the Himalayan plant, *Malus domestica* (apple) comprising of 1015 NBS-LRRs using highly stringent computational methods. Surprisingly, equal distribution of Toll/interleukin-1 receptor (TIR) and coiled coil (CC) (1:1) was detected in apple while the unequal distribution was reported in majority of all other known plant genome studies. Prediction of gene duplication events intriguingly revealed that not only tandem duplication but also segmental duplication (Fig. 1) may equally be responsible for the expansion of the apple NBS-LRR gene family. Gene expression profiling using expressed sequence tags database of apple and quantitative real-time PCR (qRT-PCR) (in collaboration with Dr Anil Singh's Group) revealed the expression of these genes in wide range of tissues and disease conditions, respectively. Taken together, this study will provide a blueprint for future efforts towards improvement of disease resistance in apple. The details of our lab can be provided at-https://sites.google.com/site/vishalfunctionalgenomics/.

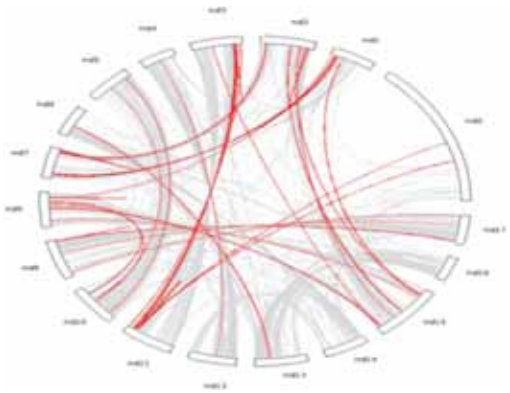

Fig. 1 Collinear gene pairs for 1015 MdNBS genes on 17 apple chromosomes

Publications:

- Kumar A, Randhawa V, Acharya V, Singh K and Kumar S (2015) Amino acids flanking the central core of Cu,Zn superoxide dismutase are important in retaining enzyme activity after autoclaving. *Journal of Bimolecular Structure & Dynamics* 10.1080/07391102.2015.1049551.
- Arya P, Kumar G, Acharya V and Singh AK (2014) Genome-wide identification and expression analysis of NBS-encoding genes in Malus x domestica and expansion of NBS genes family in Rosaceae. *PLoS One*, 9(9):e107987.

Participants: Vinay Randhawa, Shivalika Pathania and Preeti Arya.

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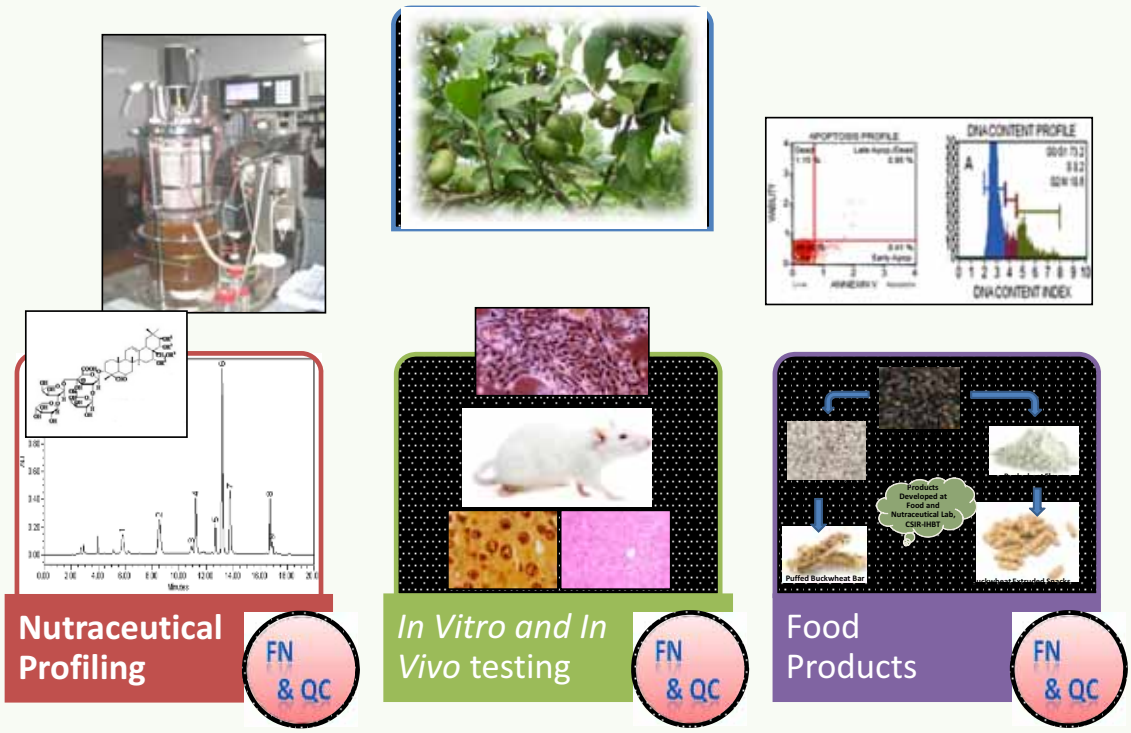
Research area: Computational biology and bioinformatics

Structural bioinformatics: Multidisciplinary approach was adopted to combine the first-principle physics with the analysis of biological systems such as 3-dimensional structure of proteins, protein-drug complex and nucleic acids. It will be interested to observe that how certain mutation alter the dynamics behavior of proteins and its interaction with other molecules? In addition, molecular folding, evolution, and binding interactions, and structure/function relationships of experimentally solved structures and from computational models are also the focus of research. Presently, the work is being focused on dynamic nature of superoxide dismutase (SOD) protein from *Potentilla atrosanguinea* and its engineered variants.

Food, Nutraceuticals and Quality Control



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Research area: Tea chemistry and quality control

We are working on biochemically characterizing the compounds responsible for distinctive cup characters of Kangra tea. During this period, the Kangra orthodox black tea aroma was fractionated to characterize the minor aroma components imparting distinctive aroma to Kangra tea infusion. The aroma constituents of Kangra orthodox black tea were isolated by different methods like simultaneous distillation extraction, supercritical fluid extraction and beverage method to get the complete profile of the aroma components present in Kangra orthodox black tea. Beverage and simultaneous distillation extraction methods gave the profile of water extractable volatiles while supercritical fluid extraction method gaves the total aromatic compounds present in orthodox black Kangra tea. The major aroma components present in all the extracts were geraniol, linalool, (Z/E)-linalool oxides, (E)-2-hexenal, phytol, β-ionone, hotrienol, methylpyrazine and methyl salicylate. The minor components in all the extracts were 2-ethyl-5-methylpyrazine, ethylpyrazine, 2-6,10,14-trimethyl-2-pentadecanone, acetylfuran, hexanoic acid, dihydroactinidiolide and (E/Z)-2,6-nonadienal were the minor volatile compounds. Apart from the major and minor aroma components, further fractionation of Kangra orthodox tea aroma on silica gel yielded pyrazines mainly ethyl-6-methylpyrazine, 2-ethyl-3-methylpyrazine and 2,5-dimethylpyrazine imparting a roast and nutty aroma to the infusion. Unlike many food products, short- and long-chained fatty acids were present in the acidic fractions from Kangra tea, while 2-penten-1-ol, (E)-2-hexenyl hexanoate, isopropyl myristate, 2-hexenol, nonanal and 1-pentanol were present in the water-soluble fractions imparting grassy and fruity aroma. Interestingly, most of the acidic compounds along with 3-ethyl-4-methyl-1-H-pyrrole-2,5-dione, γ-Undecanolide, and 1-ethyl-2,5-pyrrolidinedione were recorded in extracts obtained following supercritical extraction.

Apart from the normal green shoot variety, many purple coloured shoot tea cultivars have been identified in the tea world. Purple coloured anthocyanins rich clones were taken from Banuri Tea Experimental Farm of the Institute. The purple coloured anthocyanin-rich tea cultivars were compared with standard Kangra clone for quality parameters in fresh shoots, black tea and green tea. Polyphenols recorded higher levels in purple tea shoots compared to standard green tea shoot while epigallocatechin gallate (EGCG) levels were higher in GL. Amino acids mainly theanine, histidine, threonine and phenyl alanine along with alkaloid caffeine recorded higher contents in GL compared to PL. Higher levels of theaflavins were recorded in orthodox black tea made from purple shoots (BTP) compared to black teas from normal shoots (BT). Volatile flavour profiles of green and black teas from different types of shoots showed qualitative and quantitative

differences. Trans-linalool oxide, geraniol, linalool and cis-linalool oxide were major components while methyl salicylate, α-terpineol and hotrienol were present in all the tea extracts. Higher contents of linalool, trans-linalool oxide, methyl salicylate, phenylethanol, epoxylinalool and ethyl pyrazine and methylpyrazine were recorded in teas made from purple shoots compared to GT and BT, while β-damascenone was not detected in GTP and BTP. Higher aroma impacts were found in BTP than BT as determined by aroma extract dilution assay. Colour palate of infusions of GTP and BTP showed a taint of purplish tinge due to extracted anthocyanins as anthocyanins are highly water soluble. Further, we isolated and characterized by UPLC-ESI-QTOF-MS/MS four anthocyanins from purple tea clones growing in Banuri Tea Farm. These anthocyanins are cyanidin-, cyanidin-glucoside, delphinidine- and delphinidine acylated with glucose. Antioxidant, anticancer and immunostimulatory activities of these purified and crude anthocyanins showed high cytotoxicity against C-6 cancer cells lines high therapeutic perspective.

Pilot scale production and demonstration of technology of purification of catechins from tea shoots: Technology of catechin extraction from tea shoots was standardized and optimized at pilot scale at the Institute. More than 10 kg of tea catechins was extracted and purified using the standardized up-scaled technology in our pilot plant maintaining the purity levels. Demonstrations of up scaled purification of catechins were given to representatives of our clients M/s. Baijnath Pharmaceuticals Pvt. Ltd.

Publications:

- Rana A, Bhangalia S, Majid R, Singh HP, Gulati Ashu, Adid H, Vyas D and Dhyani D (2014) Cytotoxic activity of major iridoid glucosides of IncarveIlia emodi against human cancer cell lines. *Natural Product Research*, 28(8): 593–596.
- Bhattacharya A, Saini U, Joshi R, Kaur D, Pal AK, Kumar N, Gulati A, Mohanpuria P, Yadav SK, Kumar S and Ahuja PS (2014) Osmotin expressing transgenic tea plants have improved stress tolerance and quality parameters. *Transgenic Research*, 23(2):211-223.
- Rana S, Rana A, Gulati A and Bhushan S (2014) RP-HPLC-DAD Determination of Phenolics in Industrial Apple Pomace. *Food Analytical Methods*, (7)7:1424–1432.
- Joshi R and Gulati A (2015) Fractionation and identification of minor aroma-active constituents in Kangra orthodox black tea. *Food Chemistry*, 167: 290–298.

Participants: Khushal Chand, Amita Sharma, Eshita Sharma, Dr. Ashu Gulati, Ranjana Sharma and Dr. Ajay Rana.

Dr. Ashu Gulati's group

Mahesh Gupta

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Research area: Functional food and nutraceuticals

Functional Ingredient(s): Functional foods can be an opportunity for economic growth for many developing countries endowed with rich biodiversity and traditional knowledge of the health effects of certain indigenous bioresources/plant species. Buckwheat is a traditional crop of the high altitude Himalayan region having potential health benefits. Analysis of its nutritional properties revealed that puffed buckwheat is rich in protein, fat and carbohydrate as well as rutin content. There is a great potential for value addition of buckwheat into other products such as bars, ready to eat cereals, extruded snacks, pasta, noodles and specialty bread etc. Some puffed buckwheat products has been developed and launched at Tribal Fair at Keylong (Lahaul and Spiti). Food processing facility for buckwheat has been established at CeHAB, Keylong (Lahaul and Spiti) for demonstration to the farmers, progressive entrepreneurs, NGOs and SHGs for promoting entrepreneurship development in the region.

Composition in (%)	Buckwheat Grain	Puffed Buckwheat
Moisture	8.67±0.02	2.96±0.01
Protein	13.22±0.08	7.63±0.04
Fat	3.90±0.05	2.85±0.08
Carbohydrates	58.50 ±0.04	77.69±0.09
Dietary Fiber	13.36 ±0.02	6.52±0.03
Ash	1.98 ±0.08	2.15±0.02

In our ongoing work, nutritionally enriched food products to combat malnutrition particularly calcium and iron deficiencies are being developed. Using low cost affordable technology two products such as fruit bar and nutri mix were developed by incorporation of underutilized bioresources that meets 40% and 60% of %RDA (Recommended daily allowances) of iron and calcium in the products, respectively. Screening and survey of malnourished population were conducted in CSIR-IHBT Tech-village of Gopalpur (Distt. Kangra). Two hundred peoples were selected and screening for their nutrition profile and results found that 99% female volunteers under this survey were found to be anemic although not severely.

Fruit Bar

Nutri Mix

Waste to Wealth: Pomegranate peel, a waste generated from fruit processing industry, is a potential source of active ingredients such as polyphenols that are known for their antioxidative properties. The local variety of pomegranate (*Punica granatum)* fruit (DARU) were collected and processed to separate peel and seeds. The phytochemical extraction methods were standardized using different solvents, microwave and water to obtain the highest yield and bioactive compounds. The highest yield was observed in 60% ethanol extraction samples compared to water extraction. The prepared phytochemical extracts were then evaluated for different antioxidant profiles (TPC, TFC, DPPH, FRAP). Identification of punicalagins from pomegranate peel and their safety and toxicity study are under progress.

Publications:

- Sharma A, Himadri M, Dwivedi JP and Gupta M (2015) Optimization of nutritionally enriched mango bar using response surface methodology. *Journal of Food Measurement and Characterization*, 9:152-159.

Participants: Jai Prakash Diwedi, Virat Abhishek, Vikas Dadwal, Madhu Kumari, Aarti Sharma, Charul Sharma, Kanika Sonkhla and Himani Agrawal.

Dr. Mahesh Gupta's group

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Research area: *In Vitro* and *In Vivo* pharmacology

Cytotoxic activity of the essential oils: Plant-based traditional system of medicine continues to play an important role in healthcare. In order to find new potent source of bioactive molecules, we studied the cytotoxic activity of the essential oils from the flowers and leaves of *Callistemon citrinus*. The GC and GC-MS analysis of these essential oils revealed high content of α-pinene, limonene, α-terpineol in leaf, whereas the flower oil was dominated by 1,8-cineole and α-pinene. Cytotoxicity of these essential oils were evaluated using sulfo-rhodamine B (SRB) assay against human lung carcinoma (A549), rat glioma (C-6), human colon cancer (Colo-205) and human cervical cancer (SiHa) cells. Although both leaf and flower oils showed highest cytotoxicity on A549 cells only, 100 µg/mL flower oil was found significantly active against C-6 cells. Interestingly, no toxicity was recorded on normal cells. These observations were further, confirmed by apoptosis induction and caspase-3/7 activity followed by western blotting. Percentage cell apoptosis was determined by Annexin V based dead cell assay followed by DNA content as cell cycle analysis against A549 and C-6 cells. While 3-(4,5-dimethythiazol-2-yl)-2,5-diphenyl tetrazolium bromide (MTT) assay was used to check the toxicity against normal human peripheral blood mononuclear cells (PBMCs), the immunomodulatory activity on mouse splenocytes was evaluated using SRB assay. Higher concentration of 1,8-cineole and/or synergistic effect of the overall composition were probably responsible for the efficacy of flower and leaf oils against the tested cells. These oils may form potential source of natural anti-cancer compounds and play important role in human health.

Cytotoxic activity of secondary metabolite of *Tinospora cordifolia*: In another study, secondary metabolites isolated from *T. cordifolia* were against four different human cancer cell lines i.e. KB (human oral squamous carcinoma), CHOK-1 (hamster ovary), HT-29 (human colon cancer), SiHa (human cervical cancer) and murine primary cells, respectively. All extracts and fractions were found active against KB and CHOK-1 cells, whereas among the pure molecules 'palmatine' was found to be active against KB and HT-29 cells. Further, 'tinocordiside was found active against KB and CHOK-1; yangambin against KB cells, however *N*-Formylannonain and 11-hydroxymustakone showed immunomodulatory activity. The pharmacological evaluation of extract, fractions and pure molecules indicated that ethnomedicinal value for anticancer and immunomodulatory activities of *T. cordifolia* may be attributed due to the synergistic effect of group of compounds.

Publications:

- Kumar D, Sukapaka M, Kiran Babu GD and Padwad YS (2015) Chemical composition and *in vitro* cytotoxicity of essential oils from leavesand flowers of *Callistemon citrinus* from Western Himalayas. *Plos One*, DOI: 10.1371/journal.pone.0133823.
- Bala M, Pratap K, Verma PK, Singh B and Padwad YS (2015) Validation of ethnomedicinal potential of *Tinospora cordifolia* for anticancer and immunomodulatory activities and quantification of bioactive molecules by HPTLC. *Journal of Ethanopharmacology*, DOI: 10.1016/j.jep.2015.08.001.
- Walia Mayanka , Rawat Kiran, Bhushan Shashi , Padwad Yogendra S , Singh Bikram. 2014. Fatty acid composition, physico-chemical properties, antioxidant and cytotoxic activity of apple seed oil obtained from apple pomace. Journal of the Science of Food and Agriculture. 94:929–934 DOI: 10.1002/jsfa.6337.
- Rana Shalika, Rawat Kiran, Mahendru Madhavi,Padwad Yogendra, Pakade Yogesh B, Lal Brij & Bhushan Shashi (2015). Screening of bioconstituents and in vitro cytotoxicity of *Clematis gouriana* leaves. *Natural Product Research*. DOI:10.1080/14786419.2014.1000891.
- Sharma P, Sharma S, Patial V, Singh D and Padwad YS (2014) Zebrafish (*Danio rerio*): a potential model for nephroprotective drug screening. *Clinical Queries: Nephrology*, 3(2-4): 97-105.

Participants: Rakesh Kumar, Sourabh Soni, Shiv Kumar, S. Mahesh, Anamika Sharma, Kiran Rawat, Rajneesh and Dharmesh Kumar.

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Research area: Toxicology and pharmacology

Safety and toxicity evaluation: The evaluation of plant molecules for anticancer, wound healing, nephroprotective and hepatoprotective potential was done by using biochemical, histopathological and immunohistochemical techniques. Dendrimer conjugated podophyllotoxin was tested less toxic to its parent molecule and showed promising antitumor activity in mouse skin papilloma model. The drug molecule found to induce the apoptosis in the cancer cells and reduced the hyperplastic changes in the skin. In other work the plant based nanoformulations were evaluated for wound healing activity and found to enhance the wound healing cascade by influencing a number of processes which include inflammation, cell proliferation, synthesis and maturation of collagen, wound contraction and re-epithelialization. Currently, the biologically active pure molecules, fraction and crude extract of *Picrorhiza kurroa* were screened *in vitro* to find out the most active component. Further, the nephroprotective potential of active component is under investigation in drug induced renal injury mice model.

Publications:

- Ugir Hossain Sk, Patial V and Sharma S (2015) Low toxic synthetic dendrimer conjugated podophyllotoxin nanodevice with potent antitumor activity against DMBA/TPA induced mouse skin carcinogenesis model. *Toxicology Research*, DOI:10.1039/C5TX00112A.
- Sharma P, Sharma S, Patial V, Singh D and Padwad YS (2014) Zebrafish (Danio rerio): a potential model for nephroprotective drug screening. *Clinical Queries: Nephrology*, 3(2-4): 97-105.

Participants: Pankaj Kulurkar and Supriya Sharma

Dr. Vikram Patial's group

Damanpreet Singh

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Research area : Neuropharmacology

Neuroprotective nutraceuticals : The aim of our research work is to explore and validate the therapeutic potential of western Himalayan region plants in experimental animal model and *in vitro* studies. In development of neuroprotective nutraceuticals, biologically active pure molecules, fraction and crude extract of *Picrorhiza kurroa* was first screened using *in vitro* cell culture model for further *in vivo* studies. The effect of crude extract and different bioactive components picroside-I, picroside-II and kutkin has been studied against H_2O_2-induced cellular damage in C6 glioma cells. The rat C6 glioma cell line was maintained in HAMS F-12 culture medium with 10% fetal bovine serum. The test components were incubated with H_2O_2 in cell media and survival rate was determined colorimetrically using 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyl tetrazolium assay. Among different tested components, kutkin was found to be the most potent, hence was selected for further studies. Early apoptosis and necrosis were identified after treatment with kutkin by double fluorescence staining using Annexin V- FITC/PI Apoptosis detection kit. The cells were harvested, washed with PBS and incubated with 5 µL of Annexin V-FITC and 10 µL of PI for 30 min in dark at room temperature, and cellular fluorescence was measured. Further *in vivo* studies on kutkin in mice model are in process to explore its systemic usefulness.

The stigmas along with other botanical parts of *Crocus sativus* are being extensively used in ethnomedical treatment of varied CNS diseases. Extensive search was carried to comprehend the fragmented information on neuropharmacological aspects, chemistry and safety of *C. sativus* to explore its possible potential use in complex neural diseases. Preliminary *in vitro* studies on cell line showed its protective effect. Further *in vivo* studies in chronic animal models of neurological disorders are in process. The antivenom activity of the crude extracts, solvent fractions and pure molecules was also carried out by studying in vitro protease, phospholipase A2, hyaluronidase, nucleotidase, ATPase and L-amino oxidase activity.

Publications:

- Singh, D (2015) Neuropharmacological aspects of *Crocus sativus* L.: a review of preclinical studies and ongoing clinical research. *CNS & Neurological Disorders Drug Targets*, 14(7): 880-902.
- Sharma P, Sharma S, Patial V, Singh D and Padwad YS (2014) Zebrafish (*Danio rerio*): a potential model for nephroprotective drug screening. *Clinical Queries: Nephrology*, 3(2-4): 97-105.

Participants: Pallavi Sharma and Arindam Ghosh Mazumder

Dr. Damanpreet Singh's group

High Altitude Biology and Plant Conservation

- Survey and mapping of plant resources
- Documentation of traditional knowledge
- Agrotechniques for high altitude MAPs
- Process and products development
- Conservation and bioprospections
- Development of database
- Societal services

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Research areas: Ethnobotany and traditional knowledge on western Himalayan region

Rediscovery of a highly endangered taxon: As a result of extensive plant exploration carried out to different areas of the western Himalayan region, *Jasminum parkeri* Dunn (Oleaceae), a highly endangered and narrowly endemic taxon has been rediscovered from its type locality (Dist. Chamba, HP) after a lapse of about 100 years. It is a small shrub with bright-yellow, pleasantly scented having attractive flowers (Fig. 1). The species has immense horticultural potential and can be developed as an ornamental plant.

Documentation of ethnobotanical information: During ethnobotanical studies carried out among the *Gaddis* of a particular locality in Kangra district (HP), information on 91 plants was recorded through personal interaction and interviews. Of the total 91 plants reported, majority (60-70%) are used for medicinal purposes while the remaining are used for food, fodder, fibre and house building materials. The use of *Valeriana jatamansi* to reduce termite populations in crop fields and *Cynadon dactylon* in treating nose bleeding are unique to this region.

Fig. 1 *J. parkeri* Dunn- showing type locality and different stages of phenology: 1. Plant growing in the type locality, 2. Habit, 3. Plant in full bloom, 4. Fruit-bearing plant

Enrichment of herbarium: Around 800 plant specimens of angiosperms (600), gymnosperms (20), ferns and fern allies (180) were collected for preservation in the herbarium of the institute. Of the 800 specimens, 200 voucher specimens were processed, identified and deposited in the herbarium for future reference. Voucher specimens of *Dubyaea hispida, Pyracantha crenulata, Saussurea fastuosa,* and *Selinum filicifolium* are new additions to the herbarium of the institute (PLP).

Publications:

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- Bala M, Verma PK, Awasthi S, Kumar N, Lal B and Singh B (2014) Chemical prospection of important ayurvedic plant *Tinospora cordifolia* by UPLC-DAD-ESI-QTOF-MS/MS and NMR. *Natural Product Communications*, 10(1): 43-48.
- Lal B, Datta A, Parkash O and Singh RD (2014) Rediscovery of *Jasminum parkeri* Dunn, an endemicand endangered taxon from the western Himalaya, India. *Biodiversity Research and Conservation*, 34: 11-16.
- Kumar A, Singh KN, Lal B, Chawla A, Uniyal SK, Kaushal R, Singh RD and Ahuja PS (2014) Regeneration pattern of tree species in forested landscapes of Himachal Pradesh, western Himalayan region, India. *Proceedings of the National Academy of Sciences, India Section B: Biological Sciences*, 84(3):695–707.
- Kumari A, Pakade YB, Chand P, Prasad MNV and Lal B (2014). Comparative accounts of chromium accumulation in three ferns under hydrophonic system. *Indian Journal of Scientific & Industrial Research*, 73: 553-558.
- Stappen I, Wanner J, Tabanca N, Wedge DE, Ali A, Khan IA, Kaul VK, Lal B, Jaitak V, Gochev V, Girova T, Stoyanova A, Schmidt E and Jirovetz L (2014) Chemical composition and biological effects of *Artemisia maritima* and *Artemisia nilagirica* essential oils from wild plants of western Himalaya. *Planta Medica*, 80: 1079–1087.
- Stappen I, Wanner J, Tabanca N, Wedge DE, Alic A, Kaul VK, Lal B, Jaitak V, Gochevh VK, Schmidta E and Jirovetza L (2015) Chemical composition and biological activity of essential oils of *Dracocephalum heterophyllum* and *Hyssopus officinalis* from western Himalaya. *Natural Product Communications*, 10 (1): 133-138.

Participants: Priyanka Sharma, Alka Kumari, Omparkash and Ranjit Singh

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Research area: Crop physiology and agrotechnology of medicinal, aromatic and other economic plants

Revegetation of dumping sites of Indian Himalayan region: 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 different valleys viz., Manikaran (DS-01, DS-02, DS-03), Garsa (DS-06) and Sainj (DS-08, DS-09, DS-12, DS-13a and DS-13b, DS-14L and DS-14U, DS-16) of Kullu district of HP. Survival rate of the infilling tree species was 85 to 97%. It was further observed that *Robinia pseudoacacia* was the best and faster growing species, followed by *Ailanthus excelsa* and *Aesculus indica*.

***Crataegus oxyacantha*:** Experiments to standardize the agrotechnology for cultivation of *C. oxyacantha* (a medicinally important species that finds applications in cardiovascular diseases) spacing trial (1m x 1m, 2m x 1m, 2m x 2m 2m x 3m and 3m x 2m) and dozes of FYM (15t/ha, 22.5t/ha, 30t/ha and 37.5t/ha) were conducted. After 8 years, the flowering and fruiting has been started. Earlier 2-3 years the fruit yield was low, but it has been increasing with time (Fig 1& Fig 2).

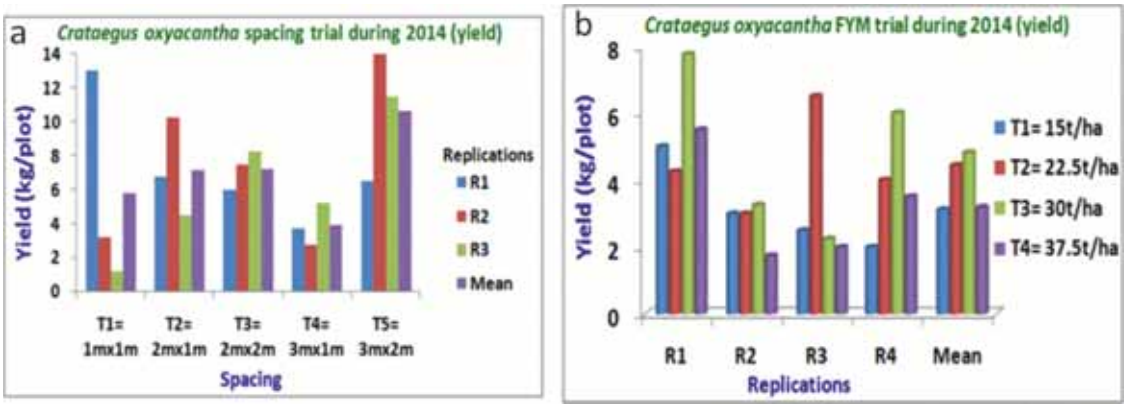

Fig. 1 Effect of a) spacing trial, and b) FYM on fruit yield

***Ginkgo biloba*:** Earlier, a field experiment was laid out by using four different doses of FYM, 15t/ha, 30t/ha, 45t/ha and 60t/ha. The pit size was 60 x 60 x 60 cm, the FYM doses were given before planting and every year in the month of December, a total no. of 315 plants were planted in five treatments (63 plants per treatment), each at the spacing 3m x 3m. The growth parameters were recorded every year and the plucking of leaves in the month of November were recorded (Fig. 3). All the FYM doses produced statistically significant leaf yield (Table 1). In second field experiment, a close plantation density was considered for optimizing leaf yield per unit time. The plant spacing (1.0 x1.0, 1.5 x 1.5, 2.0 x 2.0 and 2.5 x 2.5 m2 in interaction with two levels of FYM (15 and 30t/ha) were studied to observe their effect on leaf yield per plot (Fig. 4 and Fig. 5). Leaf yield was significantly higher in 30t/ha FYM application as compared to 15t/ha.

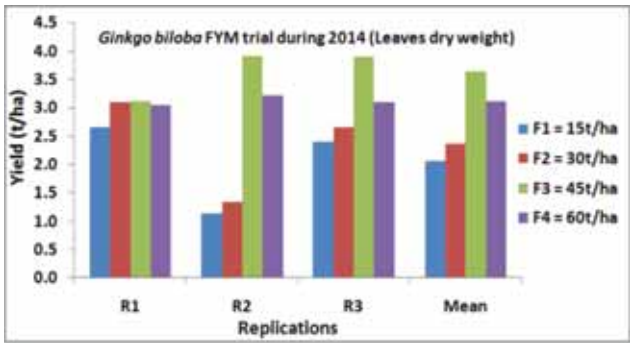

Fig. 3 *Ginkgo biloba* FYM trial Leaves dry weight t/ha 2014

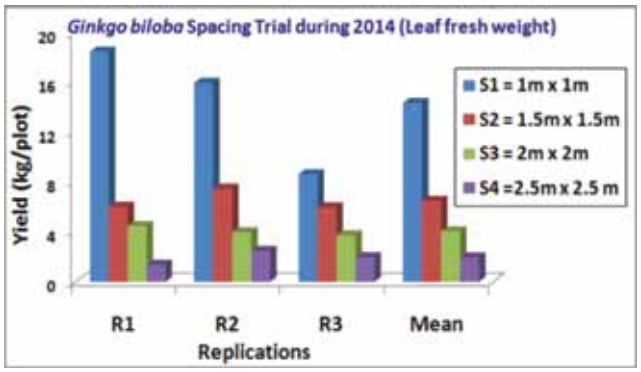

Fig. 4 *Ginkgo biloba* Spacing Trial leaf fresh weight in kg 2014

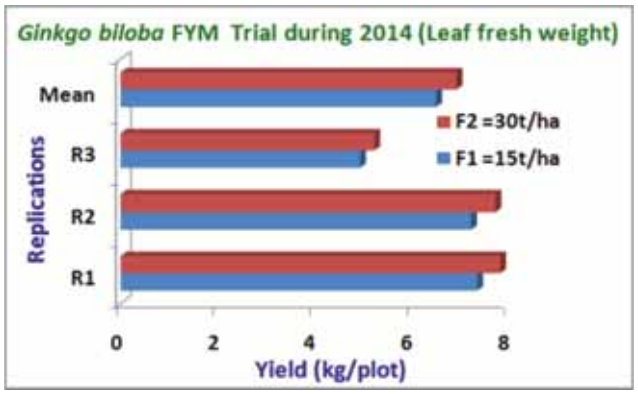

Fig. 5 *Ginkgo biloba* FYM Trial leaf fresh weight in kg 2014

Table 1. **Effect of FYM application on height, circumference and diameter on biomass production (leaves) of *Ginkgo biloba.***

Treatment	Plant height (cm)	Plant circurfrance (mm) at ground level	Plant circurfrance (mm) at brest height	Leaves Fresh weight kg.	Leaves dry weight kg.	Leaves fresh weight t/ha	Leaves dry weight t/ha
control	312.80	74.00	46.60	33.00	16.50	1.71	0.85
F1	330.40	86.95	51.47	80.00	40.00	4.14	2.07
F2	339.88	92.12	57.60	91.80	45.90	4.76	2.38
F3	349.70	94.31	57.91	115.66	57.83	5.99	2.99
F4	365.90	96.40	59.35	121.00	60.50	6.27	3.13
CD(P=0.05)	**NS**	**12.99**	**6.62**	**41.49**	**20.74**	**2.15**	**1.07**

Publications:

- Agnihotri VK, Thakur S, Pathania V and Gopichand (2014) New dihomosesquiterpene, termioic acid A, from *Curcuma aromatica* A. *Chemistry of Natural Compounds,* 50(4): 665-668.
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- Pal PK, Kumar R, Guleria V, Mahajan M, Prasad R, Pathania V, Gill BS, Singh D, Gopichand, Singh B, Singh RD and Ahuja PS (2015) Crop-ecology and nutritional variability influence growth and secondary metabolites of *Stevia rebaudiana* Bertoni. *BMC Plant Biology*, 15:67 doi:10.1186/s12870-015-0457-x.

Participants: R L Meena and Rajkesh Koundal.

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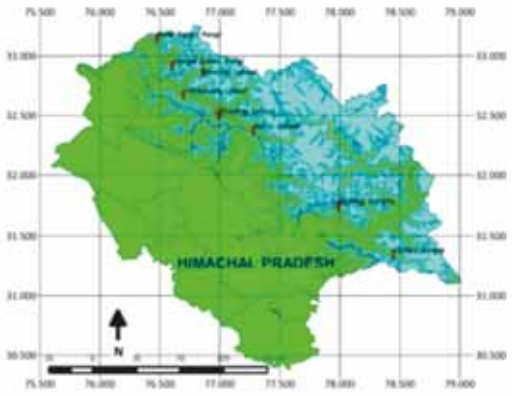
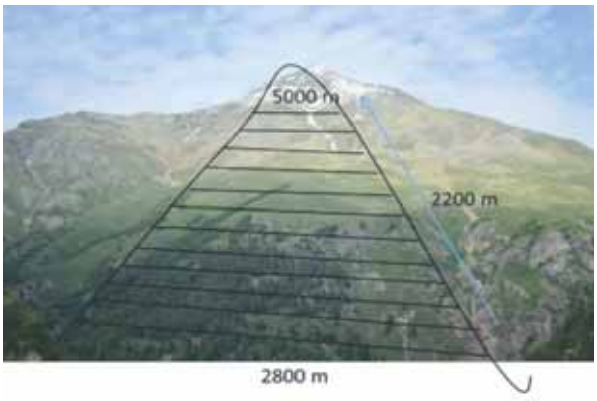
Research area: Vegetation ecology, plant adaptation strategies and biodiversity conservation in high altitudes of western Himalaya

Western Himalaya is a home to many rare and threatened species, most of them being endemic. These species being of considerable economic importance also play a pivotal role in ecological sustenance. The altitudinal variation in this zone creates natural gradients of temperature, precipitation, solar radiation, partial pressure of gases etc. that results in diverse plant assemblages along elevation. There is, however, a lack of understanding about the Himalayan ecosystem functioning. It is in this context that studies on the following objectives are being carried out in high altitude zone of HP.

Plant diversity and plant functional traits: A total of 08 elevation transects have been established between 3000 to 5000 m elevation range. The transects encompass subalpine forests, treeline zone, alpine and nival zones. The plant population structure and functional traits such as plant height, specific leaf area (SLA), succulence, pubescence, spinescence, root/shoot ratio, flower colour, growth form and life form are being recorded to understand plant adaptations at high elevations. Preliminary results indicate that there is an increasing abiotic filtering with rise in elevations. This filtering causes variation in the community traits, leading to decrease in number of species, SLA, leaf area, leaf area: perimeter ratio and plant height. On the other hand, there is an increase in succulent plants with increasing elevation.



High altitude zone HP



Sampling along elevation

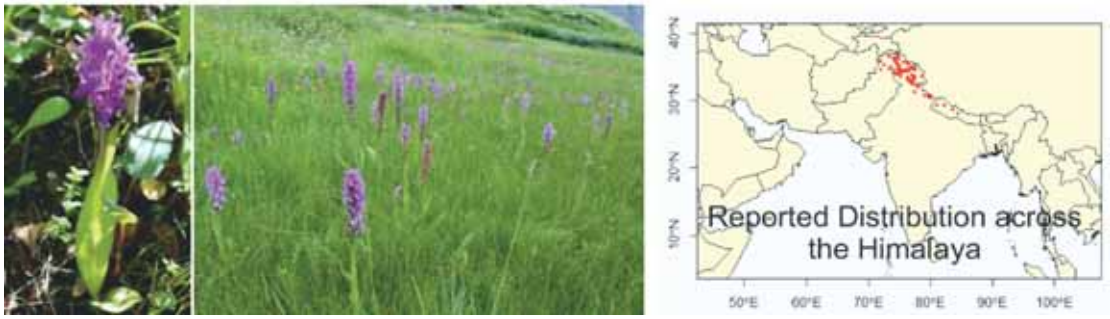
Long term ecological research

Establishment of permanent monitoring plots (PMPs): Eight PMPs of size 1 ha have been set up in treeline zone (3500 – 3800m) in the localities identified for elevation transects. *Abies pindrow*, *Betula utilis* and *Pinus wallichiana* formed climatic tree lines in the region. The structure of these treeline communities was studied and temperature data loggers installed for recording temperature. A total of 130 plant species were found in the treeline zone with average species richness of 35 ± 5.68 per location. The PFTs of the treeline community reflected adaptation strategies to survive in the harsh climate. The dominant growth form was 'short basal' (<0.5m long concentrated very close to the ground) and the major life form was 'hemi-cryptophyte' (plants whose buds remain close to the ground surface). More than 50% of the total plants species were having pubescence as survival strategy. Succulence was found in 20% plants (all non-pubescent or with localized pubescence). Community dominance by short-basal growth form and hemi-cryptophyte life form are characteristic features of species occurring at harsh conditions. Further short plants with a significant allocation to root mass, deep root penetration, pubescence and succulence represent plant strategy to adapt to low temperatures.

Further, a total of 20 litter traps were laid in the existing PMPs for periodic collection of litter samples and analysis in the laboratory. In the first year, it was observed that litter fall was highest in the months of September and October with mean dry weight ranging from 667.2 to 860.3 kg/ha in the two months. Litter decomposition experiment was set up in 05 sites in October-November 2014. 20x20 cm^2 nylon mesh bags with 10g of fallen tree leaves were placed in 05 PMPs (Pangi (01), Lahaul (03) and Kinnaur (01) with 45 bags for analysis during next five years.

Permanent monitoring plots in the treeline zone (sites)

Plant conservation and floristic assessments: The high elevation plants have narrow distribution range and population are declining due to overharvest for commercial purpose. It necessitates studies on risk categorization of threatened species. An assessment of the *Dactylorhiza hatagirea* population in the trans-Himalayan region of Lahaul & Spiti was undertaken. A total of thirteen *D. hatagirea* communities were sampled in the region, 10 in Lahaul and 03 in Spiti. Plant height, root: shoot ratio, basal area and above ground plant biomass found highly variable traits, which serve as proxy for fitness and help the plant survival in a variety of environmental conditions. Around 3000 plant specimens were collected with proper field descriptions and processed for inclusion in the herbarium (PLP).



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Research area: High altitude biology, biodiversity conservation and management

In nature, rapid decrease in population of threatened and commercially important medicinal and aromatic species by over-exploitation and habitat degradation is recorded and categorized under different IUCN threat categories for Himalayan states. *Ex-situ* conservation of recorded species through cultivation is not much attempted so far from the Lahaul-Spiti region of Cold Desert area. Under continuous demand by pharmaceutical industries regarding preparation of various formulations and unscientifically extraction from the wild, need for conservation and management has been much realized. While understanding the importance for conservation, my focused research is based on the following objectives:

- Domestication/introduction of relevant plant bioresource and developing their agro-techniques
- Conservatory on high altitude plants of economic importance (*in situ* and *ex situ*)
- To study the distribution pattern of threatened and commercially important medicinal and aromatic plant in cold desert area of Himachal Pradesh

Conserved the high altitude bioresource in herbal garden of CSIR-Centre for High Altitude Biology, Ribling (Lahaul & Spiti) 3450 m amsl:

- List of cultivated species of local accessions (app. 32 species): *Fagopyrum esculentum, Aconitum heterophyllum, Hyoscyamus niger, Podophyllum hexandrum, Cicer microphyllum, Codonopsis clematidea, Polygonatum cirrhifolium, Achillea millefolium, Inula racemosa, Picrorhiza kurrooa, Hippophae rhamnoides, Tagetes erecta, Bergenia stracheyi, Rosa webbiana, Angelica glauca, Rheum australe, Heracleum candicans, Aconitum violaceum, Saussurea costus, Dactylorhiza hatagirea, Valeriana jatamansi, Bunium persicum, Carum carvi, Hordeum vulgare*, *Triticum aestivum, Brassica rapa* (Turnip), *Hippophae salicifolia, Fritillaria roylei, Trillidium govanianum, Bergenia stracheyi, Rhodiola heterodonta, Eremurus himalaicus etc.*
- List of Introduced species (app. 12 species): *Salvia sclarea, Fagopyrum tataricum, Lavandula officinalis, Asparagus racemosus, Chinese Bamboo, Chrysanthemum* sp., *Panax ginseng, Artemissia annua, Crataegus oxyacantha, Daucus carota, Lilium pollyanna, Lilium* sp. (Red flower), *Ginkgo biloba* etc.
- Under Experimental trials:Medicinal & Aromatic. A total of 18 species introduced, 8 sp. and 10 Local available sp.) Sowing time: October-November, 2014 and June-July, 2015
- Hippophae germplasm resource centre: more than 300 plants of different genotypes from Russia,

Leh-Laddakh, Himachal Pradesh has been planted.

Publications:

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- Rana RK, Singh A, Singh V, Sharma LK, Devi R, Katoch P and Lal M (2014) Seabuckthorn (*Hippophae* L.) propagation and plantation is a new avenue to farmers and future scope of cultivation in Cold Desert area of Himachal Pradesh, INDIA. IN: Singh, Virendra; Yang Baoru; Choudhary Sonika; Morsel Jorg-Thomas; Zubarev Yury A.; Mohini K.; Singh, Sonika; Sharma, V.K.; Rana, R.K. and Lal Manohar. Eds.: *Seabuckthorn (Hippophae* L*.) A multipurpose wonder plant. Vol. IV. Emerging Trends in Research Technologies.* pp. 59-71. Daya Publishing House New Delhi.
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Research area: Pteridophytes

Pteridophytes are ancient non-flowering vascular plants, which appeared in the fossil record around 400 million years ago. This ancient group of plants consist a major part of land flora and we are exploring the diversity and distribution of its various species in different parts of western Himalaya and conserving their germplasm inside fernery of the Institute. Despite, over million years of evolution they still maintain an independent haploid gametophyte generation evolved by their distinct ancestors, and possesses all metabolic functions like sporophytes. Hence we are also culturing these gametophytes for mass propagation of some threatened species as well as economically useful ferns for their conservation as well as for experimental designs for different environmental studies. We are also taxonomically characterizing different fern species using light microscope and spore ornamentation using scanning electron microscopy. We have also contributed five fern species in the flora of HP. Besides, some species of this important plant group has extra ordinary capability of metal uptake and phytoremediation potential and we are also using the same in ecorestoration of metal loaded abandoned landfills near industrial disposal sites of National Thermal Power Stations.

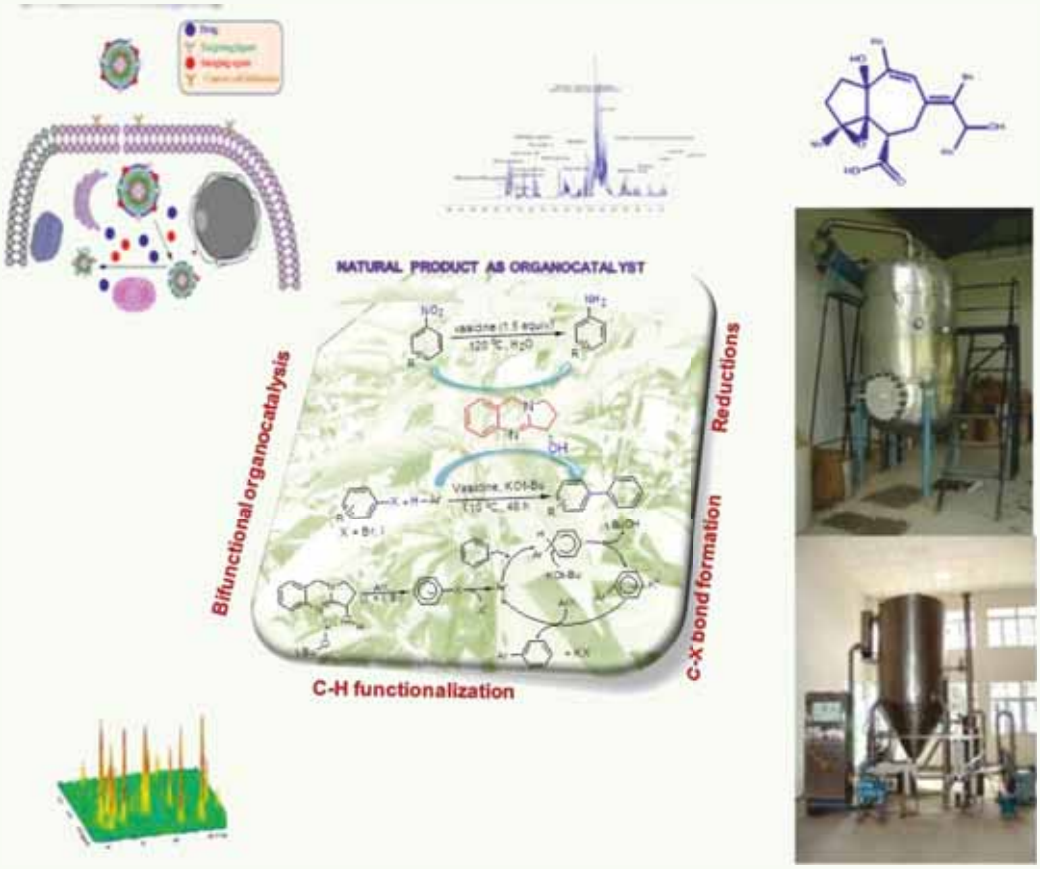
Publications:

- Kumari A, Pakade YB, Chand P, Rai UN and Lal B (2014) Comparative accounts of Chromium accumulation in three ferns under hydroponic system. *J of Scientific & Industrial Research (JSIR),* 73 (8) 553-558.
- Kumari A, Chawala A, Lal B and Fraser-Jenkins CR (2014) Dryopteris zayuensis Ching & S.K. Wu and Pteris biaurita L. Subsp. fornicata Fraser-Jenk.- Two interesting records in the Pteridophyte Flora of Himachal Pradesh, India. *Indian Journal of Forestry*, 37 (1):115-120.
- Markert B, Wuenschmann S, Baltrėnaitė E, Chudzińska E, De Marco S, Diatta J, Ghaffari Z, Gorelova S, Marcovecchio J, Tabors G, Yousef N, Wang M, Fraenzle S, Kumari A (2015) International, transdisciplinary and intercultural cooperation in bioindication and Biomonitoring studies (B & B technologies)- With specific consideration of Plant organisms and chemical elements. *International Journal of Sustainable Water and Environmental Systems*, 6(1): 17- 26.

Book Chapters:

- Alka Kumari (2014) Involvement of bacterial strains in metal extractability from fly ash isolated from rhizospheric zone of fern *Ampelopteris prolifera* growing on fly ash dumping sites', In"*Microbes in Soil and their Agricultural Prospects"*, Eds. K.K. Chaudhari and Dolly Wattal Dhar, Nova publishers, USA.

Natural Products Chemistry and Process Development



Nature Inspired Innovation to Improve Human Life

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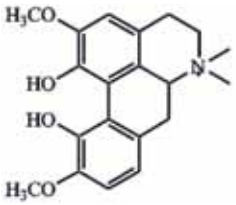
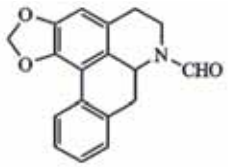
Research area: Natural products chemistry, synthetic modification & methodology development

Prospecting Himalayan flora for potential novel molecules: Our research group is engaged in characterization of new/novel molecules, chemical profiling, value addition, synthesis of natural, natural–like molecules and up scaling of lab scale to pilot scale from medicinal and aromatic plants of Himalayan region. The discovery for new bioactive compounds is often based on clues provided by traditional usage. The group is working on unfolding these secrets of nature by isolation of chemical compounds, their structure elucidation and development of analytical methods for chemical profiling, value addition and synthesis of natural and natural like molecules. Keeping this approach we had addressed many medicinal plants growing in western Himalayan region viz. *Tinospora cordifolia*, *Cissampelos pareira, Zephyranthes grandiflora, Narcisssus tazetta, Brassica juncea* and *Eruca sativa*. Some species of pteridophytes and conifers were also investigated.

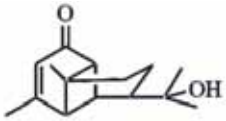
***Tinospora cordifolia*:** During the period, fourteen molecules including five isoquinoline alkaloids were reported from the stem of *T. cordifolia*. Seven compounds (syringin, cordifolioside A, magnoflorine, tinocordiside, 11-hydroxymustakone, yangambin, *N*-formylannonain) were quantified by UPLC and HPTLC in the stem of *T. cordifolia* hosted on fifteen different plants. Highest amount of compounds was observed in the stem of *T. cordifolia* hosted on *Azadirachta indica* and *Mangifera indica.* Some of the isolated compounds were screened for cytotoxicity. Tinocordiside, yangambin and palmatine were found to be active against different cancer cell lines; while, 11-hydroxymustakone and *N*-formylannonaine gave potent splenocyte proliferation.



Magnoflorine

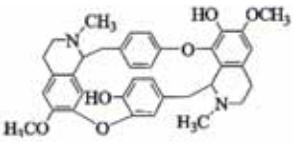


N-formylannoniane

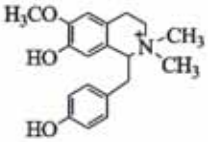


11-Hydroxy mustakone

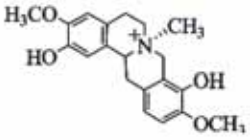
***Cissampelos pareira*:** Sixteen molecules including eight isoquinoline alkaloids were characterized from roots of *C. pareira*. The five isoquinoline alkaloids (magnoflorine, magnocurarine, curine, cissamine and hayatinin) were quantified by UPLC in the roots of *C. pareira.* The method was applied for studying the seasonal variation of the plant during one year and result showed highest content in rainy season. The cytotoxicity studies on the extract and fractions showed the activity of all extract/fractions and two compounds (hayatinine and cycleanine) against different cancer cell lines. Extracts, fractions and molecules were also evaluated for anti-venom activity and curine, magnocurarine were found to be effective.



Curine

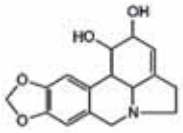


Magnocurarine

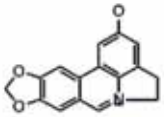


Cissamine

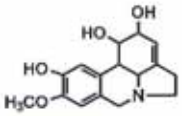
***Narcissus tazetta* and *Zephyranthes grandiflora*:** In another study, a bioassay guided isolation and characterization of anti cancer molecules was carried out from *N. tazetta* and *Z. grandiflora*. Six compounds from *N. Tazetta* and nine from *Z. grandiflora* have been isolated. The anticancer activity of pure compounds has been undertaken.



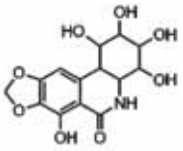
Lycorine



Ungeremine



Pseudolycorine

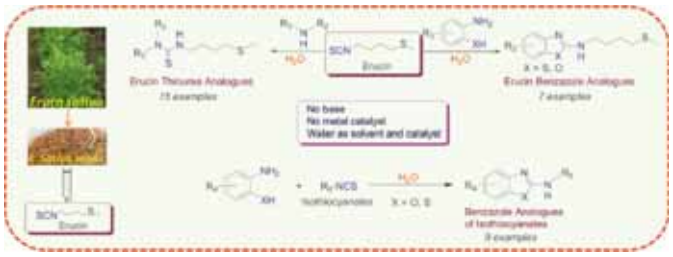


Pancratistatin

Pteridophytes: Pteridophytes are one of the oldest groups of plants on earth and mainly distributed in Himalayan and coastal regions. These are used traditionally for the treatment of various ailments. Keeping this in mind, we studied *Adiantum incisum, A. capillus*, *A. lunulatum*, *Diplazium maximum*, *D. esculentum, Pteridium aquilinum.* The extracts and fractions of these species were prepared. Three species of *Adiantum* (*A. lunulatum*, *A. capillus-veneris, A. incisium*) and two species of *Diplazium (D. maximum, D. esculentum)* were analyzed by UPLC/MS-MS. Activity screening of extracts and fractions indicate that *A.. lunulatum* showed 53, 67 and 73% mortality against larvae of *P. xylostella* at 2% concentration level after 48, 72 and 96 h; whereas, *n*-butanol fraction of *D.. maximum* showed 40 and 50% mortality against *Aphids* after 72 and 96 h, respectively. Eighty percent methanolic extract of *A. lunulatum* enhanced percent wound contraction in comparison to control and standard groups. The percent wound contraction was more prominent on 3rd and 7th day of healing process.

Glucosinolates from germplasms of *Brassica juncea* (L.) Czern *Eruca sativa* (Mill.) and their value addition: The volatile constituents were separated and profiled by GC and GC-MS. The major constituent, erucin (an isothiocyanate) was further taken for synthetic modification to study the most acting anti-mutagenic molecules. The presence of secondary metabolites was also evaluated by UPLC/MS-MS in both the plants.

Synthesis of different derivatives of erucin: An efficient, green and facile method has been developed for the synthesis of benzazole and thiourea analogues from naturally occurring erucin in moderate to good yields. Reaction was carried out in water without using any metal catalyst or base. Present method tolerated the various functional groups on aromatic rings and also applicable for other isothiocyanates.



Synthesized analogues of erucin were evaluated for their cytotoxic activity comparative to erucin & vinblastin. Erucin was found to be more active than the synthesized analogous. The cytotoxic activity of erucin and its seven derivatives were also evaluated against Human cervical cancer (SiHa), Human **mouth** epidermal carcinoma (KB) and Chinese Hamster ovarian carcinoma (CHOK-1) cells at 24 h, 48 h & 72 h. Two analogues showed activity against CHOK cell lines in 48 h, whereas, concentration dependant activity was observed with other cell lines.

New methodologies: Natural products provide the synthetic challenges and leads to development of new methodologies which can become the part of total synthesis of natural products. With this approach we had developed new methodologies for the synthesis of imines, amines, amides, isoquinolines and benzazoles which has been further applied for the synthesis of isoquinoline alkaloids.

Publications:

- Bala M, Verma PK, Sharma D, Kumar N and Singh B (2015) Highly efficient water mediated approach to access benzazoles: metal catalyst and base-free synthesis of 2-substituted benzimidazoles, benzoxazoles and benzothiazoles. *Molecular Diversity*, 19(2): 263-272.
- Bala M, Verma PK, Kumar N and Singh B (2015) Direct waste-free synthesis of amides from non-activated carboxylic acids and amines: Application to the synthesis of tetrahydroisoquinolines. *Synthetic Communications* 45(7), 847-856.

- Bala, M, Verma, PK, Awasthi S, Kumar N, Lal B and Singh B (2015) Chemical prospection of mportant ayurvedic plant *Tinospora cordifolia* by UPLC-DAD-ESI-QTOF-MS/MS and NMR. *Natural Product Communications*, 10(1): 43-48.
- Verma PK, Bala M, Thakur K, Sharma U, Kumar N and Singh B (2014) Iron and Palladium(II) Phthalocyanines as Recyclable Catalysts for Reduction of Nitroarenes. *Catalysis Letters*, 144(7): 1258-1267.
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- Kumar R, Sood S, Sharma S, Kasana RC, Pathania V, Singh B and Singh RD (2014) Effect of plant spacing and organic mulch on growth, yield and quality of natural sweetener- *Stevia rebaudiana* Bertoni and soil fertility in western Himalayas. *International Journal of Plant Production*, 8(3): 311-334.

Participants: Ritika Sharma, Deepali Katoch, Manju Bala, Praveen K Verma, Aarti Sharma and Shruti Sharma

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Research area: Natural products and bio-organic chemistry

Bioprospection of Himalayan Plants, discovery of new reactions and reactivity focusing on Lewis acid and organocatalysis

Bioprospection of western Himalayan flora: Medicinal plants have been an area of intensive research aiming at developing new drugs for various diseases afflicting mankind. The characterization of active principles is the main key to the drug discovery from medicinal plants. In order to access the economic potential of different plant species growing in Himalaya and their value addition, my group endeavour to explore the chemical diversity of Himalayan medicinal plants. This year, a new geranylbenzofuranone, zantholide (1), and eight known compounds, dodeca-2*E*,4*E*-dienoic acid isobutylamide (2), dodeca-2*E*,4*E*,8*Z*,11-tetraenoic acid isobutyl amide (3), zanthoxylin (4), sesamin (5), kobusin (6), asarinin (7), fargesin (8) and armatamide (9), have been isolated from the bark of *Zanthoxylum armatum*. This was the first report on the isolation of 2 and 3 from the Rutaceae family and 4 from *Z. armatum.*

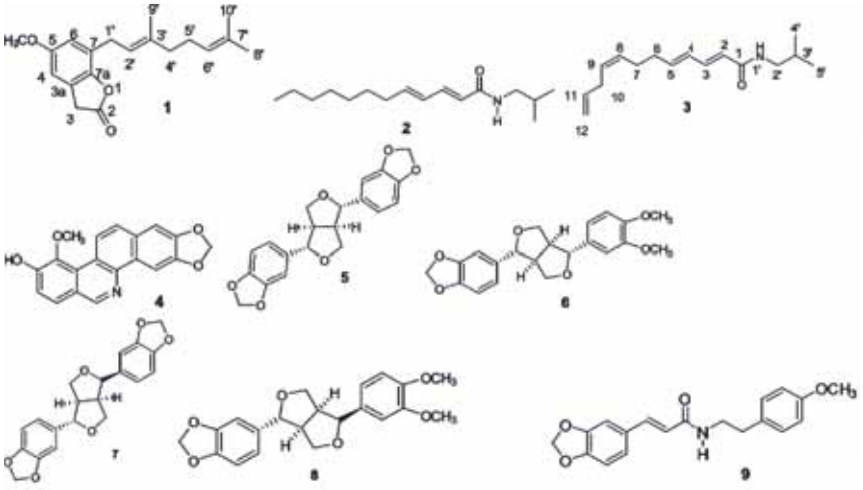

Fig. 1 Chemical structures of compounds isolated from *Z. armatum*

Organocatalysis: The use of small organic molecules as catalysts is a metal-free approach that includes several advantages over transition metals such as less-toxicity, operational simplicity, non-inert atmosphere and selectivity, hence, helpful in realization of the principles of green chemistry. My group is involved in exploring organocatalytic potential of an abundantly available alkaloid, i.e. vasicine from *Adhatoda vasica*, which is otherwise earlier known for biological activities. The utilization of abundantly available natural products as organocatalyst produced from nature's chiral pool is relatively new and promising way for the realization of idea of organic syntheses. Vasicine has been developed as an efficient and renewable organocatalyst for C-C bond formation. This year, dual role (hydrogen source as well as organocatalyst) of vasicine was disclosed for efficient chemoselective reduction of nitroarenes to

corresponding anilines in water. Selective reduction of nitroarenes in eco-friendly manner is very important transformation for pharmaceutical sectors and other chemical industries (Fig. 2).

Fig. 2 Vasicine catalyzed organic transformations

Publications:

- Bala M, Verma PK, Kumar N and Singh B (2015) Direct waste-free synthesis of amides from non-activated carboxylic acids and amines: Application to the synthesis of tetrahydroisoquinolines. *Synthetic Communications*, 45(7): 847-856.
- Bala M, Verma PK, Awasthi S, Kumar N, Lal B and Singh B (2014) Chemical prospection of important ayurvedic plant *Tinospora cordifolia* by UPLC-DAD-ESI-QTOF-MS/MS and NMR. *Natural Product Communications*, 10(1): 43-48.
- Bala M, Verma PK, Sharma D, Sharma N and Singh B (2015) Highly efficient water-mediated approach to access benzazoles: metal catalyst and base-free synthesis of 2-substituted benzimidazoles, benzoxazoles, and benzothiazoles. *Molecular Diversity*, 19(2): 263-272.
- Bhatt V, Kumar V, Singh B and Kumar N (2015). A New Geranylbenzofuranone from *Zanthoxylum armatum*. *Natural Product Communications*, 10(2): 313-314.
- Kumar V, Reddy SGE, Chauhan U, Kumar N and Singh B (2015) Chemical composition and insecticidal activity of *Zanthoxylum armatum* against diamond back moth, *Plutella xylostella*. *Natural Product Reasearch*, DOI:10.1080/14786419.2015.1036270.
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Participants: Vishal Kumar, Sushila Sharma, Manoranjan Kumar, Vinod Bhatt, Maheshwar Thakur, Onkar S. Nayal, Krishna Thakur, Shiv Kumar and Pawan Kumar.

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Research area: Nanocatalysis and organic synthesis

Development and exploration of nano-catalyst for replacing the existing problem in small molecules synthesis and cascade reactions

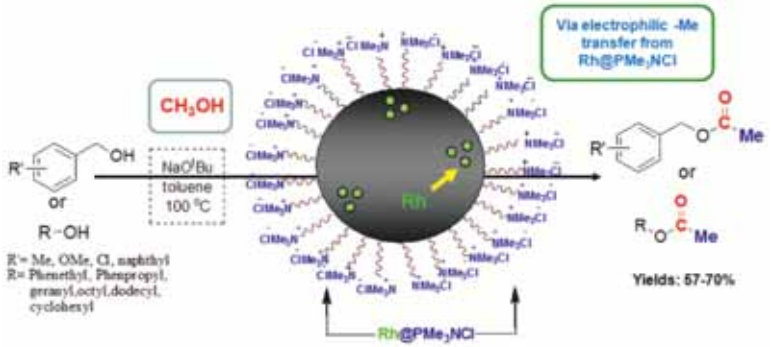
Selective reduction of nitroarenes to anilines: The rhodium catalyzed processes reported suffers from drawbacks such as chemo- and regio-selective reduction of alkenyl as well as alkynylnitroarenes, and dinitroarenes, respectively. Under this study, the developed solid-supported rhodium(0) (SS-Rh) catalyst was found to be highly reactive for chemo- and region-selective reduction of nitroarenes to their corresponding amines under hydrazine hydrate ($N_2H_4.H_2O$) condition. The high reusability of the catalyst up to 13 runs is added advantage of the present methodology.

***N*-Vinyl triazoles synthesis from terminal alkynes**: Substituted 1,2,3-triazoles are ubiquitous structural motifs found in a wide range of potent pharmaceutical compounds having anti-cancer and anti-HIV properties. An efficient general methodology was developed for sequential one-pot synthesis of *N*-(2-haloalkyl)-4-aryl-1*H*-1,2,3-triazoles through the selective mono-azidation of 1,2-dihaloethane and subsequent 1,3-dipolar cycloaddition with terminal aryl alkynes by using PRS@Pd nano-composite as heterogeneous catalyst. Potassium carbonate promoted dehydrohalogenation of synthesized N-(2-haloalkyl)-4-aryl-1*H*-1,2,3-triazoles gave the corresponding *N*-vinyl derivatives which further utilized in the synthesis of N-(2-arylalkenyl)-4-aryl-1*H*-1,2,3-triazoles following PRS@Pd catalyzed Heck coupling approach.

Hydrosilylation reaction of alkynes to vinyl silanes: Vinylsilanes, generally synthesized by catalytic hydrosilylation of alkynes, have proven to be versatile building blocks in organic syntheses. The solid supported palladium(0) nanoparticles (NPs) were found as an active heterogeneous catalyst for regioselective hydrosilylation of alkynes with organosilanes. Aliphatic as well as aromatic terminal/substituted alkynes similarly participated in the hydrosilylation to produce regioselective β-isomers of vinylsilanes. Reducible functional groups such as nitrile, ester, halide, alkene and alkyne were also found to be tolerated under this condition.

Multi-component approaches for *β*-aryl/*β,β*-diaryl alkenes synthesis: *β*-Aryl or *β,β*-diaryl unsaturated compounds such as cinnamates, stilbenoids, chalcones and neoflavonoids have attracted huge attention due to their extremely privileged biological profile. Under this study, one pot tandem procedure was developed for *β*-aryl and *β,β*-diaryl alkenes synthesis following an alternative to the classical approaches by using aryl aldehyde as one of the starting materials under Pd@PR conditions. Further an unprecedented sequential condensation-decarboxylation-Heck (CDH) and condensation-Heck (CH) strategies were developed to generate the substituted alkenes under ligand, and additive free milder basic conditions.

Esterification of alcohols through selective oxidation of methanol: Due to the high oxidation potential of methanal, the oxidation of methanol is much harder to accomplish than the oxidation of most primary benzyl alcohols. Yet there is no single report available where methanol acts as a redox media and gets oxidized faster and restricts oxidation of benzyl/alkyl alcohols. The polystyrene trimethyl ammonium chloride impregnated rhodium(0) (PMe_3NCl@Rh) nanoparticles (NPs) under this study act as a highly reactive catalyst for the selective oxidation of methanol to formaldehyde and simultaneously electrophilic methyl-transfer reagent to produce acetate esters of benzyl/alkyl alcohols through coupling approach.



Scheme 1. Acetate ester synthesis from alcohols

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- Chaudhary A and Das P (2015) Strategies for functionalized benzocycloheptene amines synthesis. *Current Organic Chemistry,* 19(2): 179-196.
- Chaudhary A, Sood S, Das P, Kaur P, Mahajan I, Gulati A and Singh B (2014) Synthesis of novel antimicrobial aryl himachalene derivatives from naturally occurring himachalenes. *EXCLI Journal,* 13: 1216-1225.
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- Guha NR, Bhattacherjee D and Das P (2015) Polystyrene trimethyl ammonium chloride impregnated Rh(0) (Rh@PMe3NCl) as a catalyst and methylating agent for esterification of alcohols through selective oxidation of methanol. *Catalysis Science & Technology*, 5(5): 2575-2580.
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- Shil AK, Kumar S, Sharma S, Chaudharya A and Das P (2015) Polystyrene resin supported palladium(0) (Pd@PR) nanocomposite mediated regioselective synthesis of 4-aryl-1-alkyl/(2-haloalkyl)-1H-1,2,3-triazoles and their N-vinyl triazole derivatives from terminal alkynes. *RSC Advances*, 5(15): 11506-11514.

Participants: Richa Bharti, Vandna Thakur, Avnesh Kumari, Abha Chaudhary, Nitul Ranjan Guha, Sumit Dadhwal, Sandeep Kumar, C Bal Reddy, Dhanajay Bhattacherjee, Arun Kumar Shil and Saurabh Sharma.

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Research area: Natural products and essential oil chemistry

Study on Himalayan bioresource for standardization and utilization: To understand world's most unique western Himalayan habitat, some crops which are aromatic and medicinal have been selected. This year we have explored *Saussurea lappa*, *Curcuma aromatica* and *Stevia rebaudiana*. The possibilities have been explored to work on fresh water algae and pteridophytes.

***Saussurea lappa**:* This plant is commonly known as costus and kuth and has repute for the usage in traditional medicinal systems of India, China and Japan. Phytochemical investigation of *S. lappa* root extract resulted in the isolation of isoalantolactone (1), *β*-cyclocostunolide (2), *α*-cyclocostunolide (3), 4-hydroxy-3,5-dimethoxycinnamyl-9-*O*-*β*-D-glucopyranoside (4), sucrose (5), and alantolactone (6). The root extract, fractions and isolated compounds were tested for cytotoxic activity against A549 (human lung carcinoma) and C-6 (rat glioma) cell lines. Chromatographic separations of active sesquiterpene lactones were accomplished on UPLC, BEH-HSS-T3 C_{18} column at 25 °C. Ethanolic extract, chloroform fraction, compounds 1, 2, 3 and 6 possessed significant activity against both tested cell lines (Fig. 1). Costunolide and dehydrocostus lactone were also characterized by comparison of MS/MS fragmentation pattern.

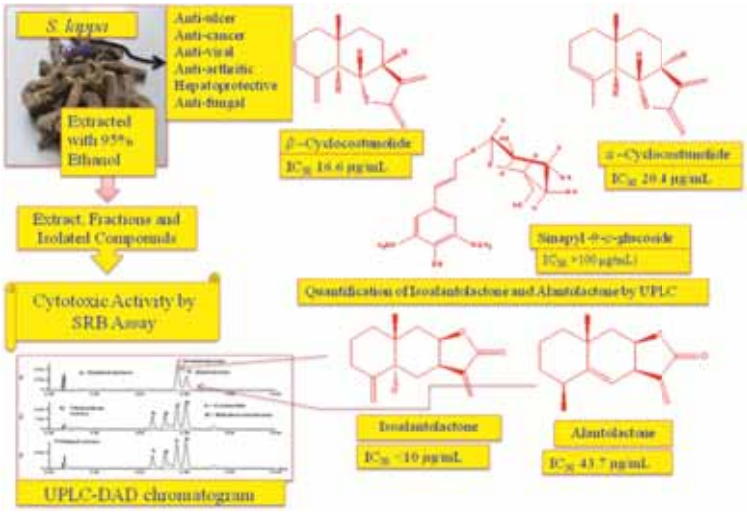

Fig. 1 A pictorial presentation of work done on roots of *S. lappa*

***Curcuma aromatica*:** Dihomosesquiterpene (1) was isolated from ethanolic extract of *C. aromatica* rhizomes. The compound 1 identified with the help of 1D- and 2D-NMR (^{1}H, ^{13}C, DEPT, ^{1}H-^{1}H-COSY,

HMQC, HMBC, and NOESY) spectroscopic techniques and was found new from nature. The compound 1 has been named as "Termioic acid A" ((1S, 4S, 5R, 6S, 8E, 10Z)-1,13-dihydroxy-4-epoxy-8(12),9(10)-diene-termi-11-oic acid). With the help of HPLC, the content of 1 in the extract was also determined (0.04 %; Fig. 2).

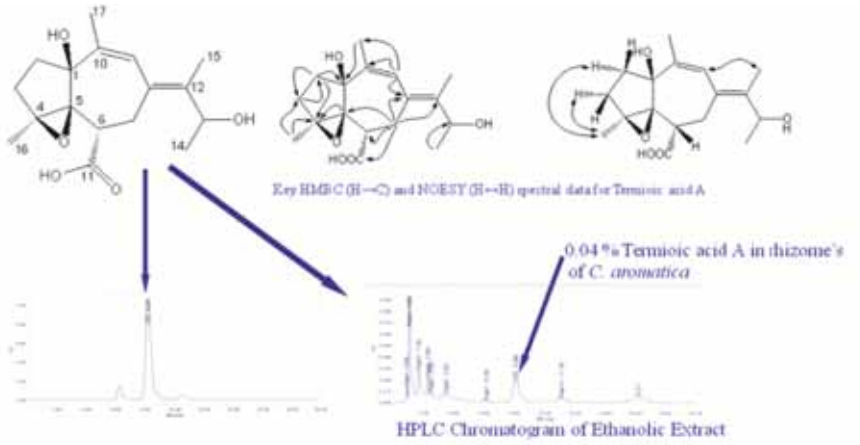

Fig. 2 Structure of termioic acid A

***Stevia rebaudiana*:** Essential oil was extracted from the flowering twigs by hydrodistillation and fractioned by chromatography. Forty three constituents of essential oil were characterized with the help of GC, GC-MS and other spectroscopic techniques. The essential oil was found to be a complex mixture of mono- and sesqui-terpenes. The essential oil and its fractions showed promising cytotoxicity against C-6 and CHOK1 cell lines. The highest activity (95.6±0.6%) showed by the essential oil on C-6 cell line at concentration of 400 µg/mL which was comparable to the standard drug Vinblastin.

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- Agnihotri VK, Thakur S, Pathania V and Gopichand (2014) A New Dihomosesquiterpene, Termioic acid A, from *Curcuma aromatica. Chemistry of Natural Compounds,* 50(4): 665-668.
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Book

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Research area: C-H activation and phytochemistry

Antimalarial agents either via C-H activation/functionalization or from natural resources in western Himalayan region

Malaria is one of the wide spread diseases as there were approximately 200 million clinical cases and 5,84,000 deaths only in 2013, estimated by WHO. The major problem is that malaria parasite has developed resistance to many of the current drugs. As a result there is search for new antimalarial agent which can be used in independent way or in combination with current drugs. Quinoline based antimalarial drugs have long been used and continuous progress is still going on to find out new lead molecules.

Activation of an inert C-H bond fetched revolutionary change in current organic synthesis and it is no more limited to proximity center. The *ortho* C-H activation/functionalization is now well familiar topic for synthetic chemist as remarkable progress has already been made in last two decades. However, the C-H activation beyond the proximity of any functional group always remains a challenge. Our group is focusing on developing efficient catalytic methodologies for the synthesis of important bioactive molecules through distant C-H activation.

Our group is working towards the synthesis of new quinoline based molecules *via* remote C-H activation. western Himalayan plants will be explored for quinoline and isoquinoline based lead molecules.

All synthesized and natural molecules will be screened against *Pf*3D7 *strain*. Lead molecules from this study will be taken further for the discovery of new antimalerial agent. Plants in the western Himalayan region will be explored for quinoline and isoquinoline based alkaloids for the discovery of lead molecules.

Publications:

- Thakur K, Sharma R and Sharma U (2015) Olefines as unprecedented feedstock for the synthesis of valuable heterocycles: regioselectivity remains an issue. Synlett, 26(02): 137-141.

Participants: Ritika Sharma, Rakesh Kumar and Inder Kumar

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Research area: Process design and development in the field of natural products and supercritical CO_2 extraction

Processing of Damask rose flowers on pilot plant

About 5278 kg fresh Damask rose flowers were processed on pilot plant and produced 1309 g rose oil with an average rose oil yield of 0.025 % (w/w) during the season. Besides the production of rose oil, 1500 L rose water was also produced for sale and as well as complimentary samples. The rose oil produced on pilot plant was analysed by GC-FID and the brief chemical composition is presented in Table 1.

Table 1 Damask rose oil composition produced during April-May 2014

Chemical Constituent	Percentage
Linalool	7.6
cis-Rose oxide	0.2
Phenyl ethyl alcohol	1.4
trans-Rose oxide	0.1
β-Citronellol	21.8
Nerol	8.7
Geraniol	18.6
Eugenol	0.8
Methyl eugenol	1.1
Pentadecane	0.4
9-Eicosene	0.1
Tetracosane	0.7
n-Henieicosane	3.9

Process standardization for extraction of Lavender aroma using supercritical Co_2

True lavender (*Lavandula angustifolia* Mill. syn. *L. officinalis* Chaix), a perennial shrub of the family Lamiaceae, is extensively used in folk medicine, flavour, fragrance/cosmetic industries and in aromatherapy.

The world production of lavender oil, including blended product, is nearly 1500 tonne. India imports 100 tonne of lavender oil annually. In view of above, our Institute has extended its cultivation on commercial scale in HP, and a small quantity of lavender oil is being produced from this region. Commercially, lavender oil is essentially produced by steam distillation. CSIR-IHBT has standardized the distillation of lavender spikes for producing higher yields as well as better quality of lavender oil. Process standardization was undertaken through evaluating the yields and quality of the lavender extracts produced by supercritical CO_2 extraction (SCE) with varying operating condition of pressures and temperatures in the rage of 100 to 140bar and 35 to 55°C.

Hydrodistillation (HD) produced higher oil yields (2.5%) than the SCE (0.6-1.8%). The extraction yields increased linearly with increase in supercritical CO_2 density. Hydrodistilled oil contained higher concentration of artifacts which were formed due to harsh conditions prevailing in the distillation flask. However, SCE produced better quality extracts in terms of higher concentration of linalyl acetate (44.4-59.8%) and β-caryophyllene (6.3-7.3%) than the HD (19.9% and 2.7%, respectively). Further, the variations in aroma constituents of SCE and HD may be attributed to variability in solvating power of CO_2 and other thermophysical properties of the solvent and/or solute at the present experimental conditions. In conclusion, for optimum extract yield and quality, the dry spikes may be extracted at 120bar and 35–45°C.

Simulation of essential oil distillation from *Eucalyptus citriodora*

The distillation process parameters such as foliage drying time, extraction time, comminution, type of distillation techniques applied etc. need to be optimized for each crop; because the plant matrix, oil content and constituent characteristics affect the production kinetics. The present study is aimed at evaluating the variability in *E. citriodora* oil yields, its chemical composition as affected by foliage drying and distillation times, sequential evolution of chemical constituents, and to simulate distillation kinetics using mathematical models involving multiple kinetic/rate constants. Higher essential oil yield (1.52%) was recorded in the foliage dried for 48h followed by fresh, 24 and 72 h (1.4% each). GC and GC-MS analysis of the samples revealed that citronellal, the major component of the oil, was found in higher content in the oil produced from the fresh foliage closely followed by oil produced from 48h dried foliage and lower content was recorded in the oil produced from 24 and 72h dried foliage.

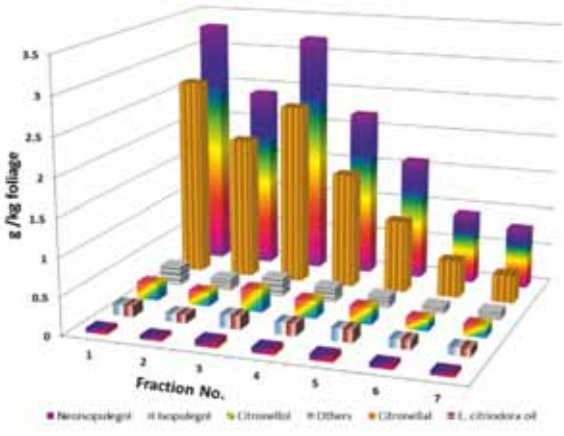

Fig. 1 Varitation in chemical composition of *E. citriodora* oil in different fractions

Essential oils are complex mixtures containing number of chemical constituents and can be considered as a pseudo-component only if (i) chemical composition of the essential oil does not changes significantly during extraction process, (ii) variation in the kinetic constants of essential oil components is insignificant. If any of these conditions are not satisfied, the assumption of considering the essential oil as a single compound with a constant diffusion coefficient throughout the distillation process is not justified. To verify the above conditions, *E. citriodora* oil fractions collected at different intervals of time were analyzed through GC and GC-MS and recorded that there is considerable variation in the chemical composition of major components (viz. citronellal, citronellol, isopulegol, neoisopulegol) in these fractions.

In view of significant variation in chemical composition during distillation (Fig. 2), considering E. citriodora oil as a pseudo-component with a constant diffusion coefficient throughout the distillation process is not justified. However, the essential oil yield at any time is the sum of all component yields. The advantage of this modelling approach lies in its ability to take into account both qualitative and quantitative aspects.

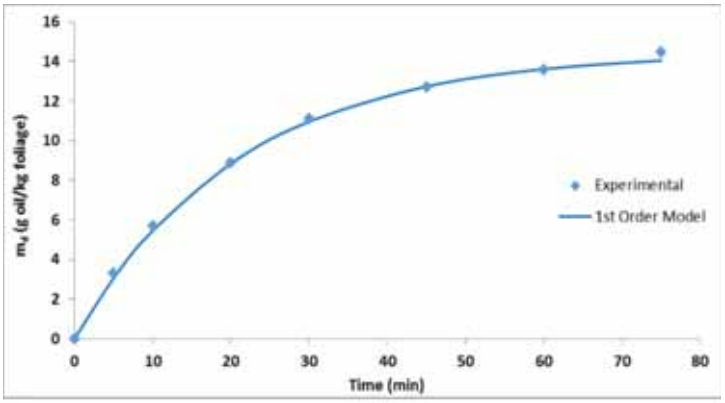

Fig. 2 Simulation of *E. citriodora* oil production using 1st order rate model

The ratio m_{oi}/m_o represents the component *i* content in the essential oil which is obtained experimentally by GC analysis. Equation (4) is known as General Model of Component Contribution (GMCC) and contains several kinetic constants (equals to number of components present in the essential oil) and can be assimilated to Equation (1) only in the case of negligible variations in the k_i values. In order to verify the GMCC, a graph of $\ln(1/1-y_i)$ verses *t*, was plotted for each major constituents of the oil produced from the foliage. It was observed that the plots yield straight line indicating that the production of individual chemical constituent did follow the first order kinetic model. It is interesting to observe that although the chemical composition varied significantly throughout the process, the variations in kinetic constants (k_i) values is insignificant. In view of above, the whole process of water distillation was simulated using simple first order rate equation (Fig. 3) and found that the rate constant *k* for *E. citriodora* oil production was found to be 0.0472 min^{-1}. The simulated curve and experimental data are in good agreement as shown in Figure 3. It is, therefore, concluded that the assumption of considering the essential oil as a pseudo-component is justified when there is insignificant variations in k_i values of the individual chemical components, even if there is a significant variation in the essential oil composition during the distillation process.

Process development for natural colours and dyes

The global food colour market growth is inclined towards natural colours, as there is an increase in the health conscious consumer base that demands nature derived ingredients and additives in food. It has been reported that black carrot (*Daucus carota*) has six anthocyanins. CSIR-IHBT has standardized the technology after process up-scaling studies at pilot scale for production of non-hygroscopic natural colours from black carrot employing patented green technology. Around 500 kg of fresh


Fig. 3 Black Carrot

black carrot (Fig. 3) was extracted on pilot plant with an average recovery of 1.2% dry powder (Fig. 4). The quality of natural colour was evaluated by HPLC and a characteristic chromatogram is presented in Fig. 5. Toxicological parameters for natural colour produced from black carrot was also evaluated and the results were presented in Table 2 & 3. Further, value addition to waste black carrot pomace was achieved by developing extruded snacks (Fig. 6).

Fig. 4 Natural colour from Black Carrot

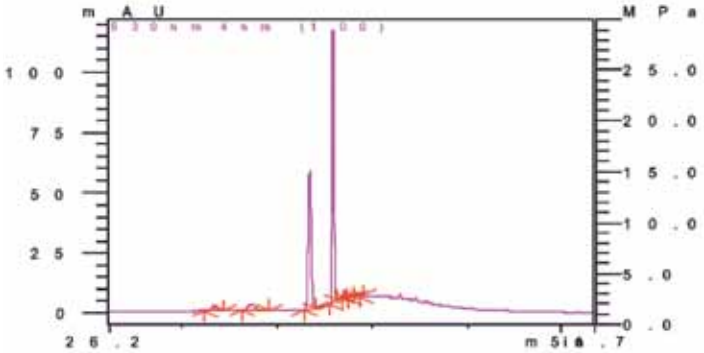

Fig. 5 Characteristic HPLC chromatogram of natural colour extracted from black carrot at 530 nm

Table 2 Toxicological test report of black carrot powder

Parameters	Result
Total plate count, cfu/g	Not Detected
Coliform/g	Not Detected
Yeast & Mould/g	Not Detected
Salmonella/25g	Absent
E. coli, cfu/g	Absent
S. aureus, cfu/g	Absent
Clostridium	Absent
Acidity as acetic acid % by wt.	11.37
Colouring strength at 650nm of 250 ppm solution	0.123
Water soluble pigment	Soluble in warm water
Synthetic colour	Absent
Arsenic, mg/100g	Not Detected
Lead, mg/100g	0.229
Mercury, mg/100g	Not Detected
Cadmium, mg/100g	Not Detected

Fig. 6 Extruded Snack with black Carrot pomace

Table 3 In-house quality analysis of Black carrot power

Parameters	Result
Moisture content (%)	2.29
Ash (%)	2.82
pH	5.49
Water Activity	0.64
ΔE Colour Index	56.92

Area of application: This natural colour produced from black carrot employing CSIR-IHBT technology can potentially be used in applications such as beverages, bakery, confectionary, dairy & frozen products, meat products etc.

Participants: (From Left to Right) Rakesh Kumar, Kamal Singh, Balak Ram, Vikas Kumar, J.P Dwivedi, G.D. Kiran Babu, Mohit Sharma, Vivesh S Bod, Arvind Kant and Deepika Singh.

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Research Area: Metabolomics

Metabolomics, lipidomics and quality control of Himalayan bioresource and their derived products

From the primitive age, plants and marines have been used to cure serious complications of health and are still very significant. Their derived products are used either as such or template in the discovery of new drugs. Several biologically active secondary metabolites have been used for their medicinal values. Hence to understand the chemistry, metabolite composition and alterations in plant, marines and biofluids, along with quality profile and quality control are the need of hours. Our group is working on metabolite profiling and quality control of some medicinally important plants of western Himalaya using NMR, UPLC-MS/MS and HPTLC techniques. We are also working on *Cratageous oxycantha* (high altitude cardioprotective plant) to find out its mechanistic role for toxicity/safety in cardiac disorders especially myocardial tissue through lipidomics and metabolomic studies. Search for bioactive principles from bioresource is also one of the targets.

Metabolites profiling of *Picrorhiza kurrooa* Royle ex Benth using 600 MHz NMR techniques was performed successfully (Fig. 1). Wherein, primary and secondary metabolites from leaves and rhizomes were unambiguously identified and significant qualitative differences with respect to the secondary metabolites were also noticed. A reversed phase HPTLC method was also developed for the quality and quantity assessment of picrosides (P-I and P-II). The method has been applied for quantification of picrosides in two accessions of *P. kurrooa* (Fig. 2).

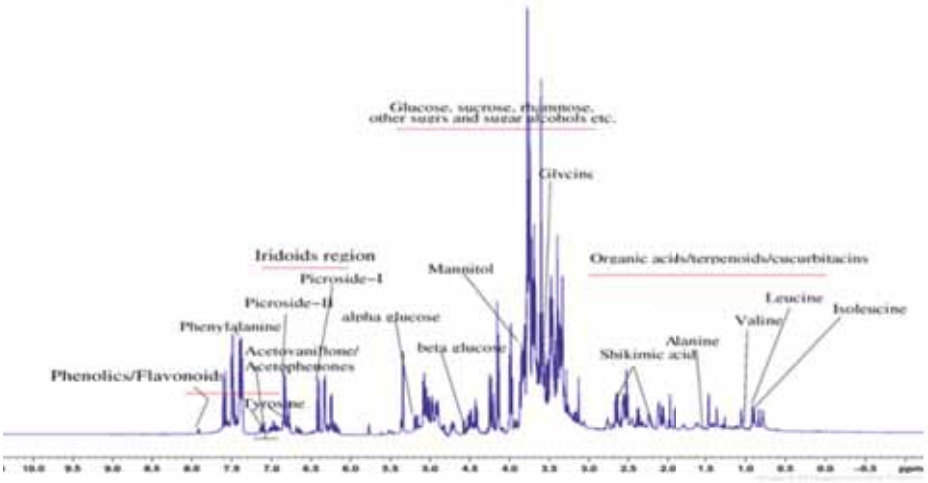

Fig. 1 NMR based metabolic profiling of *P. kurrooa*

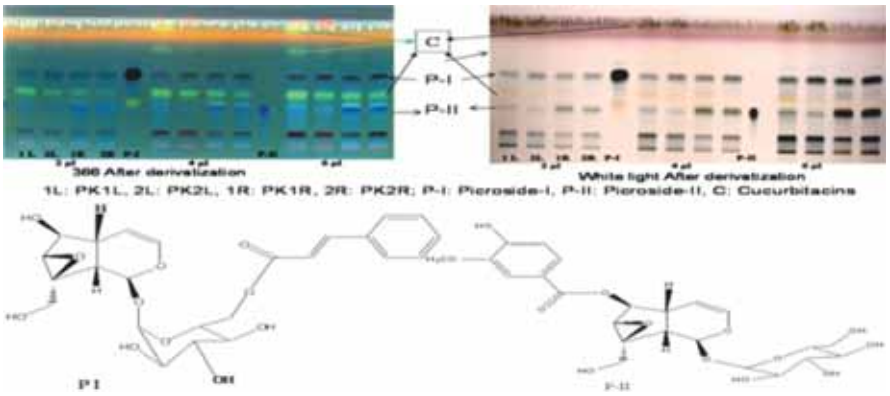

Fig. 2 HPTLC profile of *P. kurroa*

Publication:

- Kumar D, Kumar R, Singh B and Ahuja PS (2014) Reproducible RP-HPTLC based quality control method for endangered medicinal plant *Picrorhiza kurrooa* Royle Ex Benth. *Journal of Planar Chromatography-a modern TLC* Dec. 2014 (Accepted).

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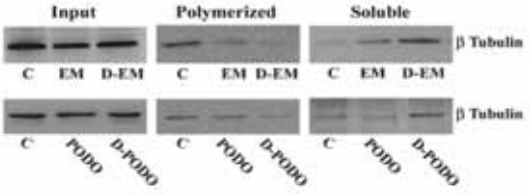
Research area: Medicinal chemistry and nanotechnology based drug delivery

Systemic small molecules, cytotoxic chemotherapeutics often have a low therapeutic index and, thus, are accompanied by harmful toxic effects. Substantial effort has been focused on the development of drug delivery systems to enhance the therapeutic index of chemotherapeutic drugs. Conjugation of drugs and/ ligand to macromolecular carriers offers a mechanism to enhance the solubility of hydrophobic therapeutics, prolong blood circulation time, minimize nonspecific uptake, improve intracellular penetration and allow for site-specific targeting via both passive and active targeting methods. As a result drug-delivering devices confer a substantial reduction in toxicity by accompanied improved efficacy thereby increase importance of clinical utility.

In our ongoing work, we are developing dendrimer based targeted drug-conjugated nanodevices with sustained drug release capacity, by which possibility of the drug release at the target organ and keep normal tissue unaffected from the cytotoxic drug. To validate our drug delivery nanodevices we monitor drug release from nanodevices, *in vitro* and *in vivo* antitumor study. In recent report, we have conjugated natural podophyllotoxin (PODO) to the generation four PAMAM dendrimer, which showed sustained release characteristic in DMEM cell culture medium and physiological pH condition (Sk et al., Euro J. Med Chem. 2013, 68, 47-57), and low toxicity on Swiss albino mice compared to its free PODO. The dendrimer conjugated podophyllotoxin also inhibit DMBA induced papilloma formation (Sk et al., Toxicol Res. 2015, In press).



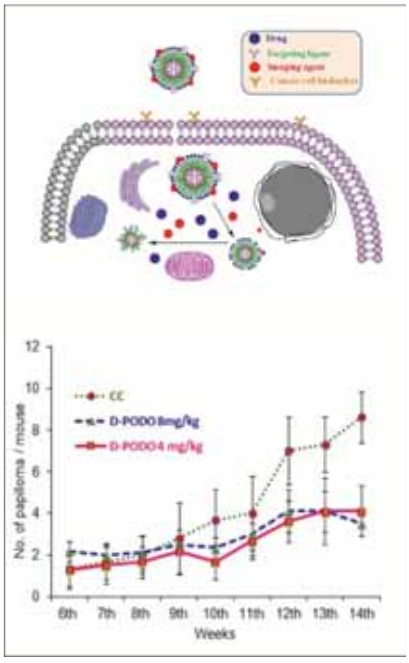


Fig. 1 (top) The ability of D-EM (dendrimer conjugated estramustine) and D-PODO to inhibit tubulin polymerization on T98G glioma cell is greater than EM and PODO, representative western blots indicating tubulin levels in cell lysate and polymerized and soluble microtubule fractions isolated from EM, D-EM, PODO and D-PODO treated cells. (rhs) Incidence of papilloma each week in mice in the different groups, until week 14, after DMBA–TPA application. CC, carcinogen control; DMBA–TPA, group; D-PODO 4 mg kg−1 and 8 mg kg−1, mice treated with 4 mg kg−1 and 8 mg kg−1 dendrimer–PODO conjugate as a daily intraperitoneal injection

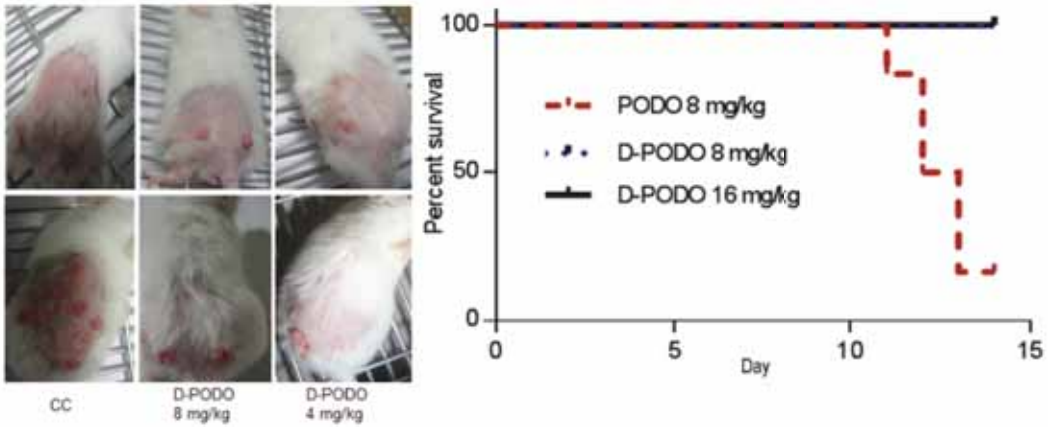


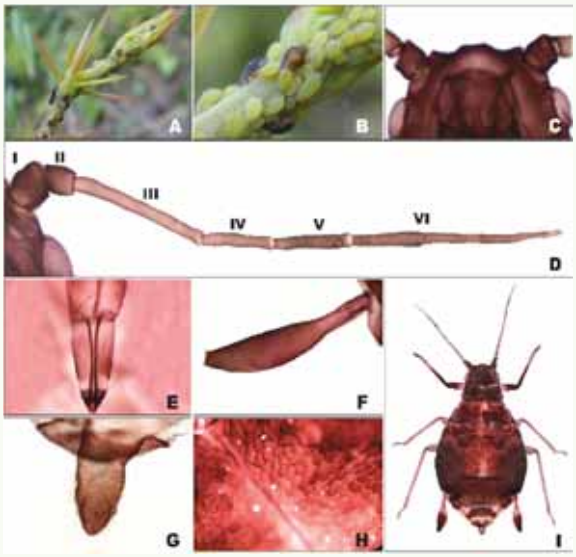
Fig. 2 Inhibition of papilloma on Swiss albino mice: before and after treatment; Dose-dependent survival effects of PODO and D-PODO on normal Swiss albino mice

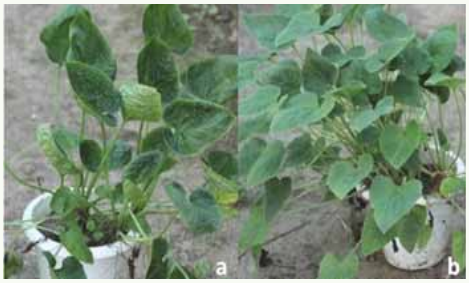
The major disadvantage of the most traditional anticancer drugs is their low bioavailability, non-specific distribution to lead to toxic side effects. Our dendrimer-nanodevices would be achieve the successful drug targeting to tumor tissues, which would be potential to lower drug dosages required for a therapeutic response with limiting systemic toxicity.

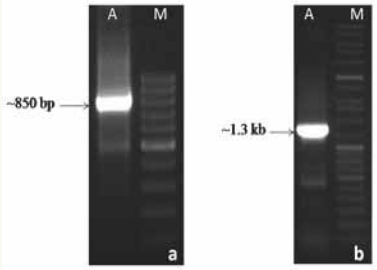
Publications:

- Sk Ugir Hossain, C. Kojima (2015) Dendrimers for theranostic applications. *BioMolecular Concepts*, 6(3): 205-17
- Sk Ugir Hossain, C. Kojima (2015) Dendrimers for Drug Delivery of Anticancer Drugs. Frontiers in Clinical Drug Research- Anti Cancer Agents, (Ed. Atta-ur-Rahman) 2015, Vol. 2, P3-25; Bentham Science Publishers.
- Sk Ugir Hossain, Patial V and Sharma S (2015) Low toxic synthetic dendrimer conjugated podophyllotoxin nanodevice with potent antitumor activity against DMBA/TPA induced mouse skin carcinogenesis model. *Toxicology Research*, DOI:10.1039/C5TX00112A.

Plant Protection







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Research area: Plant-virus interaction

The group is interested in (i) understanding the genome organization of viruses infecting apple and cherry and their natural reservoirs, (ii) plant microbe interaction in the *Cucumber mosaic virus* (CMV)-*Cucumis sativus* system and (iii) to study the role of viruses in plant adaptation taking highly adapted *Rumex nepalensis* as example. We basically employ approaches that utilize protocols established in this lab for initial detection of apple and cherry pathogens. This is followed by establishment of complete genome amplification of the viruses infecting these woody hosts. This is a tedious procedure and protocol was standardized in this regard. In addition to this, Himalayan 'maggar' bamboo (*Dendrocalamus hamiltonii*), widely distributed in the Himalayas, was found to exhibit mild virus-like symptoms, which included mosaic, chlorosis, necrotic spots and mottling. Leaf samples from symptomatic plants were subjected to reverse transcription polymerase chain reaction (RT-PCR) for the detection of Cherry necrotic rusty mottle virus (CNRMV). Sequencing of the amplicon confirmed the presence of the virus. To further establish bamboo as a natural host of CNRMV, 35 varieties of bamboos maintained at CSIR-IHBT were subjected to double-antibody sandwich enzyme linked immunosorbent assay (DAS-ELISA) and dot blot hybridization. Results showed the presence of CNRMV in 21 species of bamboos belonging to five genera, viz. Bambusa, Dendrocalamus, Fargesia, Arundinaria and Melocanna. For further confirmation of the results, the coat protein (CP) gene of CNRMV was amplified from two different local 'maggar' plants. This was also a new finding with regard to the host range of this virus. Similarly, Himalayan wild cherry (*Prunus cerasoides*) and wild rose were identified as a new natural hosts of *Cherry necrotic rusty mottle virus* (CNRMV).
Another important virus that infects apples is *Apple stem grooving virus* (ASGV). Employing a similar approach as indicated above, kiwi (*Actinidia deliciosa*) was identified as an alternate host of the virus. During survey of kiwi plantations in Palampur, Kangra district some plants were found to exhibit virus-like symptoms viz., severe interveinal mottling, severe leaf distortion, ringspots and chlorosis along the leaf margins. Six out of 15 samples were found positive for ASGV. Three of the positive samples (06) were subjected to further analysis by RT-PCR so as to amplify and characterize CP gene of the virus. Sequencing of the amplicons confirmed presence of the virus. The three isolates from kiwi plants, namely Ki-1, Ki-2 and Ki-3, shared 94–99% sequence identity (at amino acid level) among themselves. Sequence information from three isolates of the virus was published.

Work is being done towards studying the role of transcription factors in disease development by CMV. In this reference, WRKY21, GATA27 and G Box binding factor 1 were found regulated during virus infection in *C. sativus* (Fig.1). The virome of Valeriana and Rumex is under investigation so as to devise strategies for understating their role in plant adaptation. In this reference, whereas valeriana was found infected with CMV subgroup I and II, rumex was found associated with a begomovirus and a betasatellite (Fig.2).

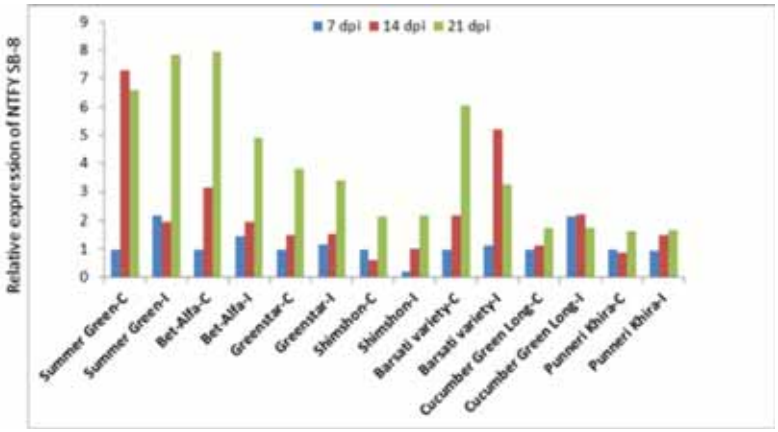

Fig. 1 Showing relative quantification of NTFY SB-8 expression using Actin as a house-keeping gene in different varieties of *Cucumis sativus* at 7th,14th and 21st day post inoculation (C=Mock inoculated plants; I=CMV inoculated plants)

Fig. 2 Valeriana showing symptom of amplified virus genome components

Publications:

- Awasthi P, Dhyani D, Ram R, Zaidi AA and Hallan V (2015) Wild roses as natural reservoirs of Cherry necrotic rusty mottle virus. *European Journal of Plant Pathology*, 142(2): 403-409.
- Awasthi P, Ram R, Reddy SGE, Nadda G, Zaidi AA and Hallan V (2015) Himalayan wild cherry (*Prunus cerasoides*) as a new natural host of Cherry necrotic rusty mottle virus (CNRMV) and a possible role of insect vectors in their transmission. *Annals of Applied Biology*, 1116(3): 402-409.
- Awasthi P, Sood A and Hallan V (2014) Molecular evidence for bamboo as a new natural host of Cherry necrotic rusty mottle virus. *Forest Pathology*, 45: 42-50.
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- Dhir S, Walia Y, Zaidi AA and Hallan V (2015) A simplified strategy for studying the etiology of viral diseases: Apple stem grooving virus as a case study. *Journal of Virological Methods*, 213: 106-110.
- Kumar S, Singh L, Ram R, Zaidi AA and Hallan V (2014) Simultaneous detection of major pome fruit viruses and a viroid. *Indian Journal of Microbiology*, 54: 203-210.

- Sharma D, Sharma S, Singh N and Hallan V (2015) *Valeriana jatamansi* as a new natural host of Bhendi yellow vein mosaic virus and Papaya leaf curl virus betasatellite from Northern India. *New Disease Reports*, 32: 4.

Participants: Monika Vaisnav, Monika Bhagat, Dolly Sharma, Poonam Roshan, Prachi Awasthi, Pooja Bhardwaj,Tanuja Rana Guleria, Reenu Kaundal, Anita Kumari, Aditya Kulshrestha, Sunny Dhir, Raja Ram, Rahul Mohan Singh, Manpreet Singh and Surender Kumar.

Dr. Vipin Hallan's group

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Research area: Entomology and biopesticide

Development of bioinsecticides: Our research group is working on the area of botanical and microbial bioinsecticides. We are bioprospecting ferns from Indian western Himalayan region for management of economically important insect pests. Crude extracts of ferns and fractions were evaluated for insecticidal activities against diamondback moth (*Plutella xylostella*) and aphids (*Aphis craccivora*). The extracts showed little to moderate activities in dose and time dependent manner. The extract IHB PEAL00VI showed promising larvicidal activity (76% after 96 hrs at 2% concentration) against *P. xylostella* and IHB DMBF (0III) showed 50% mortality against adult aphids after 96 h of treatment. In order to characterize the virus based microbial insecticide, polyhedrin gene of *Helicoverpa armigera* nucleopolyhedrovirus (HaNPV) was sequenced (EMBL Accession Number: LK031772).

Insect diversity: Surveys were conducted in different areas of HP to study the insect diversity. Aphid, *Liosomaphis ornata* Miyazaki, 1971 (Hemiptera: Aphididae) making colonies on *Berberis lycium* Royle (Berberidaceae) has been reported for the first time from India (Naggar, Kullu, HP). The viviparous female is re-described with the help of photographs and measurements (Fig. 1). A key is provided to the species of *Liosomaphis* Walker occurring in India. A root aphid, *Forda orientalis* George was also reported for the first time from roots of *Arenaria festucoides* Benth, grown at an altitude of 3263 m amsl in Lahaul and Spiti district of HP (Fig. 2). Besides these new reports, aphid (*Myzus persicae* (Sulzer)*, Aphis polygonacea* Matsumura*, Brachycadus helichrysi (*Kaltenbach*), Macrosiphoniella sanborni* Gillette), mites and scale were also reported. Salix trees were severely infested with the scale insects (*Chionaspis salicis* (Linnaeus) and *Lepidosaphes* sp.). Himalayan wild cherry was found infested with two aphid species (*Astegopteryx bambusae* and *Tinocalloides montanus*) and *Bambusiphaga* sp. Scale insect was identified as the major pest of tea growing in the Kangra valley.

Fig. 1 *L. ornata* A, Colony infesting *Berberis lyceum*; B, Nymphs (greenish yellow) and completely grown up female (brown); C, Head; D, Antenna; E, Rostrum; F, Siphunculus; G, Cauda; H, Abdominal pattern; I, Habitus.

Fig. 2 Uprooted *A. festucoides* plant showing colonies of root aphid, *F. orientalis* George

Publications

- Awasthi P, Ram R, Reddy SGE, Nadda G, Zaidi AA and Hallan V (2015) Himalayan wild cherry (*Prunus cerasoides*) as a new natural host of *Cherry necrotic rusty mottle virus* (CNRMV) and a possible role of insect vectors in their transmission. *Annals of Applied Biology*, 1116(3): 402-409.
- Reddy SGE, Chauhan U, Kumari S, Nadda G and Singh MK (2014) Comparative bio-efficacy of acaricides against two spotted spider mite, *Tetranychus urticae* (Koch) on Chrysanthemum in Polyhouse. *International Journal of Research in Chemistry and Environment*, 4(4): 15-19.

Sequence data submitted

- Guleria S, Kumari R, Bharti M, HallanV and Nadda G (2014) Polyhedrin gene of nucleopolyhedrovirus (NPV) amplified from *Helicoverpa armigera* (Accession No. LK031772.1).

Participants: Ruchi Sharma, Anika Kumari, Shweta Guleria and Akruthi

Dr. Gireesh Nadda's group

S. G. Eswara Reddy

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Research area: Entomology, pest management, development of bio-pesticides and climate change on insects

Our research group is mainly focussing isolation and characterization of native strains of entomopathogenic fungi (EPF) from insect cadavers and soil samples from agricultural, horticultural and forest ecosystem in Western Himalayan region for development of microbial bio-pesticides against sucking/lepidopteron/coleopteron insect pests. Similarly, different plant extracts/fractions/pure compounds/essential oils from Western Himalayan flora were also utilized for screening against target pests for the development of botanical insecticide. On the other hand, we are studying the effect of climate change (elevated temperature and carbon dioxide) on insect biology.

Development of bio-pesticides for pest management

Identification of promising native strains of entomopathogenic fungi (EPF) for the development of microbial bio-pesticides for the management of major pests: Field surveys were carried out in different parts of Himachal Pradesh in agricultural, horticultural and forest ecosystems to collect insect cadavers and soil samples for EPF isolation. Five strains were identified and characterized by molecular tools. The isolated strains will be screened for their pathogenicity against Lepidopteron caterpillars, Coleopteron beetles, aphids, whiteflies and mites. The promising strains will be further used for the development of bio-pesticide.

Screening plant extracts/fractions/pure compounds/essential oils against target pests for development of botanical pesticide: Different fractions of leaf extract of *Zanthoxylum armatum* was screened for their larvicidal activity against diamond back moth, *Plutella xylostella* (L.) (Lepidoptera: Yponomeutidae). Results showed that, *n*-Hexane fraction of *Z. armatum* showed more toxicity (LC_{50} =2988.6 ppm) to *P. xylostella* followed by ethanol (LC_{50} = 12779.7 ppm) and methanol fraction (LC_{50} = 12908.8 ppm). The GC-MS analysis of *n*-hexane fraction of leaf extract showed more activity, which may be due to presence of two major compounds (2-undecanone (19.75%) and 2-tridecanone (11.76%).

Essential oils of *Acorus calamus*, *Cedrus deodara, Aegle marmelos, Tagetes minuta* and *Murraya koenigii* were screened for their biological/insecticidal activities against larvae of *P. xylostella*. Results showed that *A. calamus* was most toxic (LC_{50} = 0.29 mg/mL) to second instar larvae of *P. xylostella* followed by *C. deodora* (LC_{50}= 1.08 mg/mL) and *M. koenigii* (LC_{50}=1.93 mg/mL) *via* residual toxicity bioassay. Per cent feeding deterrence index and growth inhibition to third instar larvae of *P. xylostella* was significantly higher in *A. calamus* (42.20 and 68.55, respectively) followed by *C. deodara* (35.41 and 52.47). In repellent activity studies, *C. deodara* showed high repellence (64.76%) followed by *A. calamus* (55.05%).

to second instar larvae of *P. xylostella* followed by *C. deodora* (LC_{50}= 1.08 mg/mL) and *M. koenigii* (LC_{50} =1.93 mg/mL) *via* residual toxicity bioassay. Per cent feeding deterrence index and growth inhibition to third instar larvae of *P. xylostella* was significantly higher in *A. calamus* (42.20 and 68.55, respectively) followed by *C. deodara* (35.41 and 52.47). In repellent activity studies, *C. deodara* showed high repellence

(64.76%) followed by *A. calamus* (55.05%).

Insecticidal activities and structure activity relationship of cinnamoyl amides isolated from *Zanthoxylum armatum* was screened for their insecticidal activity against *A. craccivora* under laboratory conditions. Among them, compound **6**, *N*-(3′-bromophenethyl)cinnamamide exhibited good control against *A. craccivora* (LC_{50} =109.21 mg/L) followed by 4, *N*-(3′,4′-dimethoxyphenethyl)cinnamamide (LC_{50}=206.31 mg/L) and 5, *N*-(2′-bromophenethyl)cinnamamide (LC_{50} =241.98 mg/L). Compound **6**, displayed best insecticidal activity against *A. craccivora* due to 3′-Br substituent (ring B) among all the tested compounds.

Virus-induced gene silencing of *Withania somnifera* squalene synthase negatively regulates sterol and defence-related genes resulting in reduced withanolides and biotic stress tolerance: To assess the effect of reduced phytosterols and withanolides in Withania somnifera squalene synthase (WsSQS)-virus-induced gene silencing (VIGS) leaves on insect feeding, a dual-choice feeding preference test was performed using tobacco cutworm, *Spodoptera litura*. Equal numbers (six each) of second-instar larvae were placed on similar-sized leaves placed in a Petri dish from WsSQS-vigs and EV plants (control). After 12 h, most *S. litura* larvae preferred eating SQS-silenced leaves rather than control leaves. There was approximately 2.7-fold higher consumption of leaves in WsSQS-vigs samples than EV. Also, preference index (PI) determination showed a higher preference of *S. litura* larvae for WsSQS-vigs leaves (PI=1.4) compared with EV (PI=1.0).

Effect of elevated temperature and carbon dioxide on tobacco cutworm, *S. litura:* Newly hatched (neonate) larvae of *S. litura* were fed with leaves of *Hypericum perfortum* grown under ambient and simulated environment (FACE & FATE) till pupation stage to study the larval indices and growth parameters of *S. litura*. Results showed that, the larval indices viz., total leaf consumption, relative consumption ratio (RCR), relative growth rate (RGR) was significantly less in FATI as compared to ambient and FACE. Approximate digestibility (AD) of *S. litura* was less in FATI as compared to ambient and FACE; whereas efficiency of conversion of digested food (ECD) was more in FATI than ambient and FACE environment. Polyphenol content measured in terms of gallic acid equivalents was higher in the *H. perforatum* foliage grown under FACE followed by ambient and FATI.

Publications:

- Awasthi P, Ram R, Reddy SGE, Nadda G, Zaidi AA and Hallan V (2015) Himalayan wild cherry (*Prunus cerasoides*) as a new natural host of Cherry necrotic rusty mottle virus (CNRMV) and a possible role of insect vectors in their transmission. *Annals of Applied Biology.*1116(3): 402-409.
- Kumar V, Reddy SGE, Chauhan U, Kumar N and Singh B (2015) Chemical composition and insecticidal activity of *Zanthoxylum armatum* against diamond back moth, *Plutella xylostella*. *Natural Product Research*. DOI:10.1080/14786419.2015.1036270.
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- Singh AK, Dwivedi V, Rai A, Pal S, Reddy SGE, Rao DKV, Shasany AK and Dinesh AN (2015) Virus-induced gene silencing of *Withania somnifera* squalene synthase negatively regulates sterol and defence-related genes resulting in reduced withanolides and biotic stress tolerance. *Plant Biotechnology Journal*. DOI: 10.1111/pbi. 12347.

Participants: Shudh Kirti Dolma, Kamlesh Kumari, Shalini Rana and Sonali Bhardwaj

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Research area: Plant-microbe interaction

As apple (*Malus domestica*) is the life line of Himachal, we are focusing on to understand the important aspects of apple scab disease, the most devastating disease of apple. This disease causes havoc during epidemic cycle. Almost all the major cultivar growing in Himalayan region in India are susceptible to this disease caused by *Venturia inaequalis*. To understand the disease cycle and its mechanism we are trying to analyze available raw transcriptome data. The preliminary analysis showed involvement of many transcription factors and receptors during compatible interaction from Royal gala challenged with *V. inaequalis*. To further study the molecular basis of disease interaction, a multiple time point analysis of apple transcriptome using tolerant and susceptible cultivar needed (Compatible Vs Incompatible interaction). Presently, we are working in this direction and few scab tolerant cultivars have been procured from CITH, Srinagar. The study will provide important insight for combating the pathogen. Our long term goal will be to identify the important genetic and molecular factors responsible for scab susceptibility and tolerance in apple crop.

Participants: Ashish Kumar, Karnika Thakur, Supriyanka Rana and Yashu Sharma.

Dr. Kunal Singh's group

Extension and Advisory Services

Virendra Singh

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Research area: Agronomy and extension activities

Institute is translating its research findings at the grass root level through extension and advisory services in value-added agriculture and non-farm sector. Crop selection and its agro-technology for different land capability and land use planning have been seen critical issues to the farmers in changing scenario of agricultural production. Climate change, field production sustainability, biodiversity losses, wild life and human conflicts, market demand for healthy food ingredients and decorative plants are influencing crop choices and farm income.

Therefore, extension and advisory services on specialty plants, its associated processes for field production, value addition, quality control and marketable products have been forefront activities of the Institute. Hand on trainings in medicinal herb collection and drying, essential oil distillation, floral arts, mushroom production and bioresources based processed food such as bamboo candies were provided to the participants as alternative avenues of non-farm income generation activities.

A total of 280 numbers of rural beneficiaries and farmers from Kangra, Chamba, Mandi, Kullu and Shimla districts of Himachal Pradesh were registered during our field surveys, trainings and counseling sessions. Efforts were towards rural sector empowerment, capacity building, maintaining information bank, providing know-how, scientific communication via Hindi media on medicinal, aromatic, culinary herbs, spices, specialty plants, process, products that augmented science culture among farmers and their families.

Around 250 farmers in 9 different groups from Kinnaur and Kalpa of HP and Rasi, Srinagar, Baramulla, Sophia and Bandipora from Jammu and Kashmir were given awareness and exposure to our demonstration fields of bamboos, ornamentals, medicinal and aromatic crops.

An additional area of around 11 ha was brought under Stevia, Damask rose, wild marigold, lavender, rosemary, ginkgo, muskbala, and ornamental crops in Chamba, Mandi and Kullu districts through supply of planting material and advisory services by CSIR-IHBT. In addition, over 2,100 nursery plants of minor medicinal and aromatic crops *viz*., ashwagandha, ghrit kumari/gar patha, baccopa, oregano and scented geranium and sandal wood were supplied for home gardens and nursery multiplication.

Cultivation of wild marigold as pure crop and relay crop in maize fields has proven economical at farmers fields in mid and high Himalayan region. A field demonstration on this crop was carried out at farmers' field through a society namely The Vaishnavi Herbal & Aromatic Growers, Processing Marketing & Supply Cooperative Society Ltd., at village Sei-Kothi, Tissa, Distt. Chamba. The crop grown in 1.50 ha area produced 38.73 q semi dried biomass. The biomass was distilled in 24 batches using the Institute's mobile essential oil distillation unit and yielded 34.51 litres high quality Tagetes oil with an overall recovery of 0.89%. It is pertinent to mention that about 3 tonnes of commercial Tagetes oil is produced annually in Himachal Pradesh through CSIR-IHBT technological intervention.

Domestication for Ornamentals and Landscaping

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Research area: Horticulture, floriculture, breeding and agro-technology

Rose Breeding: Hybridization program was undertaken to generate new floral variations among scented, ornamental and wild roses through Inter-specific and inter-varietal crosses (Table 1). Four different rose species were involved in crossing program viz., *Rosa damascena*, *R. bourboniana*, *R. hybrida*, and *R. indica*) to generate desirable variations for plants phenotype, flower types, fruit and essential oil characters. Overall, 136 seeds were obtained from 161 pollinations involving inter-specific/inter-varietal crosses, while 1038 seeds were collected from open pollinations in F_1 hybrids of cross *Rosa damascena* X *R. bourboniana*.

In an earlier cross involving parents' *R. brunonii* (strain No.16) and *R. chinensis minima*, some of the F_2 progenies were recurrent flowering in behavior (Fig. 1) as compared to the F_1 plants obtained from the cross which had non-recurrent flowering. The results confirm that recurrent flowering in roses is recessive trait and can be recovered in F_2 population of crosses involving recurrent and non-recurrent flowering genotypes as parents. These F_2 progenies are expected to combine the vigorous growth habit of *R. brunonii*, with recurrent flowering trait of *R. chinensis minima*.

Table 1. Seed set obtained under inter-varietal and inter-specific hybridization programme

Cross	No. of pollinations	No. of seeds
Inter-specific	83	33
Inter-varietal		
a) Damasc rose	22	12
b) Ornamental rose	56	91
Total	161	136

Calla lily breeding: Two species of calla lily (*Zantedeschia aethiopica* and *Z. elliotiana*) were introduced under greenhouse and open field conditions to study their performance and flower production potential under both the conditions in HP (Fig. 2). *Z. aethiopica* is ever-green and produces white flowers from January to May both under field and greenhouse conditions, whereas *Z. elliotiana* is of variable colors ranging from light yellow to dark red purple, sprouts from the rhizomes during first week of April and flowers in the first week of May under greenhouse conditions and in the month of June under open field conditions. Both *Z. aethiopica* and *Z. elliotiana* set seeds in field as well as polyhouse. Seed germination in *Z. aethiopica* takes

Fig. 1 Recurrent flowering in F_2 plants obtained from cross *R. brunonii* X *R. chinensis minima*

about a month whereas that of *Z. elliotiana* has vernalization requirement and germinates after over-wintering under sub-tropical conditions at Palampur. Large morphological variations were observed among seed raised plants of *Z. aethiopica* with respect to shape and size of flowers and also number of flowers produced per plant. Hybridization among the two genotypes of yellow and red purple color of *Z. elliotiana* resulted in seed progeny which is expected to segregate for different colors and is presently being maintained for further evaluation.

Fig. 2 Flowering plants of calla lily species *Z. aethiopica* (white flowers) and *Z. elliotiana* (yellow flowers)

Seed germination studies in Bird of Paradise: Bird of Paradise is one of the important cut flowers gaining popularity in many parts of India. The major problem in its large scale cultivation is lack of quality planting material due to slow vegetative multiplication rate of plants, erratic seed germination and long gestation period. Since last many years its seeds were sown in different soil media but the results were variable over years and not satisfactory. Therefore, a series of experiments were conducted under controlled conditions in polyhouse during 2008-13 to determine the proper procedure of seed germination based on different seasons and seed treatments so as to produce large number of plants from seeds and study the factors affecting seed germination in Bird of Paradise (*Strelitzia reginae*) at CSIR-IHBT, Palampur. As a result of many year efforts a suitable technique for maximum seed germination has been developed and large numbers of plants were produced (Fig. 3).

Fig. 3 Germinated seedlings and plant material production of Bird of Paradise

Participants: Ashok Kumar, Sanat Sujat Singh,Raja Ram, Akhil Sharma, Somu Kaundal and Jyoti Sharma

Sh. Devendra Dhyani's group

Microbial Prospection

Arvind Gulati

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Research area: Diversity analysis, characterization, inventorization, genome sequencing and bioprospection of microorganisms for plant growth promoting activities and biomolecules of industrial importance.

Characterization of microflora of rhizosphere associated with saffron with a target to develop consortia of beneficial microbes

The project has been initiated with the objectives to develop microbial inoculants with multiple plant growth promoting activities, antagonism towards wilts and corm rot fungal and bacterial-pathogens, and abiotic stress tolerance with the consortial partners for improving growth and productivity in saffron. Over 2400 bacterial isolates raised from the rhizosphere soils collected from 9 locations (Fig. 1) of the main saffron growing areas of J&K were catalogued into 113 morphotypes which showed highest affinity based on 16S rRNA gene sequencing to 22 diverse genera represented by 75 species. Thirty-six isolates were selected by qualitative and quantitative assaying for high phosphate-solubilization, siderophore production, ACC-deaminase activity and auxin production as the potential PGPR (Fig. 2).

Fig.1 Soil sampling from saffron fields in J&K

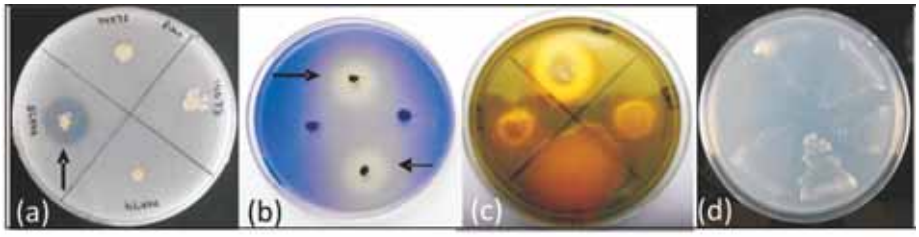

Fig. 2 Zone of tricalcium phosphate solubilization by rhizobacteria on PVK (a) and modified PVK (b), siderophore production on Chrome Azurol Sulphonate medium after 5 day incubation (c) and ACC-deaminase activity on DF salts minimal medium after 48 h incubation at 28±0.1 C (d) Arrows indicate zones of phosphate solubilzation and siderophore production.

Diversity analysis and selection of plant growth promoting rhizobacteria for plant growth promotion in tea: Previously, a total of 370 rhizobacteria were isolated by spread plating soil dilutions on tryptone soy agar, R2A and rhizosphere isolation agar. Assessment of variability resolved these rhizobacteria into 34 rRNA types by amplified ribosomal DNA restriction analysis and 42 rRNA types by ERIC. 16s rRNA sequencing of the representative strains of rRNA types showed 22 diverse genera represented by 75 species (Fig. 3).

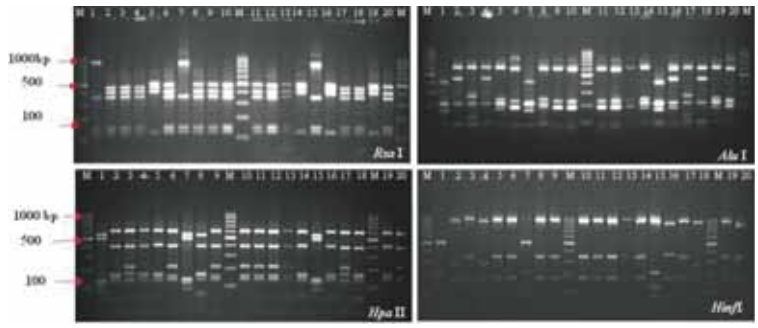

Fig. 3 16S rRNA amplified products fingerprints of tea by ARDRA
Lane M = 1 kb DNA ladder. Lane 1-20 rhizobacteria

PGPR tools for improving crop productivity in stressed agricultural systems (plant microbe and soil interactions): Stress limits growth and yield in plants. Consequently, improving stress tolerance in is increasingly important for enhancing crop productivity under stress agriculture in cold deserts, hot deserts and saline-sodic soils of semi-arid regions. The ACC-deaminase producing bacteria enhance plant resilience and growth particularly under stress conditions by regulating over production of the stress-hormone ethylene. The development of microbial formulations of ACC-deaminase producing PGPR with multiple plant growth promoting attributes can serve to alleviate stress besides functioning as biofertilizers. We have reported the isolation of ACC-deaminase producing PGPR with attributes of phosphate-solubilization, siderophore production, ACC-deaminase, and auxin production leading to the selection of 17 isolates. Further, the evaluation of these isolates for abiotic stress tolerance have led to the selection of six PGPR isolates with high tolerance against salinity, desiccation and acidity/alkalinity (Fig. 4).

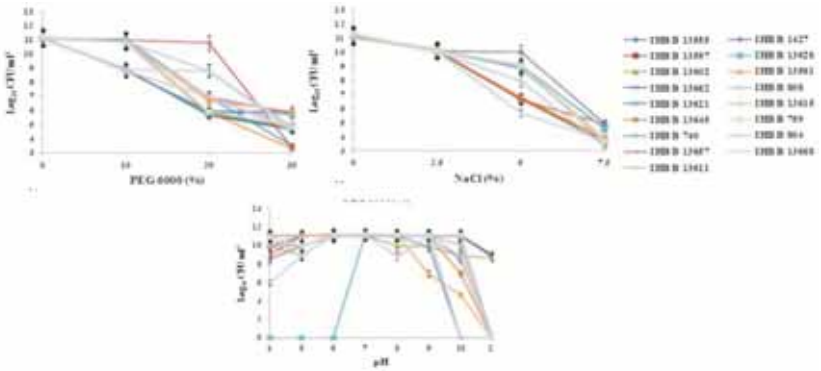

Fig. 4 Effect of PEG 6000, NaCl, and pH on survival of ACC-deaminase producing PGPR grown for 24 h in tryptone soya broth.

Bioprospecting microbial endophytes and their natural products from some medicinal plants from the indian trans-himalayas: Among 538 isolates screened in agar overlay assay against a panel of test organisms, 182 bacteria showed antimicrobial activity against one or more test organisms. The broad spectrum antimicrobial activity was exhibited by 1 isolate against 8 test organisms, 2 isolates against 7 test organisms, 5 isolates against 6 test organisms, 4 isolates against 5 test organisms, 3 isolates against 4 test organisms, 2 isolates against 3 test organisms, and 46 isolates against 2 test organisms. The isolates showing relatively high broad spectrum activity exhibited maximum relatedness to *Bacillus*, *Paenibacillus*, *Variovorax* and *Serratia*.

Characterization and screening and of microorganisms from Indian trans-Himalayas for antimicrobial activity: In continuation to the earlier work on diversity analysis and characterization of microorganisms from novel niches, including high altitude lakes and glaciers from the Indian trans-Himalayas, primary screening of 1540 bacterial isolates and 60 actinomycetes by agar overlay method and secondary screening using Diaion HP-20 was carried out against a panel of test microorganisms. The isolates showing broad spectrum activity were identified as *Bacillus endophyticus*, *Bacillus idriensis*, *Bacillus tequilensis*, *Brevibacillus laterosporus*, *Bacillus pseudomycoides*, *Paenibacillus terrae*, *Pseudomonas cedrina* subsp. *cedrina*, *Streptomyces subrutilus*, *Streptomyces avidinii* and *Streptomyces albidoflavus* based on 16S rRNA gene sequencing. Structure elucidation of a cyclotetrapeptide from *Streptomyces cirratus* IHBB 10198 was carried out through LC-MS and NMR (Fig. 5).

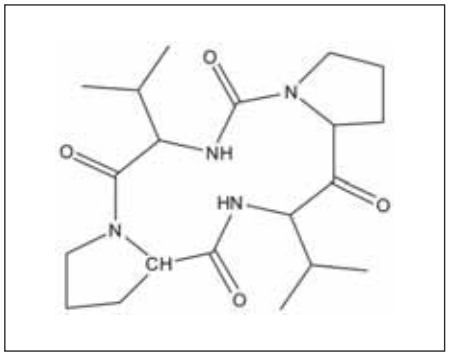

Fig. 5 Structure of a cyclotetrapeptide from Streptomyces cirratus IHB B 10198, Cyclo (L - Pro - L - Val)$_2$

Complete genome sequencing of novel strains: Complete genome sequencing of two putative novel species was carried out. The complete genome sequence of 5.77 Mb is reported from a novel *Paenibacillus* sp. strain IHBB 10380 exhibiting amylase and cellulase activities from the cold environment of the North Western Himalayas. *Athrobacter* sp. strain IHBB 11108 (MCC 2780), is a Gram-positive, strictly aerobic, nonmotile, cold-adapted, and protease-producing alkaliphilic actinobacterium, isolated from shallow undersurface water from Chandra Tal Lake, Lahaul-Spiti, India. The genome size was 3.5 Mb with 58.97% G+C content and a 3.716-kb plasmid (55.32% G+C content) was also identified. Various gene clusters were predicted which code for the hydrolytic enzymes of O-glycosyl hydrolase (one gene), glycoside hydrolase (five genes), and β-glucosidase (five genes) families, which have been reported for application in the food, pharmaceutical, textile, paper, and detergent industries.

- **Publications:**
  - Pal M, Swarnkar MK, Thakur R, Kiran S, Chhibber S, Singh AK and Gulati A (2015) Complete genome sequence of *Paenibacillus* sp. strain IHBB 10380 using PacBio single molecule real time sequencing technology. *Genome Announcements* (accepted)
  - Kiran S, Swarnkar MK, Pal *M,* Thakur R, Tewari R, Singh AK and Gulati A (2015) Complete genome sequencing of a protease producing novel *Arthrobacter* sp. strain IHBB 11108 using PacBio

single molecule real time sequencing technology *Genome Announcements* (accepted).

- Dhar H, Swarnkar M, Gulati A, Singh AK and Kasana RC (2015) Draft genome sequence of a cellulase producing psychrotrophic *Paenibacillus* sp. IHBB 3415 isolated from the cold environment of Western Himalayas, India. *Genome Announcements* 3(1):e01581-14.
- Gohain MB, Talukdar S, Talukdar M, Yadav A, Gogoi BK, Kiran S, Gulati A and Bora TC (2014) Effect of physico-chemical parameters on nitrile hydrolyzing potentials of newly isolated nitrilase of *Fusarium oxysporum*. f.sp. lycopercisi ED-3. *Biotechnology and Applied Biochemistry* DOI: 10.1002/bab.1260.
- Singh Y, Khattar JIS, Singh DP, Rahi P and Gulati A (2014) Limnology and cyanobacterial diversity of high altitude lakes of Lahaul-Spiti in Himachal Pradesh, India. *Journal of Biosciences*, 39(4): 643-657.
- Khattar JIS, Praveen S, Singh Y, Singh DP and Gulati A (2014) Intracellular uptake and reduction of hexavalent chromium by the cyanobacterium *Synechocystis* sp. PUPCCC 62. *Journal of Applied Phycology*, 27 (2): 827-837.
- Sharma SK, Atri NS, Thakur R and Gulati A (2014) Taxonomy and compositional analysis of two new for science medicinal mushroom taxa from India. *International Journal of Medicinal Mushrooms* 16(6): 593–603.
- Vyas P, Rahi P and Gulati A (2014) Statistical optimization of medium components for mass production of plant growth-promoting microbial inoculant *Pseudomonas trivialis* BIHB 745 (MTCC5336). *Indian Journal of Microbiology*, 54 (2): 239-241.

Participants: Mohinder Pal, Shashi Kiran, Aditi Rana, Rishu Thakur, Kanishk Kaushal, Shivali Rana, Namika Thakur, Ruchi, Anuradha, Harmesh Chand and Avinash C Rana

Dr. Arvind Gulati's group

Water Management and Farm Mechanization

K.K. Singh

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Research area: Water and farm mechanisation

A prototype adjustable type improved three-row diamond shape hand hoe was designed and fabricated for cultivating the land between rows. The frame of hand hoe had a provision of placing tynes at a requisite space as per the soil type and spacing of crop and the strength of the operator and can be extend frame in either side for offset inter-cultural operation without disturbing the plantation/crop. The frame also had provision of fitting tynes as per the need of crop and its spacing. The least count spacing for fixing tynes at desired spacing. It is light weight, easy to adjust tynes as per the crop spacing, soil type, and strength of the operator. It is fabricated by locally available material by local fabricator and can be suitable for agricultural, floricultural or plantation crop. A Simple Portable type Charcoal Kiln for wood, sticks and leaves was designed, fabricated and evaluated for bamboo, sticks and culm pieces with excellent conversion efficiency as bamboo charcoal had tremendous adsorption, electromagnetic shielding, and infrared emitting property for industrial applications. Irrigation cum fire fighting net work system under gravity was designed and developed for the institute.

Publications:

- Singh KK, Prakash O and Sood A (2015) A Simple portable type kiln for bamboo charcoal. *Journal of Agricultural Mechanization in Asia, Africa and Latin America, Tokyo,* 46(1): 14-17.

Planning, Project Monitoring and Evaluation

Aparna Maitra Pati

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Research area: R&D Management

Strategic planning: Coordinated and facilitated in conduction of key meetings to stratezie projects, analyzed leads and devised means to take them forward. Catered to the need of scientists from time to time. Conducted the 51st Research Council meeting held on 9th June 2014 and kept track of "follow up actions" for implementation of planned targets. Facilitated in planning of manpower need and their recruitment.

Project monitoring: As a part of project monitoring process, scientists were sensitized for submission of technical reports and utilization certificates to respective funding agencies.

Support decision making: On a regular basis the performance of the institute was analysed w.r.t publication, patent, technology transfer, ECF generated, new projects submitted etc. and apprised to the competent authority that facilitate decision making.

Streamlining processes: (i) Creation of online tools for store and purchase section to hasten the issue "order" , which drastically reduced the time taken in issue of orders from stores. ii) Online tool was also developed to record the material and bill received, which immensely beneficial for monitoring and material management. iii) As per suggestion received from SWOT analysis, an online database has been created such that scientist can record their achievements that can be further transmitted, as and when required.

Dissemination of institutional information: Every month CSIR Head Quarter was apprised about the major achievements of the institute. PPME section furnish information for annual report of CSIR, replies for Parliament questions, materials for CSIR News. In addition, regular update of website, intranet, publication and the compendium of completed projects was also undertaken at regular interval.

RTI: Furnished information to 16 RTI queries.

Impact analysis of IHBT technologies: Stevia cultivation: A brief study was under taken to assess the status of stevia cultivation in Punjab with assistance from Mr. Sukhjinder Singh. The responses were collected through personal interviews and visit to their fields. The feed back indicated that farmers had problem in marketing their produce at desired price as there is no organised market. Now, most of the farmers have set up their own linkage and are doing a good business. It emerged that stevia

is still a promising crop, but farmers can realize its true value only if there is a proper tie up with companies through contract farming in buy-back mode.

Tissue culture technologies: Most of the tissue culture firms established with the help of CSIR-IHBT found to have good business. The firms involved in raising virus free apple root stocks are supplying large scale planting materials to planters in Jammu & Kashmir and HP. The firms involved in raising disease free elite lilum are also satisfied with the market demand. However, one of the firm in Chamba is facing problem of hiring qualified manpower and high rate of contamination. Overall tissue culture looks to be a promising entrepreneurship for educated youth.

Human Resource: Trained one student of MBA in the project entitled "Assessment of Employe's view and research environment for better management of institute". Facilitated placement of 46 students for their project internship in different departments of the institute;

Management Representative of ISO- Implementation of ISO at institutional level.

Participants: Sukhjinder Singh, Jasbeer Singh and Vikrant Gautam

Dr. Aparna Maitra Pati's group

CSIR 800: RURAL DEVELOPMENT ACTIVITIES

Institute is translating its research findings at the grass root level through extension and advisory services in value-added agriculture and non-farm sector. Crop selection and its agro-technology for different land capability and land use planning have been seen as critical issues to the farmers in changing scenario of agricultural production. Climate change, field production sustainability, biodiversity losses, wild life and human conflicts, market demand for healthy food ingredients and decorative plants are influencing crop choices and farm income. Therefore, extension and advisory services on speciality plants, its associated processes for field production, value addition, quality control and marketable products have been forefront activities of the institute. A variety of field surveys activities were undertaken by the AcSIR scholars *viz*., surveillance and water quality monitoring, performance of greenhouses, prevalence of anemia among women, incidence of diseases of important vegetable crops and analysis of road network system in HP will form the base for improving quality of life and earnings of the rural people. Hands on trainings on medicinal herb collection and drying, essential oil distillation, floral arts, mushroom production and bioresource based processed food such as bamboo candies were integrated as non farm income generation activities.

Field surveys and registration of farmers

A total of 280 numbers of rural beneficiaries and farmers from Kangra, Chamba, Mandi, Kullu and Shimla districts of HP were registered during field surveys, trainings and counseling sessions.

Awareness and exposure visits of farmers

Around 250 farmers in 9 different groups from Kinnaur and Kalpa of HP and Rasi, Srinagar, Baramulla, Shopian and Bandipora from J&K were provided with awareness and exposure to our demonstration; fields of bamboos, ornamental, medicinal and aromatic crops. Detail of exposure visits have been shown in Table 1.

Table 1. Exposure visit to demonstration fields

S.No.	Date	Visitors	Origin of visitors
1.	05.06.2014	35	HDO, Kinnaur (HP)
2.	16.06.2014	35	HDO, Kalpa (HP)
3.	13.10.2014	35	CHO, Rasi (J&K)
4.	05.11.2014	27	CHO, Rasi (J&K)
5.	22.12.2014	20	CHO, Srinagar (J&K)
6.	15.01.2015	30	CHO, Srinagar (J&K)
7.	08.01.2015	30	HDO, Baramulla (J&K)
8.	03.03.2015	20	HDO, Sophia (J&K)
9.	13.03.2015	18	HDO, Bandipora (J&K)
Total		250	HP and J&K States

Supply of planting material for increase in area under value added agriculture

An additional area of around 11 ha was brought under Stevia, Damask rose, wild marigold, lavender, rosemary, ginkgo, muskbala, and ornamental crops in Chamba, Mandi and Kullu districts through supply of planting material and advisory services by the institute. Details have been shown in Table 2**.**

Table 2. Supply of planting material and advisory services

Crop Name	Planting material	Area covered (ha)
Damask rose	Stem cutting	5.00
Wild Marigold	Seeds	0.90
Lavender	Nursery plants	1.70
Rosemary	Nursery plants	0.43
Stevia	Nursery plants	0.36
Stevia	Seeds	1.00

In addition, over 2,100 nursery plants of minor medicinal and aromatic crops *viz*., ashwagandha, ghrit kumari/gar

patha, baccopa, oregano and scented geranium and few of sandal wood were supplied for home gardens and nursery multiplication.

ACTIVITY-WISE DETAILS OF ADVISORY AND EXTENSION SERVICES

Tea

Advisory and extension services to the tea growers of the Kangra were continued in association with regional office of Tea Board of India. A total of 12 training programmes and advisory camps were held for the growers of HP and one for the tea planters from Uttarakhand. Main emphasis was laid on setting up new plantations, mechanization of tea plucking and pest management during the year. In addition, a tea workshop on the theme "Strategies for Mechanization of Tea Farm Operations in Kangra Valley" was organized at CSIR-IHBT, Palampur. The workshop was inaugurated by the Hon'ble Speaker of HP Vidhan Sabha, Shri Brij Behari Lal Butail and was attended by over 100 growers from tea growing regions in the state. A comprehensive plan of mechanization of the Kangra tea plantation was discussed in the workshop.

Tea Workshop at CSIR-IHBT

Large Cardamom

Large cardamom (*Amomum subulatum*) is low volume, high value and environment friendly cash crop, requiring low inputs for sustenance. Mid-hill areas in HP including parts of Kangra, Chamba, Mandi, Hamirpur, Bilaspur and Sirmour have been found to be suitable for large cardamom cultivation. In the previous years, CSIR-IHBT has demonstrated its successful cultivation by using suitable cultivars and management practices and also provided the nucleus planting material to the growers. This year 480 vegetative propagated nursery plants of suitable cultivars were supplied to the growers of the region. Two trainings were arranged for the interested growers on cultivation techniques of this crop.

Promotion of Large cardamom cultivation in Jia village by the AcSIR students

Floriculture

One of the most demanded, easy to cultivate and marketable floriculture crops in this region is marigold. Being a multipurpose flower for every occasion, decoration and for worship in the nearby temples, growers find it an easy to sell. Four demonstration plots of ornamental marigold cultivar 'Pusa Narangi' were established in and around Gopalpur TECHVIL area.

Promotion of marigold cultivation

Bamboo

Bamboo, a giant grass, has spurred worldwide attention as a versatile plant with multifarious uses. Environment friendly plant, capable of growing in a wide range of soils, produces high amount of biomass and very effective against soil erosion. The Institute has been promoting cultivation and utilization of bamboo in the past decades. During the past year, the Institute supplied 17,015 saplings of different bamboo species to HP, Punjab and J&K. Details have been shown in Table 3.

Table 3. Supplied 17,015 saplings of different bamboo species

S. No.	Species	Plant supplied	Location
1.	*Phyllostachys pubescens* (Moso Bamboo)	10,696	Anant Nag and Srinagar (J&K), Faridabad (Haryana), Palampur, Khundian, Sundernagar , Shimla (HP) and Hoshiarpur (Punjab)
2.	*P. pubesence*	991	Palampur, Nurpur, Dharamshala, Rakh, Nagri and Baijnath (HP) and Srinagar (J&K)
3.	*P. aurea*	49	Palampur, Nurpur, Mansimbal and Dharamshala (HP)
4.	*P. nigra*	11	Palampur, Nurpur and Bhawarna (HP)
5.	*Dendrocalamus hamiltonii*	2,449	Dharamshala, Mansimbal, Palampur, Banjar and Kullu (HP) and Hoshiarpur (Punjab)
6.	*D. membranceous*	40	Palampur, Nurpur, and Dharamshala (HP)
7.	*D. asper*	21	Nurpur, Palampur and Dharamshala (HP)
8.	*D. giganteous*	12	Palampur and Nurpur (HP) and Hoshiarpur (Punjab)
9.	*Bambusa bambos*	2.556	Palampur, Nurpur, Dharamshala, Shimla and Kullu (HP)
10.	*B. multiplex*	87	Palampur and Kangra (HP)
11.	*Sasa auricoma*	30	Nurpur, Bhavarna and Palampur (HP)
12.	Ornamental bamboo	13	Palampur (HP)
13.	Miscellaneous bamboo species	60	Scattered location

Bamboo plantation drive in Gram Panchayat Rakh in Kangra District

Setting up of bamboo plantations in the Gram Panchayat Rakh was taken up by the Institute. Around 600 plants of *Bambusa bambos* and 400 plants of *Phyllostachys pubescens* (Moso Bamboo or Chinese Bamboo) were planted through the active participation of the AcSIR students and the Panchyat Pradhan at

Alleanbagh village located at 076° 29' 2 1.2" E, 32° 09'37.3" to 32° 09' 11.9" N and an elevation of 1771 m above mean sea level. The villagers were trained on different aspects of bamboo cultivation and plantation management.

1.Transporting bamboo saplings to the village, 2. AcSIR students and village ladies at planting site, 3. Carriage of bamboo saplings to the planting site and 4. Bamboo saplings being planted

Mushroom

Considering the potential of mushroom cultivation for income enhancement of the rural women in this region, mushroom cultivation was introduced in Gopalpur-Chachian TECHVIL region under CSIR-IHBT Rural Development. Awareness camps were organised for the village women on importance, economic and health benefits of mushrooms. A group of 15 ladies was selected. This group was imparted 7-days training on different aspects of mushroom cultivation and utilization at Mushroom Centre of State Horticulture Department. A total of 10 demonstration units of mushroom were successfully established in Gopalpur, Latwala, Darati and Tanda villages where women were also provided with compost for growing white button mushroom. Regular need based advisory was extended to these growers throughout the season through an expert (Dr. Jitender Pal).

1.Training of the women on mashroom cultivation, 2. Supply of mushroom-compost for demo units, 3-4. Setting up of mashroom units, 5. Mushroom crop in a bag and 6. Advisory on Dhingri-mushroom cultivation. Wild marigold (*Tagetes minuta*)

Cultivation of wild marigold as a pure crop and relay crop in maize fields has proven economical at farmers fields in mid and high Himalayan region. A field demonstration on this crop was carried out at farmers' field through a society namely The Vaishnavi Herbal & Aromatic Growers, Processing Marketing & Supply Cooperative Society Ltd., at village Sei-Kothi, Tissa, Distt. Chamba. The crop grown in 1.50 ha area produced 38.73 q semi dried biomass. The biomass was distilled in 24 batches using the mobile essential oil distillation unit and yielded 34.51 litres high quality Tagetes oil with an overall recovery of 0.89%. It is pertinent to mention here that 3 ton commercial Tagetes oil is produced annually in HP through this Institute's technology.

Setting up commercially important crops at High Altitude Biology (CeHAB), Ribiling.

The Institute established demonstration plots of commercially important medicinal plants like Chinese ginseng and *Picorrhiza kurroa* at farmers' plots at Lahaul and Spiti. Initial results showed suitability of the climatic conditions for these high value crops. Herbal garden and nurseries of the targeted crop species were established at the Institute's Centre for High Altitude Biology (CeHAB) at Ribling, where 42 medicinally important and threatened species were grown for agronomical and breeding purposes. Besides, commercially important plants *viz*., Chinese ginseng and saffron were also planted in the experimental farm and promising trends were observed.

AcSIR students projects on Rural Development Activities

Surveillance and water quality monitoring in CSIT-IHBT TECHVIL area (Mayanka Walia, Richa Bharti, C. Bal Reddy, Ashish Kumar, Vinod Bhatt and Saurabh Sharma)

A survey of six gram panchayats viz., Gopalpur, Chachiyan, Kaloond, Rakh, Jia and Darognu showed that villages of these panchayats have irregular drinking water supply. IPH water supply was the primary source for drinking water whereas *kuhal* (small water channel), *bauri* (small pond of seepage water), hand pump and ponds were the secondary sources. In all six gram panchayat only 20% household were using filtered water for drinking. Water borne problems like stone, stomach discomfort, acidity etc. were recorded in the villages. In summer season bacteriological count of water sample of *bauri* and *kuhal* are observed to be beyond the acceptable limits. In rainy season, dust particles and some insects were big issues. Besides, the water of *bauri, kuhal* as well as that of tap was found unacceptable with respect to microbial testing. In bacteriological testing of tap water samples, MPN of coliforms were beyond the acceptable limit. It was also noted that the people lacked knowledge of rain harvesting and soil-water conservation and there was a need to make aware of the households on water and irrigation-related schemes and water storage. The residents and school children were apprised on the management, handling and use of drinking water.

1.Discussions on water analysis with SE of IPH Department, 2. Supply of drinking water,
3. Collection of water samples.

4. Analysis of water quality, and 5-6. Educating children and villagers for rational water use.

Prevalence of anemia among women in CSIR-IHBT TECHVIL area: survey and assessment (Shalika Rana, Madhu Kumari, Kiran Rawat and Indu Gangwar)

Correlation was found between age and Hb level. AmonAnaemia is one of the most common and intractable nutritional problems in the world today. Study was conducted to access anaemic status of women in selected villages in TECHVIL area vis-a-vis nutritional status and prevalence of malnourishment in women of targeted age group, and suggest measures to overcome it using local natural bioresources. Survey of 200 female volunteers revealed that dominant blood group in the area was B+ve and 99% volunteers were found to be anaemic although not severely. Among young women (20-35 year group), 82% were anaemic. Prevalence of anaemia was more in women consuming only vegetarian diet. Low anaemia level among pregnant women was a good sign. Unlike hypothesis, women who consuming tea were observed to be less anaemic. It would be pertinent to mention that this survey supported some of the well known notions while it rejected others. In order to take this study to a conclusive path, some points were suggested viz., sample size may be increased and functional food development may be considered as an option to avoid disinterest of consuming iron pills. Apart from iron, one may also consider enriching food with other micronutrients viz., vitamin B_{12}, folic acid, etc., as they play important role in iron absorption.

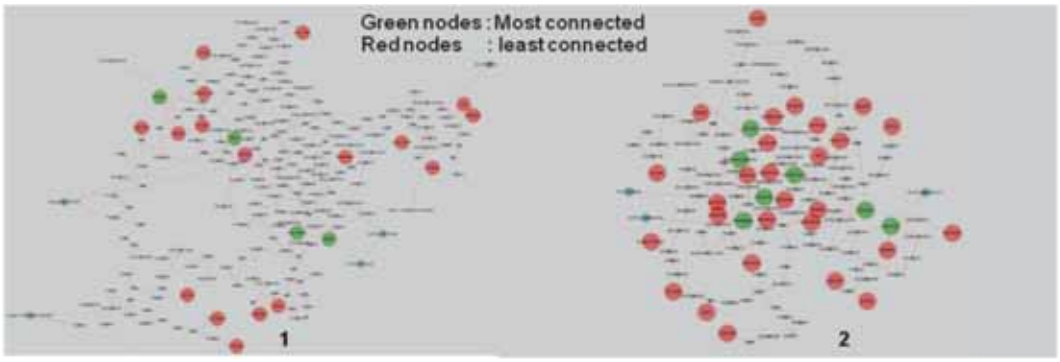
1.Discussion on anaemia with Medical Officer of PHC Gopalpur, 2-4. Survey and data collection, 5-6. Collection and analysis of blood samples, and Imparting education on anaemia to the women and children.

Analysis of State Road Network System: A case study of HP State Highways and Bhawarna Block

roads representing secondary and tertiary road system (Vinay Randhawa and Ashwani Jha)

In mountains, rapid mass movement hazards such as earthquakes put human, property, infrastructure and road networks at risk with dramatic consequence. Roads play a significant role in achieving national development and contributing to the overall performance and social functioning of the community. The present study was aimed to understand topological characteristics of HP State Road Network (HPSRN) and Bhawarna Block Road Network (BBRN) systems using structural network analysis. Highly and least connected places in the state road network as well as in Bhwarna Block network were identified. Mandi, Pandoh, Palampur, Bhuntar, Jogindernagar, Baijnath, Kullu, Gaggal, Rohtangpass, Chamunda, Dharamsala, Chailchowk, Chamba, Hamirpur and Nauni were found to be the most stress places in the state. In Bhawarna Block, top 5 places with highest connectivity were Kaloond, Chachian, Gopalpur, Darati and Bagora. The connectivity of least connected places should be increased for social welfare. Additionally, the places highly connected (hubs) and highly in between (high BC) could be considered for making base camps during natural calamities like earthquake. This study may also provide necessary information for planners to design the systems accordingly. Similar undertakings can be implemented to other urban infrastructure systems e.g., electricity grid, water/wastewater system, etc. There is a need for construction of database hosting HPSRN, BBRN, and other road networks. There would also be a need for more realistic modeling of the failure caused by the adverse event just by removing one link at a time in the network. Similar type of analyses can be done for irrigation, drinking water facility and transportation.

Most and least connected nodes, 1. Himachal Pradesh and 2. Bhawarna Block Road Network System



Scenario of polyhouse cultivation and maintenance of protected cultivation in CSIR-IHBT TECHVIL area (Poonam Roshan, Surender Kumar, Anita Kumari and Deep Mala)

Polyhouse culture has mushroomed in different villages in Distt. Kangra (HP) yet in the present situation a state of abandoned, ineffective and underutilized condition of some of them is quite common. A survey was conducted to understand the status of protected cultivation in the TECHVIL area and guide the growers on management of polyhouses and crop protection from pests especially diseases. Survey showed that in the TECHVIL area, 117 polyhouses of different capacities and types were built under NHM and Pandit Deen Dayal Kissan Bagwan Samridi Yojna of the State Government. The polyhouses were used for cultivation of different vegetables and cut flowers. Majority of polyhouses were of medium cost ranging from Rupees 2-5 lakhs. Three entrepreneurs were running commercial scale business of flowers (lilium, gladiolous, carnation, etc.) and were providing employment to the local villagers. Whereas, others were growing vegetables and cash crops, and very little spices (like coriander, garlic etc.). Except commercial growers,

others lack knowledge of good quality seeds and planting material although some of them were processing from state agriculture department. In some polyhouses particularly in village Bhaled and Gopalpur, irrigation was a problem. Growers complained for not imparting technical trainings, providing quality seeds, and not facilitating repair and maintenance of polyhouses by the concerned departments. It was noted that people were not well aware of control measures of pests and diseases, resulting in poor crop performance. Farmers were not satisfied with the use of biocontrol agents viz., *Trichoderma, Trcihogamma*, NPV due to their imperfect performance in pest management. Keeping in mind the facts about protected cultivation, some recommendations for polyhouse cultivation and management were given to the growers through subject experts.

1.Polyhouses in a village, 2-3. Survey and data collection, 4-5. Crops grown by farmers in different villages, and 6. Collection of infected shoots for disease identification advisory.

Socio-economic survey and development plan for Chachian Gram Panchayat in Kangra district of Himachal Pradesh (Ajay Kumar, Bharati Barsain, Vanita Patial and Shikha)

Households survey showed that the village constituted of average as well as poor living population. Traditional agriculture is the main occupation though some villagers were employees in the Government and private sectors. Agriculture was mostly rainfed, though *kuhal* water was available in some pockets. Menace of wild animals and stray cattle, lack of post harvest management, inadequate marketing infrastructure, shortage of farm machinery for timely field operations, unawareness of soil health status, quality seeds, elite planting material were limitations in the productive farming. Allied agriculture activities *viz*., vermicomposting, poultry, apiculture, cultivation of high value crops and biogas were not noticed. However, drinking water supply, sanitation and local transport were satisfactory. Overall health of villagers and livestock was good with average standards of living. Scope was observed for improving agriculture through value added agriculture activities and ensured irrigation. Planting of *Bambusa bambos* around the periphery of fields could serve as fence against wild animals. Training related to cultivation and propagation of commercial crops could supplement the farmers' income. For successful implementation

and management of value addition enterprises, women empowerment needs attention.

AcSIR Students conducting base-line survey in Gram Panchayat, Chachian.

Socio-economic survey and development plan for Jia Gram Panchayat in Kangra district of Himachal Pradesh (Preeti, Monika Bhuria, Vishal Sharma, Gulshan Kumar and Munish Kaundal)
Jia Gram Panchayat is located at Longitude 76.4461857, Latitude 32.1496654 and at an altitude of 1254 m above mean sea level in Bhawarna Block of Palampur tehsil and Kangra district. The Gram Pachayat had 5 wards inhabiting 1872 people of 441 families. Sex ratio was better with 1046 females against 1000 males. Majority of the villagers were farmers except few who had government or private jobs. Wheat, rice, maize, barley and potato were common crops grown in the villages. Daily wage workers mostly worked under MNERGA programme. Panchayat was well connected with road except one ward which was situated across Baner khudd. The panchyat had anganwadi Kendra in each ward, two primary schools, one high school and a health care centre. Survey and SWOT analysis suggests that Jia panchayat had many resources that could be exploited for development and raising the socio-economic status of the people. Villagers could

be encouraged to adopt value added agriculture including cultivation cash crops viz., marigold, cut-flowers and vegetables, large cardamom, and poultry and fisheries as subsidiary occupation to increase their economic status. As gifted with natural beauty, the panchayat had tremendous potential for eco-tourism.

AcSIR Students conducting base-line survey in Gram Panchayat, Jia. Survey of incidence of disease of important vegetable crops with specific emphasis on potato in Gram Panchayat Bagora in Kangra District of Himachal Pradesh (Rimpy Diman and Pritu Pratibha)
Questionnaires were developed for demographic survey by interviewing farmers in the Gram Panchayat Bagora. Data collection included household characteristics (age, education and gender of head of household and average family size). The questionnaire was further refined by addition of few questions like

farm characteristics, average size of farm, type of land, major crops cultivated, major constrains in crop cultivation and use of inputs including labour etc. The final version of the questionnaires was to interview 17 potato growers randomly selected from different villages of Bagora panchayat. Survey was conducted to throw some light on socio-economic condition of potato growers and identifying limiting factors for potato production and to develop a work plan so that the livelihood of poor farmers could be uplifted through enhancing potato productivity.

Survey on status of vegetable crops and prevalence of different diseases in Gram Panchayat, Bagora.

R&D Support Service

Tissue culture labs supported by CSIR-IHBT, Palampur produced 8.78 lakh TC raised plants annully. The institute provided technical know-how to the following tissue culture labs:

- M/s Rajat Biotech, Vill. Padyalag, Ghumarwin, Dist. Bilaspur (HP)
- M/s Kunal Bio-tech, Vill. Nagwaine, Dist. Mandi (HP
- M/s Neva Plantation, Vill. Gopalpur, Dist. Kangra (HP)
- M/s A.K. Biotech, Vill. Juthed, Tehsil Chaurah, Dist. Chamba (HP)
- M/s Sagar Biotech, Thakurdwara, Tehsil Palampur, Dist. Kangra (HP)
- M/s Nishant Biotech, Vill. Padyalag, Ghumarwin, Dist. Bilaspur (HP)

Workshop Organized

- RK Sud (2015) Tea workshop on strategies for mechanization of tea farm operations in Kangra Valley, inaugurated by Hon'ble Speaker, HP Vidhan Sabha, Shri Brij Behari Lal Butail, Sponsored by Tea Wing of State Agriculture Department, HP, 125 participants, CSIR-IHBT, Palampur, on March 14.
- Mahesh Gupta (2014) Awareness seminar on "Value added Food Products" organized at CSIR-IHBT, Palampur in association with MSME, Govt. of India, December 30**.**

Participation in Workshops

- RK Sud (2014) Workshop on 'Training Programme on Guidance towards Integrating Climate Risk Resilient Adaptation in Himachal Pradesh', September 4-5, Shimla, HP, Kapurthala Pb., April 04.
- Sukhjinder Singh, JP Dwivedi and RK Sud (2014) Workshop on 'Review cum National Meet of TePP Outreach cum Cluster Innovation Centres (TOCICs)' and 4th Meeting of the PRISM Advisory and Screening Committee, October 8-9, College of Technology & Engineering, Udaipur.

Lectures Delivered

- Mahesh Gupta (2014) Delivered a lecture on "Nutraceuticals & Functional Food: Recent

Advancement", at Department of Life Sciences and Technology, Punjab Institute of Technology, Kapurthala, April 04.

- RK Sud (2014) Key-note lecture on the national seminar on the "Socio-economic, health and ecological implications of tea gardens in Himachal Pradesh", Department of Sociology SCVB Government College, Palampur, April 19.
- Mahesh Gupta (2014) Participated in Annual Tribal Fair, Keylong (Lahaul & Spiti), August 14-16.
- Rakesh Kumar. (2014) High altitude medicinal and aromatic plants J&K Aroma Festival- 2014 held at Kathua, Jammu, August 16.
- Mahesh Gupta (2014) Delivered lectures in five days training programme. 28 local youth and potential farmers. CSIR-IHBT and Horticulture Department, Keylong, August 28-31.
- Rakesh Kumar (2014) Status of damask rose (*Rosa damascena* Mill.) research and production in indian western Himalayas. 1st HP Science Congress, Peterhoff Hotel, Shimla, HP, September 15-16.
- Virendra Singh (2014) Cultivation and marketing of medicinal plants. Workshop on cultivation of medicinal plants in Punjab and their marketing, held at Dayanand Ayurvedic College, Jalandhar, Novemebr 4.
- RK Sud (2014) Role of CSIR-IHBT on implementation of plant protection code in tea growing areas of Himachal Pradesh, Tea Board of India, Palampur, November 21.
- RK Sud (2014) Rural Development Activities of CSIR-IHBT. BDO office at Bhawarna. November 24.
- Mahesh Gupta (2014) Delivered a Talk in 13th Silviculture Conference on "Role of Technology in Enhancing Bamboo Use", FRI, Dehradun, November 25-26.
- RK Sud (2014) Rural Development Activities of CSIR-IHBT and CSIR-800 projects pursued by AcSIR students at TECHVIL Gopalpur, CSIR-IHBT, November 26.
- RK Sud (2014) PRISM scheme for innovators. In: Awareness Seminar on Value added Food Products, organized at CSIR-IHBT, Palampur in association with MSME, Govt. of India, December 30.
- RK Sud (2015) Mechanization of tea plucking. In: Workshop on Mechanical Plucking of Tea, Mansimbal Tea Estate, sponsored by Tea Board of India, January 2.
- RK Sud, Sukhjinder Singh and Vikrant Awasthi (2015) Promotion of innovation in individuals and S&T Institutes. Sri Sai University, Palampur, February 9.
- RK Sud (2015) Prospects and constraints of tea farm mechanization in China hybrid tea. Workshop on Tea Farm Mechanization, chaired by Hon'ble Speaker of H.P. Vidhan Sabha, Sh. B.B.L. Butail, Villa Camellia, Palampur, February 27.
- RK Sud and Sukhjinder Singh (2015) Promotion of innovation in individuals and S&T Institutes. Govt. Polytechnic College, Batala, March 3.
- RK Sud and Sukhjinder Singh (2015) Promotion of innovation in individuals and S&T Institutes. GNDU Engineering College, Gurdaspur, March 4.
- RK Sud (2015) Innovation management and innovative technologies developed at CSIR-IHBT, Palampur– An invited lecture by the College. Beant College of Engineering and Technology, Gurdaspur, March 4.

- RK Sud and Sukhjinder Singh (2015) Promotion of innovation in individuals and S&T Institutes. Beant College of Engineering and Technology, Gurdaspur, March 4.
- RK Sud and Er. KK Singh (2015) Tea Farm Mechanization in Kangra: Advantages and Constraints. Tea Workshop on Strategies for Mechanization of Tea Farm Operations in Kangra Valley, CSIR-IHBT, Palampur, March 14.
- RK Sud (2015) Strategy for tea farm mechanization in Kangra Valley. Tea workshop on Strategies for Mechanization of Tea Farm Operations in Kangra Valley, CSIR-IHBT, Palampur, March 14.

DOORDARSHAN/ RADIO TALK

Beul (*Grewia optiva*): A multipurpose plant Bioresource of mid Himalayan region, Krishi-Darshan programme, Doordarshan Kendra, Shimla.	10.04.2014	Dr. Brij Lal
Agro-technique of Damask rose cultivation including and crop protection. Doordarshan Ajmer (channels *Sarara*)	13.04. 2014	Dr. Gopichand
Ginkgo biloba: A commercially important medicinal plant. Krishi-Darshan programme, Doordarshan Shimla.	22.04. 2014	Dr. Gopichand
Bamboo utilization. Doordarshan Punjabi.	11.06.2014	Dr. Anil Sood
Hand Card Making: a source of additional income for the rural women. Doordarshan Kendra. Shimla	18.06.2014	Dr. Alka Kumari and Dr. RK Sud
HimStevia: a promising new cultivar of the alternate cash crop Stevia. Krishi-Darshan programme, Doordarshan Shimla.	29.07.2014	Dr. Ashok Kumar and Dr. RK Sud
Him Glow and Him Peace - two new cultivars of gerbera for floriculture growers of Himachal Pradesh"Krishi-Darshan programme. Doordarshan Kendra. Shimla.	31.07.2014	Dr. Sanatsujat Singh and Dr. RK Sud
Diversity of bamboo and their uses. Krishi-Darshan programme, Doordarshan Kendra, Shimla.	14.08.2014	Dr. Anill Sod and Dr. RK Sud
Production technologies for medicinal plant Kutki (*Picrorhiza kurrooa*) in the western Himalayas, Doordarshan Kendra, Shimla.	24.10.2014	Dr Rakesh Kumar and Dr. RK Sud
Nursery raising and cultivation practices of carnation, Doordarshan Kendra, Shimla.	27.02.2015	Dr. Bhavya Bhargava and Dr. RK Sud
Fern, a multipurpose plant group for rural upliftment. Krishi-Darshan programme, Doordarshan Kendra, Shimla.	30.09.2014	Dr. Alka Kumari and Dr. RK Sud
Mechanization of tea farm operation. Palampur City Cable Network, Palampur, HP	14.03.2015	Dr. RK Sud
Charcoal and other diversified products from bamboo as means for income generation in rural India.Doordarshan Kendra, Shimla.	26.03.2015	Dr. Anil Sood and Dr. R.K. Sud

Training Received

- Two Weeks Programme on Managing Innovation and Technology for Competitiveness, Incorporating STI Policy, Solution Science & Innovation Management (Sponsored by DST), Administrative Staff College of India, Hyderabad, December 1-12, 2014.
- Exposure visit to ICAR-Central Soil and Water Conservation Research and Training Institute, Dehradun, October 29, 2014.

Training organized

- Mahesh Gupta (2014) Organized one day entrepreneurship development workshop on "Functional Food Development", 64 participants, IHBT-CeHAB, Tandi, (Keylong) and MSME, Govt. of India, August 27.
- Mahesh Gupta (2014) One day awareness seminar was organized in association with MSME, Govt. of India on "Value added food products", 29 progressive participants, CSIR-IHBT, Palampur, December.
- Anil Sood (2014) Training cum demonstration on making of bamboo candy, 10 participants. CSIR-IHBT, Setember 1,10,11&15.
- Mahesh Gupta (2014) Under CSIR-800, Utilization of edible bamboo for food product development, 22 rural women clusters of Gopalpur village, Palampur, September 10.
- Anil Sood (2014 & 2015) Training and demonstration on edible bamboo food products, 38 participants, Talwara, Punjab and Gagret Himachal Pradesh, December 22 and March 10.
- Mahesh Gupta (2014 & 2015) Training and Demonstration of edible bamboo food products to the thirty eight potential bamboo growers and small entrepreneurs in the Talwara region of Punjab and Gagret region of Himachal Pradesh, December 22 and March 10.
- RK Sud (2014) Training programme on tea farm mechanization in Nagri area, April 30.
- Rakesh Kumar (2014) Improved production technologies for natural sweetener plant stevia.2 participants, Chandpur Farm, CSIR-IHBT Palampur, May 1-2.
- RK Sud (2014) Training programme on tea farm mechanization: handling of tea skiffing machines. Bir area. May 15.
- Rakesh Kumar (2014) Improved production technologies for natural sweetener plant stevia. 2 participants Chandpur Farm, CSIR-IHBT Palampur, June 6-7.
- RK Sud and VS Dhadwal (2014) Training and demonstration of young tea planting in Chambi Tea Estate, July 9.
- Alka Kumari and RK Sud (2014) Three-day training programme on Card Making with dried flowers and vegetation, CSIR-IHBT, 24 ladies from TECHVIL area and Rajpur-Tanda participated, June 03-05.
- Mahesh Gupta (2014) Two days workshop on value added buckwheat products, 16 participants, IHBT–CeHAB, Tandi, Lahaul and Spiti, June 27-28.
- RK Sud (2014)Training and exposure of interested growers of Techvil on cultivation of large cardamom and marigold to two growers, July 14.
- Mahesh Gupta (2014) One-day entrepreneurship development workshop on functional food development, 64 participants, IHBT–CeHAB, Tandi, Lahaul and Spiti, August 27.

- Mahesh Gupta (2014) Five-day training programme in association with Horticulture Department, 28 participants, Keylong, August 28-31.
- Rakesh Kumar (2014) Nursery raising practices, cultivation and essential oil extraction of important medicinal and aromatic plants. 17participants. CeHAB, Ribling (Tandi), Keylong, district Lahaul & Spiti, September 17.
- RK Sud, Virendra Singh and Arvind Verma (2014) Seven-day training programme on Mushroom Cultivation and Its Business Management for farmers of Chachian-Gopalpur region, 15 participants, Mushroom Development Project, Deptt. of Horticulture, Palampur, October 14-20.
- Arvind Verma, R.K.Sud and Virendra Singh (2014) Three-day training programme on Modern nursery and cultivation techniques of flowers, medicinal and aromatic crops under protected conditions, 25 growers, CSIR-IHBT Palampur, November 26-28.
- RK Sud and V.S. Dhadwal (2014) Advisory and training on winter operations of tea plantations to the field workers of Thandole area, 14 trainees, Novemeber 10.
- RK Sud and V.S. Dhadwal (2014) Demonstration of mechanical pruning, skiffing and weeding in tea plantations. 6 trainees, Banuri Tea Expt. Farm, November 14.
- RK Sud and V.S. Dhadwal. (2014) Demonstration of mechanical pruning and skiffing in tea plantations, 7 trainees, Hoodle Tea Estate, Dharmshala, November 22.
- RK Sud and V.S. Dhadwal (2014) Training on growing large cardamom to the growers of Kangra, 10 growers, Banuri Tea Expt. Farm, Novemeber 24.
- R.K.Sud (2014) Training programme for small growers on tea plantation management, regarding winter operations, 30 growers (Organized by Tea Board of India), Nagri area, December 29.
- RK Sud (2014)Training programme of tea plantation management regarding winter operations, 35 growers, Tea Board of India, Bir, December 30.
- RK Sud and V.S. Dhadwal (2015) Mechanization of tea farm operation specifically the operations to be undertaken during winter season. 70 participants, Tea Board of India, Mansimbal Tea Estate, January 2.
- RK Sud and V.S. Dhadwal (2015) Training on young tea planting, 12 participants, Thandole Tea Estate (Palampur Zone), January 19.
- RK Sud (2015) Mechanization of tea farm operation specifically operating and handling of plucking machines, 70 participants, Tea Board of India for Palampur & Baijnath Zones, January 27.
- RK Sud, Khushal Katoch and Ajay Rana (2015) Exposure visit cum training of small tea growers from Uttrakhand on tea plantation management and tea processing and preparation of value added diversified products. The 6 participants batch was led by the regional office of Tea Board of India at Uttarakhand, January 27.
- Bhaivya Bhargva (2015) Training cum demonstration on cultivation and post harvest technologies of cut flower crops, 35 participants, CSIR-IHBT, February 9-11.
- RK Sud and V.S. Dhadwal (2015) Training programme on skiffing operations, drainage and fertilizer management in tea plantation in Nagri-Gopalpur-Chambi area, 50 participants, Tea Board of India for Dharmshala Zone, February 13.

- Virendra Singh and R.K.Sud (2015) One day training programme training to artisans/farmers and field functionaries on bamboo propagation and product development, CSIR-IHBT, March 16.
- RK Sud, Virendra Singh and Arvind Verma (2015) Mushroom cultivation awareness camp for the farmers of TECHVIL area at Mushroom Farm of State Horticulture Department, 15 participants, Palampur, March 25.
- Mahesh Gupta (2014) One-day entrepreneurship development workshop on functional food development, 64 participants, IHBT–CeHAB, Tandi, Lahaul and Spiti, August 27.
- Mahesh Gupta (2014) Five-day training programme in association with Horticulture Department, 28 participants, Keylong, August 28-31.
- Rakesh Kumar (2014) Nursery raising practices, cultivation and essential oil extraction of important medicinal and aromatic plants. 17participants. CeHAB, Ribling (Tandi), Keylong, district Lahaul & Spiti, September 17.
- RK Sud, Virendra Singh and Arvind Verma (2014) Seven-day training programme on Mushroom Cultivation and Its Business Management for farmers of Chachian-Gopalpur region, 15 participants, Mushroom Development Project, Deptt. of Horticulture, Palampur, October 14-20.
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- RK Sud and VS Dhadwal (2014) Advisory and training on winter operations of tea plantations to the field workers of Thandole area, 14 trainees, Novemeber 10.
- RK Sud and VS Dhadwal (2014) Demonstration of mechanical pruning, skiffing and weeding in tea plantations. 6 trainees, Banuri Tea Expt. Farm, November 14.
- RK Sud and VS Dhadwal. (2014) Demonstration of mechanical pruning and skiffing in tea plantations, 7 trainees, Hoodle Tea Estate, Dharmshala, November 22.
- RK Sud and Shri V.S. Dhadwal (2014) Training on growing large cardamom to the growers of Kangra, 10 growers, Banuri Tea Expt. Farm, Novemeber 24.
- RK Sud (2014) Training programme for small growers on tea plantation management, regarding winter operations, 30 growers (Organized by Tea Board of India), Nagri area, December 29.
- RK Sud (2014)Training programme of tea plantation management regarding winter operations, 35 growers, Tea Board of India, Bir, December 30.
- RK Sud and VS Dhadwal (2015) Mechanization of tea farm operation specifically the operations to be undertaken during winter season. 70 participants, Tea Board of India, Mansimbal Tea Estate, January 2.
- RK Sud and VS Dhadwal (2015) Training on young tea planting, 12 participants, Thandole Tea Estate (Palampur Zone), January 19.
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- Virendra Singh and RK Sud (2015) One day training programme training to artisans/farmers and field functionaries on bamboo propagation and product development, CSIR-IHBT, March 16.
- RK Sud, Virendra Singh and Arvind Verma (2015) Mushroom cultivation awareness camp for the farmers of TECHVIL area at Mushroom Farm of State Horticulture Department, 15 participants, Palampur, March 25.

Entreprenwurship Development Workshop on Functional Food at IHBT- CeHAP, Tandi, Lahual & Spiti on August 27, 2014

Training programme for rural women on Candy Making at CSIR-IHBT, June 3-6, 2014

Training programme for rural women on Bamboo candy making at CSIR-IHBT, September 10, 2014

Setting up of Demonstration Plots

A demonstration plot of marigold was established in the farmers field (Shri Hari Singh, VPO: Gopalpur, Tehsil: Palampur: Kangra) on 28th July, 2014. 1000 plants of cv. Pusa Narangi were planted in the area of 50 sq mtr.

A demonstration plot of marigold was established in the farmers field (Shri Vipin Kumar Sharma, VPO: Chachiyan/ Nagri, Tehsil: Palampur: Kangra) on August 11, 2014. 1000 plants of cv. Pusa Narangi were planted in the area of 50 sq mtr.

A demonstration plot of marigold was established in the farmers field (Shri Vikas Singh, VPO: Bagoda, Tehsil: Palampur: Kangra), March 31, 2015. 1000 plants of cv. Pusa Narangi were planted in the area of 50 sq mtr.

A demonstration plot of marigold was established in the farmers field (Shri Akshay Kumar, VPO: Gopalpur, Tehsil: Palampur: Kangra), August 11, 2014. 1000 plants of cv. Pusa Narangi were planted in the area of 50 sq mtr.

Demonstrating pinching in Marigold at farmers field

Visit to farmers field

Interaction with Dr. Jitendra Singh, Minister of State for Prime Minister's Office, Personnel, Public Grievances and Pensions, Govt. of India during National Seminar-cum-exhibition on Kissan Mela, Entrepreneurship Programme, Flower Show: Rural Prosperity through MAPS organized by CSIR-Indian Institute of Integrative Medicine, Jammu, J&K, March 15, 2015 (Exhibitors: Dr(s) Rakesh Kumar, Sanat Sujat Singh, Shashi Bhushan and Sanjay Kumar)

Training Programme

Training cum demonstration on "Cultivation and post harvest technologies of cut flower crops" was imparted to rural community participants from Rohru Block, Shimla (H.P.) on February 9-11, 2015. Participants: 35, Coordinator Dr. Bhavya Bhargava

Training and demonstration at CSIR-IHBT

Exposure Visit to Farmers Field

Exhibition participation

Occasion	Theme	Exhibitor	Date
CSIR-CIMAP, Tech village Dau, Lucknow	Health Mela	Dr. Mahesh Gupta	August 14, 2014
J&K aroma Festival 2014 at Kathua, Jammu	Aroma Festival	Dr(s) Rakesh Kumar, Sanat Sujat Singh, Shashi Bhushan and Sanjay Kumar	August 16, 2014
3rd Science Expo-2015	CSIR-IHBT technologies and products	Dr Bhavya Bhargava	September 18-20, 2014

Indo-Norwegian meet, India Expo Centre, Greater Noida.	Food and Bio based Science, Technology and Innovation	Dr. Mahesh Gupta	November 21, 2014
Avishkar Expo: The Rural Technologies Fair 2014, Kangra	CSIR-IHBT technologies and products for farmers and entrepreneurs	Dr Bhavya Bhargava	December 14-16, 2014
Mahashivratri Mela, Mandi, HP	CSIR-IHBT technologies and products for farmers and entrepreneurs	Sh. Randeen Prasad and Dr. Ajay Rana	February 17-20, 2015
National Seminar – cum-exhibition on Kissan mela, Entrepreneurship programme, Flower Show: Rural Prosperity through MAPS	CSIR-IHBT technologies and products for farmers and entrepreneurs	Dr Bhavya Bhargava	March 15-16, 2015

Release of new cultivar 'Him Stevia' of *Stevia rebaudiana* along with Technical brochure

Contributors: Dr. Ashok Kumar, Dr. Sanatsujat Singh, Dr. Bikram Singh, Dr. R.K. Sharma, Smt. Vijaylata, Dr. Anil Sood and Dr. P.S. Ahuja

Release of Gerbera cultivars 'Him Glow' and 'Him Peace'

The selections IHBT-Gr-23-1 and IHBT-Gr-E-3 performed well under polyhouse conditions over two years and have been released as new cultivars of gerbera namely 'Him Glow' (IHBT-Gr-23-1; yellow flower colour RHS 16C; derived from the cross IHBT-Gr-2 X IHBT-Gr-3) and 'Him Peace' (IHBT-Gr-E-3; white flower colour RHS 155D an acyanic genotype and is advanced progeny line from cross IHBT-Gr-1 X IHBT-Gr-7) which are complete double flower types and have high micro-propagation potential for commercial utilization.

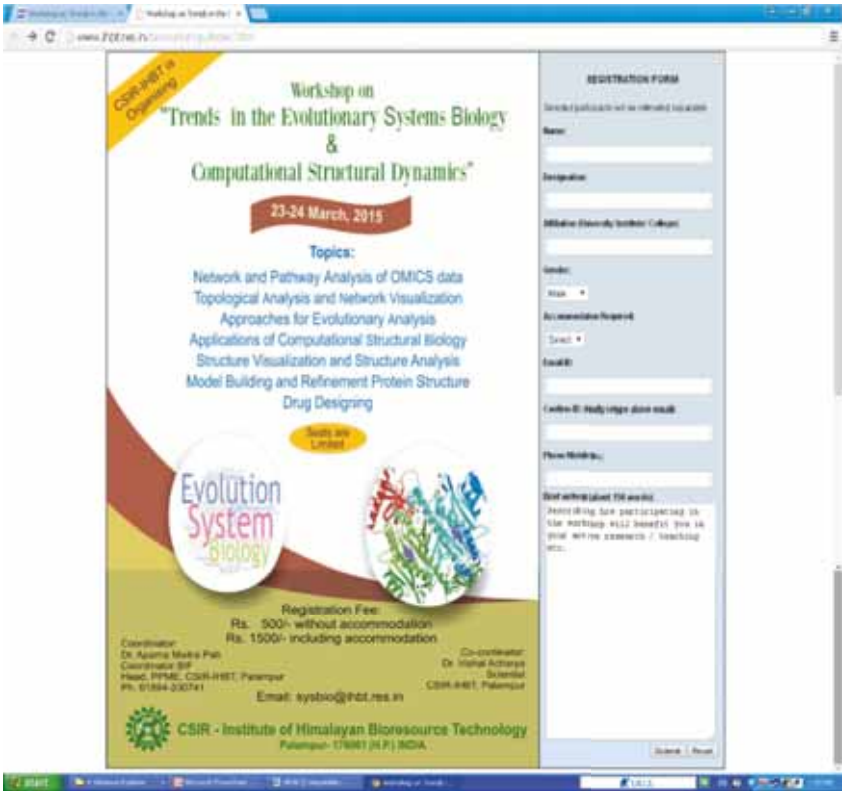
TePP Outreach cum Cluster Innovation Centre (TOCIC) at CSIR-IHBT, Palampur

TePP Outreach cum Cluster Innovation Centre (TOCIC) of DSIR, New Delhi was set up at the Institute for promotion of their scheme "Promoting Innovations in Individuals, Start-ups and MSMEs (PRISM) in Himachal Pradesh and adjoining area. For publicity of the scheme in the region, a webpage was designed and placed in the Institutes website (www.ihbt.res.in/PRISM). A brochure was printed and widely circulated during exhibitions, meetings and training programmes among the potential stakeholders. The news of setting up of the centre was published in two online papers and six dailies of Hindi and English. Advertisement for inviting proposals was sent in 11 issues of different Hindi and English dailies. A total of 8 workshops/outreach camps conducted in the region at Palampur, Kangra, Ghumarwin, Hamirpur, Bilaspur Shimla and Solan in Himachal Pradesh and at Amritsar and Batala in Punjab. Similarly, 12 MSME clusters located at Amritsar and Batala in Punjab were contacted and made aware of the scheme. A total of 9 project proposals, 4 under Category-1 and 5 under Category-2 of PRISM Phase-I scheme, were received which were in different stage of evaluation.

Planning
Patents, Publications, Human Resources and Publicity

PLANNING PROJECT MONITORING & EVALUATION CELL

- Compiled information for CSIR-IHBT and CSIR annual report. Report on significant achievements of the institute were sent to CSIR Headquarters on monthly basis.
- Developed webpage for workshop on "Trends in the Evolutionary Systems Biology & Computational Structural Dynamics (23-24 March 2015)" for online registration of participants.



- Organized "Faculty Training and Motivation Programme for School Teachers" during 16-17 October, 2014. 22 teachers participated.
- To facilitate purchase process, a web enabled programme developed for creating Rate Contract Proposal (Store) and their respective purchase order.
- Developed programme using VB.NET and SQL Server 2008 R2 for DRR entry and DRR report.
- Information of 12 completed projects were included in the compendium. It now has information of 174 Projects along with their outputs.
- The cell recorded initiation of 18 new projects funded by various agencies.
- Carried out monitoring of institutional performance w.r.t publication, ECF patent, and technology transfer.

- As a part of routine activity carried out maintenance of database and regularly updated information pertaining to project, staff, paper, patent, ECF, royalty, MoU, resource management etc.
- Conducted 51st Meeting of Research Council of IHBT, Palampur on 9th June 2014.
- Handled queries for project training and facilitated training of 49 students as winter and summer trainees in different divisions of the institute.
- To nurture scientific temper among young children the cell organized visit of students from schools and colleges.
- Furnished information on 16 cases under RTI Act and filed quarterly report to RTI portal www.rti.gov.in
- Organized National Technology Day, IHBT Foundation Day, CSIR Foundation Day and National Science Day celebrations on behalf of the Institute.
- Regularly updated information in CSIR-IHBT website and intranet.

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Yadav AK, Singh S and Bhardwaj G (2014) Nuclear DNA content and genome size estimation of Stevia rebaudiana using flow cytometry. *Minerva Biotec*, 25(3):1-6.

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Yadav R, Kumar D, Kumari A and Yadav SK (2014) Encapsulation of podophyllotoxin and etoposide in biodegradable poly-d, l-lactide nanoparticles improved their anticancer activity. *Journal of Microencapsulation*, 31(3): 211-219.

Book(s)/Book Chapter

Agnihotri VK (2014) Terpenoids and Phenylpropanoids from Useful Medicinal/Aromatic Plants LAP LAMBERT Academic Publishing, Saarbrücken, Germany, (ISBN-3659477834) pp288.

Ahuja PS, Lal Brij and Singh S (2015) Medicinal and Aromatic Plants for Livelihood Enhancement. *In*: *Technologies for Livelihood Enhancement* (Ed. VL Chopra) ISBN-10: 9383305819, New India Publishing Agency, New Delhi.

Rana RK, Singh A, Singh V, Sharma LK, Devi R, Katoch P and Lal M (2014) Seabuckthorn (Hippophae L.) propagation and plantation is a new avenue to farmers and future scope of cultivation in Cold Desert area of Himachal Pradesh, INDIA. IN: *Seabuckthorn (Hippophae L.) A multipurpose wonder plant* (Singh, Virendra; Yang Baoru; Choudhary Sonika; Morsel Jorg-Thomas; Zubarev Yury A.; Mohini K.; Singh, Sonika; Sharma, V.K.; Rana, R.K. and Lal Manohar. Eds.) Vol. IV. Emerging Trends in Research Technologies. pp. 59-71. Daya Publishing House New Delhi.

Sharma A, Singh V, Lal M, Singh A and Dixit SP (2014) Status of soil nutrients under Seabuckthorn (Hippophae rhamnoides) vegetation in Lahaul valley, Himachal Himalayas. IN: *Seabuckthorn (Hippophae L.) A multipurpose wonder plant*. Vol. IV. Emerging Trends in Research Technologies. pp. 521-532. Daya Publishing House New Delhi.

Singh RD, Sud RK and Pal PK (2014) Integrated weed management in plantation crops. *In*: *Recent Advances in Weed Management* (Eds. Bhagirath Singh Chauhan and Gulshan Mahajan). Springer, New York.

Ugir Hossain Sk, Kojima (2015) Dendrimers for Drug Delivery of Anticancer Drugs. Frontiers in Clinical Drug Research- Anti Cancer Agents, (Ed. Atta-ur-Rahman), Vol. 2, P3-25; Bentham Science Publishers.

Sequence data submitted

Guleria S, Kumari R, Bharti M, HallanV and Nadda G (2014) Polyhedrin gene of nucleopolyhedrovirus(NPV) amplified from *Helicoverpa armigera* (Accession No. LK031772.1).

TRAINING IMPARTED

Forty nine students from different Institutes/ Universities:

- Amity University, Jaipur
- Amity University, Noida
- ARNI University, Kathgarh, Kangra (H.P.)
- Baba Ghulam Shah Badshah University, Rajouri (J&K)
- Beant College of Engineering & Tech, Gurdaspur (PB)
- CCT, Rajasthan University, Rajasthan
- Central University Himachal Pradesh, Dharamshala
- College of Agriculture Biotechnology, MKV, Parbhani (MP)
- Dr. BR Ambedkar National Institute Technology, Jalandhar
- E-Max Group of Institutions, Ambala
- GSS Indraprastha University, New Delhi

- Guru Nanak Dev University, Amritsar
- Gurukula Kangri Vishwavidyalaya, Haridwar
- Indian Institute of Technology, Guwahati
- Institute of Integrated Himalayan Studies, Himachal Pradesh University, Shimla
- Maharishi Markandeshwar Unviersity, Mullana, Ambala
- Panjab University, Chandigarh
- Punjab Institute of Technology, PTU, Kapurthala
- Punjabi University, Patiala
- Sam Higginbottom Institute of Agriculture, Tech & Sci., Allahabad
- School of Bio Sciences and Technology, VIT University, Vellore, Tamil Nadu
- Shaheed Udham Singh College, Mohali (Pb.)
- Shoolini University, Solan
- Sri Sai University, Palampur
- SRM College of Pharmacy, Kattankulathur, Tamilnadu
- Thapar University, Patiala

Conference/Training/Workshop Organised

Reddy SGE. (2014) Imparted training to farmers/ stake holders on Insect pest management of stevia under the training programme entitled "Improved production technologies for natural sweetener plant stevia", May 1-2.

Reddy SGE. (2014) Imparted training to Industry people from Mumbai (Maharashtra) on Insect pest management of stevia on 6th June under the training programme entitled "Improved production technologies for natural sweetener plant stevia", June 6-7.

Kumar Amit (2014) Integrated drainage morphometry, RUSLE and landscape patch analysis for characterization and prioritization of Baner river watershed in Kangra region of Himachal Himalaya using geo-informatics (pp44). Proceedings on national workshop on status of natural hazards in Himachal Pradesh (NHHP-14), Central University of Himachal Pradesh, Sahpur, November 6-8.

Lal Brij (2014) Organized National Conference on "Modern Approaches to Pteridophytes: Biology, Biodiversity", Bioresource, 70 participants, December 20-21.

Lal Brij (2014) Imparted training two months training in the areas of biodiversity conservation and documentation of ethnobotanical knowledge to two M.Sc. students from a GGS Indraprastha University, New Delhi.

Pati Aparna Maitra & Acharya Vishal (2015) Organized workshop on "Trends in the evolutionary system biology and computational structural dynamics", 15 participants, March 23-24.

Conference/Training/Workshop attended

Kumar Rakesh (2014) Project advisory committee meeting on Agrometeorological Research DST, New Delhi Orissa Engineering College, Bhubneswar, Orissa, April 28-29.

Singh Virendra (2014) Mountain Agriculture Assistance Service (MAAS) - lunch meet on collaboration for climate adaptation in mountain agriculture. India Habitat centre, New Delhi, August 7.

Kumar R, Sharma, S, Sharma M and Singh, B (2014) Status of damask rose (*Rosa damascena* Mill.) research and production in Indian Western Himalayas (Oral presentation p34). *In*: 1st Himachal Pradesh Science Congress, Shimla, HP, September 15-16.

Singh RD, Gopichand, Vats SK, Ogra RK, Gulati Arvind, Sood Anil, Pawar RR, Singh Jaspreet, Bhatnagar Sharad, Jaryan Vikrant, Meena RL, Singh Ranjeet, Parkash Om, Goel Rakesh, Singh AK and Ahuja PS (2014) Revegetation of muck dumping sites in Indian Himalayan region (Abstract no. 455, pp248).. 11th International Phytotechnologies Confrence Heraklion, Crete, Greece, September 30 to October 3.

Kumar Rakesh and Sharma RK (2014) 1st Himachal Pradesh Science Congress on Role of Science & Technology in Sustainable Development at Hotel. Peterhoff Shimla, HP Science and Technology Department, October 15-16.

Reddy SGE (2014) IIIrd International Conference on Agriculture & Horticulture Sciences, Hyderabad International Convention Centre (HICC), Hyderabad, Andhra Pradesh, India, October 27-29.

Kumar Rakesh (2014) National Discussion meeting on modelling and projections for spices, aromatic and medicinal plants, coffee and tea. CMMACS, Bangalore, Karnataka, CSIR-CMMACS, Bangalore, August 26 and October 27-28.

Singh Virendra and Sud RK (2014) Presentation of a R&D project proposal on Agricultural forest farming for sustenance of Indian western Himalayan ecosystem before Technical Advisory Expert Committee Meeting. DST TIME-LEARN Programme. Wildlife Institute of India, Deharadun. October 27.

Reddy SGE (2014) Chemical composition and larvicidal activities of *Zanthoxylum armatum* against diamondback moth, *Plutella xylostella*. by S.G. Eswara Reddy, Vishal Kumar, Urvashi Chauhan and Neeraj Kumar. *In*: 3rd International Conference on Agriculture and Horticulture Sciences, Hyderabad, India, October 27-29.

Pati Aparna Maitra (2014) NKN Conference. IIT Gowahati from November 15-17.

Bhargava B (2014) Good agronomic practices of lilium and carnation. Modern nursery and cultivation techniques of flowers, medicinal and aromatic crops under protected conditions, CSIR-IHBT, Palampur, November 26-28.

Kaundal M, Kumar, R, Vats SK and Kumar S (2014) Effect of elevated CO2 and temperature on growth and biomass accumulation of *Rumex nepalensis* (Summary, pp727-728). *In* extended summary of "National Symposium on Agricultural Diversification for Sustainable livelihood and Environmental Security", Punjab Agricultural University, Ludhiana (Punjab), November 18-20.

Sharma S, Kumar R and Singh B (2014) Post harvest drying affects Steviol Glycosides in Stevia (*Stevia rebaudiana* Bertoni): extended summary (pp.852-853). *In*: National symposium on Agricultural Diversification for Sustainable livelihood and Environmental Security, Punjab Agricultural University, Ludhiana, November 18-20.

Pati Aparna Maitra (2014) Project Proposal Meeting, DSIR, New Delhi on December 4.

Gupta Mahesh (2014) Participated in Indo-UK delegation on "Food Processing Technologies", CIAB, Mohali, December 9.

Kumari Anika, Gupta Neha, Kumari Alka, Nadda Gireesh, Lal Brij, Singh Bikram (2014) Insecticidal activities of ferns of Western Himalaya Poster presentation. p91. *In*: National Conference on Modern Approaches to Pteridophytes: Biology, Biodiversity and Bioresource, CSIR-Institute of Himalayan Bioresource Technology, Palampur, India, December 20-21.

Lal Brij, Kumari Alka, Sharma Priyanka, Prakash Om, Kumar Amit, Gopichand and Singh RD. (2014) Lungru (*Diplazium maximum* (D.Don) C.chn.)– A livelihood of the native people of western Himalaya (pp50-51). National Conference on Modern Approaches to Pteridophytes; Biology, Biodiversity and Bioresource. CSIR-IHBT Palampur, HP, December 20-21.

Nadda Gireesh (2014) National Conference on Modern Approaches to Pteridophytes: Biology, Biodiversity and Bioresource, CSIR-Institute of Himalayan Bioresource Technology, Palampur, India, December 21-22.

Reddy SGE (2014) National Conference on Modern Approaches to Pteridophytes: Biology, Biodiversity and Bioresource, CSIR-Institute of Himalayan Bioresource Technology, Palampur, HP, India, December 20-21.

Banerjee Arghadyuti, Kumari Alka, Lal Brij and Kumar Amit (2014) Using geospatial techniques for mapping of potential distribution of *Diplazium esculentum* (Retz.) Sw. in Kangra region of Himachal Pradesh (p41). Proceeding on national conference on modern approaches to Pteridophytes: Biology, Biodiversity and Bioresources, CSIR-IHBT, Palampur, HP, December 20-21.

Gupta YC and Bhargava Bhavya (2015) Protected cultivation of flowers in hilly region. *In*: National seminar on Hi tech Horticulture for enhancing productivity, quality and rural prosperity. pp23-28. ICAR-National Research Centre on Seed Spices. Organized by Indian Society of Seed Science, Ajmer and Indian Society for protected cultivation, Tabiji, Ajmer, Rajasthan, January 19-20.

Pati Aparna Maitra (2015) 26th BTISnet Annual Coordinators Review MeetingNational Education Summit. DBT-Tirupati, AP, February 3-4.

Nadda Gireesh (2015) A 6 days training programme on "Pest Risk Analysis" Organized at National Institute of Plant Health Management, Hyderabad, February 16-20.

Bhargava B and Kumar S (2015) International Symposium on Commercial Floriculture and Landscape Gardening for Urban and Peri-Urban Horticulture, Horticulture Association of India (CHAI), New Delhi and Media Today group., Sector 34, Exhibition Ground Chandigarh, February 21-22.

Gupta Mahesh (2015) National Workshop on "The Art and Science of Scholarly Communication: Writing Better papers" at DAV University, Jalandhar on March 14.

Nadda Gireesh (2015) Tea Workshop on "Strategies for Mechanization of Tea Farm Operations in Kangra Valley", CSIR-IHBT, Palampur, March 14.

Bhargava B (2015) Protected Cultivation of Flowers in Hilly Regions. National Seminar –cum-exhibition on Kissan mela, Entrepreneurship programme, Flower Show: Rural Prosperity through MAPS , CSIR-Indian Institute of Integrative Medicine, Jammu, J&K, March 16.

Singh Bikram, Kumar Rakesh, Kumar Neeraj and Sharma RK (2015) International Conference on Medicinal and Aromatic Plants. CIMAP, Lucknow, UP, March 20-22.

Sharma S, Kumar R and Singh B (2015) Dynamics of steviol glycoside and biomass production under

different harvest regimes of *Stevia rebaudiana* Bertoni in western Himalayas (Poster, p30). *In*: International Conference on Medicinal and Aromatic Plants (ICOMP), CSIR-CIMAP, Lucknow, UP, March 20-22.

Thakur D and Chawla A (2015) Functional characteristics of west Himalayan treelines (Abstract). Cryobiotech 2015. *In*: International conference on Low Temperature Science and Biotechnological Advances, NASC Complex, New Delhi, India, April 27-30.

Conference/Training/Workshop Presentations

Reddy SGE, Kumar V, Bhardwaj A, Dolma SK and Kumar N (2014) Larvicidal activity and structure activity relationship of Cinnamoyl amides from *Zanthoxylum armatum* and their synthetic analogues against the diamond back moth, *Plutella xylostella* (Oral Abstracts p125) In: Proceedings of IIIrd International Conference on Agriculture & Horticulture Sciences, Hyderabad International Convention Centre (HICC), India, October 27-29.

Dadwal Vikas, Gupta Mahesh and Sood Anil (2014) Characterization of shoots of *Dendrocalamus Hamiltonii* and *Bambusa tulda* for food purposes. 13th ICFRE Silviculture Conference, FRI, Dehradun, Uttarakhand, November 25-26.

Bhargava Bhavya (2014) Good agronomic practices of Lilium and Carnation Modern nursery and cultivation techniques of flowers, medicinal and aromatic crops under protected conditions. CSIR-IHBT, Palampur, November 26-28.

Rathore S, Chauhan S, Kumar M, Sud RK (2014) Tropical Ecology Congress 2014- Quantifying carbon density for tea plantation at Palampur, Himachal Pradesh (Abstract). *In*: Tropical ecosystem in a changing world at J.N.U., New Delhi, December 10-12.

Kumari Madhu, Padwad Yogendra S and Gupta Mahesh (2014) Identification of probiotic from traditional fermented food for gut health. ICFOST-XXIII Conference, AFST (I) Mysore, Karnataka, December 13-14.

Sood Ankita, Dwivedi JP and Gupta Mahesh (2014) Characterization of whole pomegranate as a functional food ingredients. ICFOST- XXIII Conference, AFST (I) Mysore, Karnataka, December 13-14.

Verma M, Wali A, Dhadwal S, Lal B, Kumari A, Sinha AK, Agnihotri VK (2014) Comparative Estimation of Natural Colors and Dyes from some Selected Pteridophytes Growing in Western Himalayas (p72-73). *In*: National Conference on Modern Approaches to Pteridophytes: Biology, Biodiversity and Bioresource, CSIR-IHBT, Palampur, HP, India, December 20-21.

Wali A, Walia M, Thakur S, Lal B, Kumari A, Agnihotri VK (2014) Comparative Antioxidant Activity of *Diplazium esculentum* and *Diplazium maximum* Growing in Western Himalayas (p74). *In*: National Conference on Modern Approaches to Pteridophytes: Biology, Biodiversity and Bioresource, CSIR-IHBT, Palampur, HP, India, December 20-21.

Dolma SK, Kumari A and Reddy SGE (2014) Repellent activity of fern extracts against tobacco caterpillar, *Spodoptera litura* (Poster P-8.6, p91-92). In: National Conference on Modern Approaches to Pteridophytes: Biology, Biodiversity and Bioresource, CSIR-IHBT, Palampur, December 20-21.

Kumari Anika, Gupta Neha, Kumari Alka, Nadda Gireesh, Lal Brij, Singh Bikram (2014) Insecticidal activities of ferns of Western Himalaya (Poster presentation) p91. *In*: National Conference on Modern Approaches to Pteridophytes: Biology, Biodiversity and Bioresource, CSIR-Institute of Himalayan

Bioresource Technology, Palampur, India, December 21-22.

Jha Ashwani, Clancy Jennifer, Preiss Thomas and Ravi Shankar (2014) Novel to Reference Free miRNA Discovery: NGS powered miRNA discovery with miR-BAG and miReader (Poster). 35th Annual Lorne Genome Conference 2014 held in Lorne, Victoria, Australia, February 16–18.

Bhavya Bhargava (2015) Protected Cultivation of Flowers in Hilly Regions. National Seminar –cum-exhibition on Kissan mela, Entrepreneurship programme, Flower Show: Rural Prosperity through MAPS at CSIR-Indian Institute of Integrative Medicine, Jammu, J&K, March 16.

Invited Lectures from CSIR- IHBT

Dr. Sudesh Kumar Yadav (2015) Synthesis and characterization of nanocomposites of natural bioactives. International Conference-Asian Network for Natural and Unnatural Materials (ANNUM-3) at Punjab University, Chandigarh, February 28 and March 2.

Dr. Bikram Singh (2015) Chemical prospection of alkaloids bearing medicinal plants. International Conference on medicinal plants: resource for affordable new generation healthcare, CSIR-CIMAP, Lucknow, March 20-22.

Dr. Sudesh Kumar Yadav (2015) Green nanotechnology for food, agriculture and therapeutics. Chemistry Division, BARC, Mumbai, March 25.

Guest Lectures delivered at CSIR-IHBT

Dr. Ingolf Kühn, Professor for Macroecology at the Martin-Luther University Halle-Wittenberg, Dept. Community Ecology, Centre for Environmental Research, Halle, Germany delivered a talk on “Patterns of Alien Invasions in Europe" on 2 April 2014.

Dr. Anjil Kumar Srivastava, Postdoctoral Research Scientist, Department of Biological & Biomedical Sciences, Durham University, UK delivered seminar on "Short hypocotyl in white light1 interacts with constitutive photomorphogenic1 and enhances its e3 ligase activity to regulate the photomorphogensis in arabidopsis" on 13 June 2014.

Er. Rakesh Nigam, Team Auditor, ISO 9001:2008 delivered talk on "Vedic. Math" on 16 June 2014.

Prajapita Brahma Kumari, A Lecture on "Addiction free and stress free life" delivered Doctors of Prajapita Brahma Kumaries Ishwariya Viswa Vidyalaya on 30 June 2014.

Dr. Suvro Chatterjee from Vascular Biology Lab, AU-KBC Research Centre, MIT Campus, Anna University, Chennai, Tamil Nadu delivered a talk on the topic entitled “Nitric oxide as an antidote to thalidomide mediated teratogenecity” on 16th March, 2015.

Dr. Mahipal Singh, Associate Professor of Animal Biotechnology, Fort Valley State University, GA delivered a lecture on the topic entitled "Postmortem cellular life in mammals" on March 19, 2015.

VISITS ABROAD

Dr. Dinesh Kumar and Shri Shiv Kumar: Attended training on Advance spectrometers at Bruker BioSpin AG, Fallanden, Switzerland, July 22-26, 2014.

Dr. RD Singh: Attended the 11th Conference on Phyto Pathologies at Herklion, Crete, Greece, October 1-3, 2014.

MEMORANDUM OF UNDERSTANDING (MoU)

Sno	Date	Agreement with	Purpose
1.	April 21, 2014	M/s AB Scientific Solutions, Palampur	Establishment of Functional Essential Oil Distillation Unit
2.	May 1, 2015	M/s Mahindra Investment (International) Pvt. Ltd. having its registered office at Plot 02, Phase IX Industrial area, Mohali (Pb)	For the production of hardened and disease free tissue culture raised plants of potato varieties
3.	May 28, 2014	M/s Dev Lakshmi Narayan Enterprises, having its Head office at Village Bashing, PO - Babeli, Distt Kullu - 175 141 (HP)	Establishment of functional essential oil distillation unit
4.	July 7, 2014	M/s Krishant Multitrade Pvt. Ltd., MALAD, Mumbai	Technology for production of Ready To Drink Tea and Tea Wines
5.	July 7, 2014	M/s Baijnath Pharmaceuticals, Paprola (H.P.)	Technology for Catechins and Theaflavins production from tea leaves
6.	March 18, 2015	The Unati Co-Operative, Marketing cum processing society ltd. and having their registered office at 5 KM, Talwara Milestone, New Mukerian Hydel Power House No. 1, G.T.Road, Talwara, The-Mukerian, Distt Hoshairpur, Talwara, Pb 144216	To develop suitable strategies for identifying the plant varieties, farmer groups, regions, trainings, modules and extraction processes as a means of value addition to ensure their commercial sale

AWARDS/ HONOURS/RECOGNITIONS

Dr. Sanjay Kumar received the prestigious VASVIK (Vividhlaxi Audyogik Samshodhan Vikas Kendra) award for the year 2013 in the field of agricultural science and technology for his work on industrial enzymes, plants in cold desert at high altitude, improving the photosynthesis rate, stress tolerance and yield of plants in a function held at Bhaidas auditorium, Mumbai.

Dr. Paramvir Singh Ahuja, Director General, CSIR received the Birbal Sahni Birth Centenary Medal and Birbal-Savitri Sahni Foundation Honour by Birbal Sahni Foundation.

Dr. Paramvir Singh Ahuja elected as Honorary Fellow of Indian Fern Society.

Dr. Anil Sood elected as Fellow of the Indian Fern Society.

Dr. Sudesh Kumar selected by Haryana State Council for Science and Technology for Haryana Yuva Vigyan Ratna Award for his excellent research contributions. Award conferred by Chief Minister of Haryana.

Shri Naresh Kumar nominated for Best Book Award - 2012 in Hindi for "Mann Gaon Chhorna Nahi Chahti" by J&K Academy of Art, Culture & Languages.

Membership

Dr. Rakesh Kumar Sud nominated as a member of the Innovation and Entrepreneurship Development Centre of DST at NIT Hamirpur, HP.

Best Poster Award

Shri Munish Kaundal, Dr. Rakesh Kumar, Dr. Surendra Kumar Vats and Dr. Sanjay Kumar best poster award for "Effect of elevated CO_2 and temperature on growth and biomass accumulation of *Rumex nepalensis*", in the National symposium on Agricultural Diversification for Sustainable livelihood and Environmental Security held at Punjab Agricultural University, Ludhiana on November 18-20, 2014.

Evaluator/ Judge

Dr. Bhavya Bhargava elected judge for Flower Show organized by CSIR-Indian Institute of Integrative Medicine, Jammu, J&K, March 15, 2015.

RESEARCH COUNCIL

Prof. Samir Bhattacharya Former Director, CSIR-IICB, Kolkata Emeritus Professor NASI and Sr. Scientist School of Life Sciences, Visva Bharati (A Central University) Santiniketan- 731 235	**Chairman**
Members	
Prof. Bharat B. Chattoo Professor & Coordinator Biotechnology Programme, Genome Research Centre Dept. of Microbiology and Biotechnology Centre MS University of Baroda, Baroda - 390002	**Prof. Alok Bhattacharya** Professor School of Life Sciences & Computational and Integrative Sciences Jawaharlal Nehru University, New Delhi- 110067
Dr. N. Sathyamurthy Director Indian Institute of Science Education & Research Mohali, Knowledge City, Sector 81, SAS Nagar Manauli PC - 140306	**Prof. S. K. Sharma** Former Vice Chancellor CSK -H.P. Krishi Vishwavidyalaya Shanti Kunj, Ghuggar Tanda, Palampur- 176061
Prof. Narpinder Singh Professor Dept. of Food Science & Technology Guru Nanak Dev University, Amritsar - 143005	**Prof. Sandeep Verma** Department of Chemistry Centre for Environmental Sciences and Engineering Indian Institute of Technology, Kanpur - 208016
Dr. Renu Swarup Adviser, Ministry of Science & Technology, Department of Biotechnology, Government of India Block-2, 7th Floor, CGO Complex, Lodhi Road, New Delhi-110003	**Dr. Imran Siddiqi** Chief Scientist CSIR-Centre for Cellular and Molecular Biology Uppal Road, Hyderabad – 500007
Dr. Ram A. Vishwakarma Director CSIR-Indian Institute of Integrative Medicine, Canal Road, Jammu – 180001	**Prof. Siddhartha Roy** Director CSIR-Indian Institute of Chemical Biology 4, Raja SC Mullick Road, Jadavpur Kolkata - 700032
Dr. Jai Rup Singh Founder Vice Chancellor, Central University of Punjab, Bathinda Former Vice Chancellor, GNDU, Amritsar Former President, Indian Society of Human Genetics # 52, Sector 63, Mohali 160 062, India	**Dr. Sudeep Kumar** Planning & Performance Division (PPD) Council of Scientific & Industrial Research Anusandhan Bhawan, 2, Rafi Marg New Delhi-110 001
Dr. P.S. Ahuja Director CSIR-Institute of Himalayan Bioresource Technology Post Bag No.6 Palampur-176 061 (H.P.)	**Dr. Aparna Maitra Pati (Member Secretary)** Scientist & Head Planning Project Monitoring & Evaluation CSIR-Institute of Himalayan Bioresource Technology Post Bag No.6, Palampur-176 061 (H.P.)

MANAGEMENT COUNCIL

Chairman	
Dr. PS Ahuja Director CSIR-IHBT, Palampur, HP	
Members	
Dr. Ram A Vishvakarma Director CSIR-IIIM, Jammu, J&K	Dr. Sanjay Kumar Sr. Principal Scientist CSIR-IHBT, Palampur, HP
Dr. Aparna Maitra Pati Principal Scientist CSIR-IHBT, Palampur, HP	Er. GD Kiranbabu Principal Scientist CSIR-IHBT, Palampur, HP
Dr. Sudesh Kumar Sr. Scientist CSIR-IHBT, Palampur, HP	Dr. Yogendra Padwad Scientist CSIR-IHBT, Palampur, HP
Sh. Mukhtiar Singh Principal Technical Officer CSIR-IHBT, Palampur, HP	Sh. Ishwar Dass Finance & Accounts Officer CSIR-IHBT, Palampur, HP
Member Secretary	
Sr. JK Parashar Administrative Officer CSIR-IHBT, Palampur, HP	

THESIS/ DISSERTATION/ REPORT/ SUPERVISED

Sl.No.	Name	Title of Thesis/ Dissertation/ Project	Supervisor	University / Institute
Ph. D.				
1.	Praveen Kumar Verma	Synthesis of metal phthalocyanine complexs and their catalytic applications in reduction reactions.	Dr. Bikram Singh.	AcSIR, New Delhi
2.	Monika Mahajan	Genetic engineering of flavonoid pathway through gene over-expression and silencing approaches in tobacco (*Nicotiana tabacum* L.)	Dr. Sudesh Kumar Yadav	GNDU, Amritsar
3.	Praveen Guleria	Functional evaluation of steviol glycoside biosynthesis genes from *Stevia rebaudiana* by combined approach of gene silencing and overexpression	Dr. Sudesh Kumar Yadav	AcSIR, CSIR-IHBT
4.	Ramdhan	Development of nanocomposites of bioactive molecules	Dr. Sudesh Kumar Yadav	AcSIR, CSIR-IHBT
5.	Ajay Rana	Exploration of major phytochemicals and development of value added products from underutilized parts of *Camellia sinensis* (L.) O. Kuntze	Dr. Ashu Gulati	AcSIR, CSIR-IHBT
6.	Akshay Nag	development of genomic resources and genetic diversity characterization of indian himalayan populations of *Podophyllum hexandrum* Royle	Dr Ram Kumar Sharma	AcSIR, CSIR-IHBT
7.	Rajesh Kumar	Development of green synthetic methodologies for S-S, C-S and C-C bond forming reactions and their mechanistic studies	Dr. Arun Kumar Sinha	AcSIR. CSIR-IHBT
8.	Richa Salwan	Screening, production and molecular characterization of low temperature active and alkaline stable protease from psychrotrophic bacteria	Dr. Arvind Gulati	AcSIR, CSIR-IHBT
9.	Vikrant Jaryan	Distribution characteristics of *Sapium sebiferum* (L.) Roxb: an invasive species in Himachal Pradesh, western Himalaya	Dr. Sanjay Kr. Uniyal and Dr. RC Gupta	Punjabi University, Patiala

B.Tech / B.E.				
9.	Aman Pathania	Production kinetics and estimation of physical properties of some essential oils	Er. G.D. Kiran Babu	Amity University, Jaipur
10.	Suraj Prakash	Extraction of natural flavour and fragrances	Er. G.D. Kiran Babu	Beant College of Engineering & Tech, Gurdaspur (Pb)
11.	Rohit Choudhary	Web based alumni system	Dr. Aparna Maitra Pati and Mr. Jasbeer Singh	E-Max Group of Institutions, Ambala
12.	Alakesh	Molecular characterization of transgenic *arabidopsis thaliana* co-overexpressing key genes of carbon and nitrogen metabolism	Dr. Sanjay Kumar	Indian Institute of Technology, Guwahati
13.	Kanika Sood	Studies on problems associated with field acclimatization of tissue culture raised plants of *Picrorhiza kurrooa* and their biological hardening	Dr. Anil Sood and Dr. Amita Bhattacharya	Shoolini University, Solan
14.	Madhu Thakur	An exposure to in vivo and in vitro techniques used for the safety/ toxicity evaluation of plant molecules	Dr. Vikram Patial	Shoolini University, Solan
15.	Nishant Sharma	The methylation-sensitive amplification polymorphism in dormant and active growth phases of apple	Dr. Anil Kumar Singh	Shoolini University, Solan
16.	Sanya Verma	Characterization of genetic variability in Lavandula officinalis Chaix	Dr. Sanat Sujat Singh	Shaheed Udham Singh College, Mohali (Pb.)
17.	Gaurav Sharma	Studies on SSR Marker Validation and Genotyping in Stevia Rebaudiana)	Dr. Ram Kumar Sharma	Thapar University, Patiala
18.	Davinder Singh	Studies on saffron and fern-two economically important plants of Himalayan region	Dr. Anil Sood	Thapar University, Patiala
M.Sc / M. Tech/ M.Pharma/ MBA				
19.	Sushrut Sharma	Phytochemical Investigation and Docking Approach on Hypolepis polypodioides and Diplazium maximum for preventation and management of metabolic syndrome	Dr. Vijaikant Agnihotri	SRM College of Pharmacy, Kattankulathur, Tamilnadu

20.	Kamini Koundal	Phenolic Profile & Antioxidant Activity of Tea and Tea Products	Dr. Ashu Gulati	ARNI university, Kathgarh, Kangra (HP)
21.	Kusumlata	Over expression and purification of Cucumber mosaic virus (CMV) coat protein (CP) subunits	Dr. Raja Ram and Dr. Vipin Hallan	ARNI University, Kathgarh, Kangra (H.P.)
22.	Tarannum Shaheen	In-vitro development of saffron plants (*Crocus sativus*) using corm as explants	Dr. Anil Sood & Shri Khirod Kumar Sahu	Baba Ghulam Shah Badshah University, Rajouri (J&K)
23.	Rumie Rashid	Validation and characterization of promoter from promoter trap lines	Dr. Ram Kumar Sharma	Baba Ghulam Shah Badshah University, Rajouri (J&K)
24.	Sonam Jaswal	Diversity Characterization of Promising Tea Germplasm from Abandoned Tea Gardens of North-Western Himalayas using SSR Markers	Dr. Y. Sreenivasulu	Baba Ghulam Shah Badshah University, Rajouri (J&K)
25.	Snowber Shafi	Evaluating genes for imparting tolerance to abiotic stress in Arabidopsis thaliana	Dr. Sanjay Kumar	Baba Ghulam Shah Badshah University, Rajouri (J&K)
26.	Gowher Rashid Lone	Molecular Characterization of the Somatomedin B Gene from *Trialeurodes vaporariorum*	Dr. Vipin Hallan	Baba Ghulam Shah Badshah University, Rajouri (J&K)
27.	Anshuman Mittal	Comparative analysis of extraction techniques for purification and estimation of catechins from *Camellia sinensis*	Dr. Ashu Gualti	Baba Ghulam Shah Badshah University, Rajouri (J&K)
28.	Svati Kaushal	Chemical fingerprinting of *Camellia sinensis* cultivated in North-Western Himalayas	Dr. Bikram Singh	BR Ambedkar National Institute Technology, Jalandhar
29.	Swati Mahajan	Chemical fingerprinting of *Stevia rebaudiana* cultivated in North-Western Himalayas	Dr. Bikram Singh	BR Ambedkar National Institute Technology, Jalandhar
30.	Navjot Kaur	Preparation of construct for overexpression of *Brassica juncea* NRT1.1 gene in plants	Dr. Anil Kumar Singh	Guru Nanak Dev University, Amritsar
31.	Priyanka Chambel	Basic plant molecular biology techniques	Dr. Ram Kumar Sharma	Guru Nanak Dev University, Amritsar
32.	Saurabh Chugh	Cloning of pathogen related (PR) gene in pGEMT vector and purification of PR protein	Dr. Vipin Hallan	Guru Nanak Dev University, Amritsar
33.	Manpreet Kaur	Basic plant molecular biology techniques	Dr. Sudesh Kumar	Guru Nanak Dev University, Amritsar

34.	Akhil Singh	Ethnobotanical studies of gaddi tribe of Palampur area, Kangra District H.P.	Dr. Brij Lal	GSS Indraprastha University, New Delhi
35.	Lakhbeer Singh	Biodiversity and remote sensing	Dr. Amit Chawla	Institute of Integrated Himalayan Studies, Himachal Pradesh University, Shimla
36.	Deepika Devi	Biodiversity and remote sensing	Dr. Amit Chawla	Institute of Integrated Himalayan Studies, Himachal Pradesh University, Shimla
37.	Shivani Chauhan	Quantifying carbon density for tea plantations at Palampur, Himachal Pradesh	Dr. Manoj Kumar	Gurukula Kangri Vishwavidyalaya, Haridwar
38.	Shalika Rathore	Quantifying carbon density for tea plantations at Palampur, Himachal Pradesh	Dr. Manoj Kumar	Gurukula Kangri Vishwavidyalaya, Haridwar
39.	Yogeshwar	Micropropagation of economically important bamboos and DNA fingerprinting to check the fidelity of tissue culture raised plants	Dr. Anil Sood	Maharishi Markandeshwar Unviersity, Mullana, Ambala
40.	Romani Koundal	Screening and characterization of endophytes from medicinal plants for antimicrobial activity	Dr. Arvind Gulati	Panjab University, Chandigarh
41.	Naveen Kumar	Basic techniques of molecular biology	Dr. Sudesh Kumar	Punjabi University, Patiala
42.	Priyanka Rani	Worked on expression of polyphenol oxidase gene of tea into *E.coli*.	Dr. Sanjay Kumar	Punjabi University, Patiala
43.	Shilpa Bakshi	Biotechnological exploitation of somatic embryos of *Dendrocalamus hamiltonii*	Dr. Anil Sood	Shoolini University, Solan
44.	Varun Kumar	Biosorption of lead (Pb) ions using *Tagetes minuta* from aqueous solution: equilibrium, kinetics and thermodynamics study	Dr. YB Pakade	Sri Sai University, Palampur
45.	Anshul Kumar Sharma	Fluorescent nanosensors for pesticide detection	Dr. Amitabha Acharya	Amity University, Noida
46.	Devendra Kumar Sharma	Biodistribution and toxicity studies of hybrid nanocomposite material	Dr. Amitabha Acharya	CCT, Rajasthan University, Rajasthan

47.	Aashish Sharma	Studies on creation of genomic resources for diversity characterization	Dr. Ram Kumar Sharma	CCT, Rajasthan University, Rajasthan
48.	Manpreet Saini	Nutritional and functional characteristics of different pomegranate and beetroot extracts	Dr. Mahesh Gupta	Punjab Institute of Technology, PTU, Kapurthala
49.	Jaskaran Singh Saini	Ready to eat prebiotic cereal based new product development by the use of black carrot pomace	Dr. Mahesh Gupta	Punjab Institute of Technology, PTU, Kapurthala
50.	Vijeta Dwivedi	Study on effect of process parameters and pomegranate by-product incorporation on ready to eat extrudates	Dr. Mahesh Gupta	Sam Higginbottom Institute of Agriculture, Tech & Sci., Allahabad
51.	Pramod Kumar	Development of extruded snacks incorporated with green cauliflower leaves using response surface methodology	Dr. Shashi Bhushan	Sam Higginbottom Institute of Agriculture, Tech & Sci., Allahabad
52.	Aditya Sood	Cloning and characterization of growth and development associated genes from *Picrorhiza kurrooa* Royle ex Benth: a medicinal plant	Dr. Som Dutt	School of Bio Sciences and Technology, VIT University, Vellore, Tamil Nadu
53.	Ridhi Sood	Anti-diabetic efficacy of natural plant extract IHBT-PK in streptozotocin induced type 1 diabetic rat model	Dr. Yogendra S. Padwad	School of Biosciences and Technology, VIT University, Vellore, Tamil Nadu
54.	Bandini Rana	Shelf life study of nutritionally rich natural bioresources under different processing and storage conditions	Dr. Mahesh Gupta	Shoolini University, Solan
55.	Shagun Sood	Assessment of employees' view and research environment for better management	Dr. Aparna Maitra Pati	Central University Himachal Pradesh, Dharamshala
56.	Kumari Kshama Awasthi	Study on diversity and distribution of tree species Palampur area, Kangra District, H.P.	Dr. Brij Lal	GSS Indraprastha University, New Delhi
57.	Arun Kachave	Molecular characterization of transgenic arabidopsis thaliana plants co-overexpressing key genes of carbon and nitrogen metabolism	Dr. Sanjay Kumar	College of Agriculture Biotechnology, MKV, Parbhani (MP)

राजभाषा गतिविधियां

साहित्यिक कार्यक्रम

हिमाचल कला संस्कृति भाषा अकादमी, शिमला ने हिमालय जैवसंपदा प्रौद्योगिकी संस्थान, पालमपुर के सहयोग से दिनांक 4 अगस्त 2014 को संस्थान परिसर में राज्य स्तरीय डा. यशवंत सिंह परमार जयंती समारोह का आयोजन किया। इसके अन्तर्गत साहित्यिक संगोष्ठी, कवि सम्मेलन व सांस्कृतिक संध्या का आयोजन किया गया। कार्यक्रम का उद्घाटन संस्थान के कार्यकारी निदेशक, डा. अनिल सूद तथा अकादमी के सचिव एवं निदेशक, भाषा संस्कृति विभाग श्री अरुण कुमार शर्मा ने दीप प्रज्वलन के साथ किया। बिलासपुर से आए कवि व लोक गायक श्री प्रकाश चन्द शर्मा ने सरस्वती वन्दना प्रस्तुत की।

अकादमी के सचिव एवं निदेशक, भाषा संस्कृति विभाग श्री अरुण कुमार शर्मा ने सभी साहित्यकारों का स्वागत करते हुए अकादमी की गतिविधियों की जानकारी प्रदान की तथा डा. परमार की निस्वार्थ समाज सेवा के बारे में बताया। अपने संबोधन में डा. सूद ने कहा कि डा. परमार जैसे व्यक्तित्व की जयंती का आयोजन इस संस्थान में करना एक गौरव की बात है। साहित्यिक संगोष्ठी में डा. ओम अवस्थी की अध्यक्षता में दो शोधपत्रों का वाचन किया गया। पहला पत्र 'राजनीति और संसति का समवायः डा. यशवंत सिंह परमार' विषय पर डा. तुलसी रमण प्रस्तुत किया। उन्होंने अपने पत्र में कहा कि डा. परमार स्वतंत्रता आन्दोलन के अन्तिम चरण में सक्रिय राजनीति में आए और उन्होंने तीन दशकों तक राजनीति में रहते हुए उच्च नैतिकता के साथ राजनीति और संस्कृति का सम्बन्ध कायम किया और हिमाचल निर्माता कहलाए। जिस पर सर्वश्री कमल के प्यासा, कमल हमीरपुरी, डा. गौतम व्यथित, डा. ओम प्रकाश राही, जय देव किरण ने चर्चा की। दूसरा पत्र डा. सुशील कुमार फुल्ल ने पढ़ा। उन्होंने अपने पत्र 'समकालीन हिंदी कहानी–21वीं शताब्दी' में समकालीन हिंदी कहानी में कुछ पुनरावृतियां सामने आ रही हैं। इस विषय पर केन्द्रित परिचर्चा में डा. हेम राज कौशिक, श्री सैणी अशेष, डा. पीयूष गुलेरी, श्री गंगा राम राजी, श्री त्रिलोक मैहरा, श्री सुदर्शन भाटिया ने भाग लिया।

डा. ओम अवस्थी ने अपने अध्यक्षीय भभाषण में कहा कि दोनों पत्र प्रस्तोताओं ने शोधार्थी के साथ–साथ रचनाकार के अपने कर्तव्य को निभाया है। अच्छा इन्सान ही अच्छा साहित्यकार बन सकता है। डा. परमार के बारे में उन्होंने कहा कि सिद्धांत और व्यवहार की एकता ही डा. परमार की विशेषता थी। राजनीति उनकी मंजिल नहीं अपितु कर्म मानकर उसे निभाया।

दोपहर बाद 3.00 बजे कवि सत्र में कविता और गज़ल पाठ हुआ। इस कवि गोष्ठी की अध्यक्षता डा. बरयाम सिंह ने की। उनकी अध्यक्षता में सर्वश्री जयदेव विद्रोही, दीनू कश्यप, रेखा डढवाल, डा ओम अवस्थी, विक्रम मुसाफिर, प्रीतम आलमपुरी, त्रिलोक सुर्यवंशी, अतुल अशुंमाली, यज्ञदत्त शर्मा, शेर जंग चौहान, ध्यान सिंह चौहान, सरोज परमार, कल्याण जग्गी ने अपनी नई कविताओं और गज़लों का पाठ किया। अध्यक्ष महोदय ने भभी अपनी कविता का पाठ किया। निदेशक, भाषा संस्कृति श्री अरुण शर्मा ने भी कुछ कविताएं सुनाई। कवि गोष्ठी का संचालन नवनीत शर्मा ने कविता गज़ल के मध्य गज़लों के माध्यम से किया साथ ही स्वयं भी गज़ल पाठ किया।

हिंदी दिवस समारोह–2014

संस्थान में हिन्दी सप्ताह 2014 का मुख्य समारोह 12.09.2014 को संस्थान के सभागार में आयोजित किया गया। समारोह का संचालन करते हुए पीपीएमई प्रमुख डा अपर्णा मैत्रा पति ने हिन्दी दिवस के आयोजन के उद्देश्य तथा संस्थान की राजभाषा संबन्धी गतिविधियों पर विस्तार से प्रकाश डाला।

संस्थान के मुख्य वैज्ञानिक डा. आर. डी. सिंह ने संसदीय राजभाषा

समिति के निरीक्षण के दौरान किन बातों पर ध्यान देना चाहिए, तथा कहां पर कमियां रह गई हैं तथा कैसे इन्हे सुधारा जा सकता है, के बारे में विस्तार से बताया। उन्होंने संस्थान के कर्मचारियों से निवेदन किया कि वे वैज्ञानिक कार्य को छोड़कर दैनिक काम–काज जैसे टिप्पण, पत्र लेख, रजिस्टर में प्रविष्टि आदि हिंदी में ही करें।

संस्थान के प्रशासन अधिकारी श्री जगदीश पराशर ने कर्मचारियों को राजभाषा संबन्धी आवश्यक निर्देशों की जानकारी दी तथा सभी से निवेदन किया कि वे अपना अधिक से अधिक काम हिंदी में करें। उन्होंने सभी को यह भी जानकारी दी कि संस्थान के सभी कम्प्यूटरों में यूनिकोड डाल दिया गया है तथा अब हिंदी में टंकण संबन्धी समस्या का हल हो गया है तथा सभी अपना कार्य आसानी से हिंदी में कर सकते हैं।

अपने संबोधन में संस्थान के कार्यकारी निदेशक डा. अनिल सूद ने संस्थान की गतिविधियों एवं उपलब्धियों के बारे में विस्तार से बताया। उन्होंने सभी कर्मचारियों से निवेदन किया कि वे शोध कार्य को छोड़कर राजभाषा नीति के अनुपालन के अपना कार्य हिंदी में ही करें। उन्होंने बताया कि जिस प्रकार अन्य मामलों में अनुशासनात्मक कार्यवाही का प्रावधान है उसी प्रकार राजभाषा नीति के अनुपालन की अवहेलना के लिए भी अनुशासनात्मक प्रावधान है। परन्तु संस्थान की यह नीति है कि प्रेरणा, प्रोत्साहन से ही कार्य किया जाए परन्तु इसका मतलब यह नहीं कि राजभाषा नीति के अनुपालन की अवहेलना की जाए। उन्होंने आशा व्यक्त की कि भविष्य में संस्थान में राजभाषा नीति के अनुपालन में प्रगति दिखाई देगी।

प्रशिक्षण कार्यशाला

22 सितंबर 2014 को 'राजभाषा कार्यान्वयन में डिजिटल टूल्स का उपयोग' विषय पर एक दिवसीय प्रशिक्षण कार्यशाला का आयोजन किया गया। इस समारोह में संस्थान के वैज्ञानिकों, तकनीकी एवं प्रशासनिक स्टाफ ने भाग लिय कार्यशाला के संकाय सदस्य के रूप में आमंत्रित श्री राकेश शर्मा, पूर्व वरिष्ठ उप–सचिव, सीएसआईआर ने डिजिटल टूल्स की सहायता से कंप्यूटर पर हिदी का उपयोग बढ़ने की असीम संभावनाओं के बारे में बताया। कार्यशाला के संकाय सदस्य के रूप में आमंत्रित श्री राकेश शर्मा, पूर्व वरिष्ठ उप–सचिव, सीएसआईआर ने प्रतिभागी कर्मियों को बताया कि डिजिटल टूल्स की सहायता से कंप्यूटर पर हिदी का उपयोग बढ़ने की असीम संभावनाएं हैं तथा इस प्रशिक्षण कार्यशाला का उदेश्य सभी कर्मियों को डिजिटल टूल्स के महत्व व उपयोग से परिचित कराना तथा अपने दैनिक कार्यालय कामकाज में यूनिकोड के माध्यम से इन टूल्स पर अभ्यास कराकर उन्हें राजभाषा हिंदी में काम करने में सक्षम बनाना है। श्री शर्मा ने कुछ बहुत ही उपयोगी डिजिटल टूल्स की जानकारी पीपीटी प्रस्तुतिकरण के माध्यम से दी। उन्होंने कहा कि इन तकनीकी टूल्स की सहायता से हिंदी में कार्य करना सरल हो गया है। अब हम यूनिकोड या गूगल के माध्यम से सरलता से कंप्यूटर पर हिदी में कार्य कर सकते हैं। उन्होंने बताया कि सहजडिजिटल नाम से जो वेबसाइर्ट तैयार की है उसमें सभी प्रकार के कार्यालयी पत्राचार आदि के टेम्पलेट्स तैयार किए गए हैं जिनमें बहुत कम जानकारी भरकर पत्राचार एव टिप्पण कार्य सरलता से किया जा सकता है।

संस्थान के कार्यकारी निदेशक डा. अनिल सूद ने अपने अध्यक्षीय संबोधन में कहा कि भारत सरकार की राजभाषा नीति का अनुपालन करना हमारा दायित्व है तथा हमारा यह प्रयास होना चाहिए कि हम अपना दैनिक कार्यालयी काम–काज राजभाषा हिदी में ही करें। संसदीय राजभाषा समिति के निरीक्षण के दौरान उठाए गए मुद्दों को देखते हुए हमें राजभाषा नीति के अनुपालन एवं कार्यान्वयन के लिए गंभीर प्रयास करनें होंगे तभी हम निर्धारित लक्ष्यों को प्राप्त कर सकेंगे। उन्होंने सभी वैज्ञानिकों एवं अधिकारियों से आह्वान किया कि वे अपना पत्राचार तथा आंतरिक नोट आदि अनिवार्य रूप से हिंदी में ही करें।

संस्थान के प्रशासन अधिकारी श्री जगदीश पराशर ने धन्यवाद प्रेषित करते हुए श्री राकेश शर्मा, निदेशक महोदय के प्रति आभार व्यक्त किया। उन्होंने प्रतिभागियों से यह अपेक्षा की कि वे व्यवहारिक सत्रों में अपने दैनिक कार्यालयी काम काज में विभिन्न डिज्टिल टूल्स के उपयोग के बारे में श्री शर्मा जी के अनुभवों एवं ज्ञान का लाभ उठाएंगें।

व्यावहारिक सत्र संस्थान के पुस्तकालय में आयोजित किए गए जिसमें –यूनिकोड– एक सामान्य परिचय,–यूनिकोड सक्रिय करना, –ई मेल का अभ्यास कराया गया। सभी कर्मियों ने इस प्रशिक्षण कार्यशाला को उपयोगी बताया। संस्थान के वरिष्ठ अनुवादक श्री संजय कुमार ने प्रतिभागी कर्मियों को विभिन्न डिजिटल टूल्स के बारे में जानकारी एवं व्यावहारिक प्रशिक्षण देने के लिए श्री राकेश शर्मा का धन्यवाद किया।

''आई.एच.बी.टी. संवाद'' तिमाही ऑनलाइन पत्रिका संस्थान ने रजत जयंती वर्ष के उपलक्ष्य में एक ऑनलाइन तिमाही न्यूजलेटर शुरु करने का निर्णय लिया था। इसी क्रम में अब तक इसके 22 अंक संस्थान की वेबसाइट में उपलब्ध हैं। इसके लिए सामग्री जुटाना, टंकण, संपादन एवं वेबसाइट पर उपलब्ध कराने का कार्य किया।

वेबसाइट अद्यतनीकरण

संस्थान की हिन्दी वेबसाइट का अद्यतनीकरण किया गया तथा सामग्री को अनुवाद, टंकण एवं यूनिकोड में करके संस्थान वेबसाइट पर उपलब्ध कराया गया।

राजभाषा से संबन्धित 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 तथा नए कार्यभार करने वाले कर्मचारियों को प्रशासनिक शब्दावली उपलब्ध कराया। संस्थान में वैज्ञानिक एवं सामान्य विषयों पर विभिन्न हिन्दी पत्रिकाओं को उपलब्ध कराया गया है। इसके अतिरिक्त विभिन्न प्रयोगशालाओं/संस्थानों द्वारा प्रकाशित पत्रिकाओं को भी संस्थान में उपलब्ध कराया गया। खरीदी पुस्तकें को तथा श्री शांता कुमार, माननीय सांसद, द्वारा संस्थान को उपलब्ध कराई गईं ₹ 50000/– रुपये मुल्य की पुस्तकों को रिकार्डबद्ध किया गया।

राजभाषा संबन्धी कार्यान्वयन

नए कार्यभार करने वाले कर्मचारियों को राजभाषा नीति एवं संस्थान में राजभाषा अनुभाग के कार्यों के बारे में व्यक्तिगत रूप से अवगत कराना।हिंदी की तिमाही रिपोर्ट के लिए विभिन्न अनुभागों/प्रभागों से आंकड़े प्राप्त कर रिपोर्ट सीएसआईआर मुख्यालय भिजवाई गई। राजभाषा कार्यान्वयन की दिशा में वार्षिक कार्यक्रम एवं सीएसआईआर मुख्यालय से प्राप्त निर्देशों के अनुपालन हेतु आवश्यक आदेश जारी किए गए।

संस्थान की राजभाषा कार्यान्वयन समिति की तिमाही बैठकों को का एजेंडा तैयारी, बैठक का आयोजन, कार्यवृत तैयार एवं परिपत्र एवं कायार्लय ज्ञापन जारी करना। प्रशासन में टेबल वर्कशॉप का आयोजन किया गया। भंडार एवं क्रय अनुभाग, जैवप्रौद्योगिकी, एनपीसीपीडी एवं प्रशासन का राजभाषा संबंधी निरीक्षण किया गया।विभिन्न अनुभागों से प्राप्त कागजातों का हिंदी अनुवाद उपलब्ध करवाया गया।संस्थान में राजभाषा कार्यान्वयन को बढ़ाने के लिए कर्मियों को प्रेरित एवं प्रोत्साहित करने के निमित्त आवश्यकतानुसार समस्त सहायताएं यथा अनुवाद, कम्प्यूटर में यूनिकोड सक्रिय करना आदि उपलब्ध करवाई गईं।हिंदी के ज्ञान से संबंधित रोस्टर में प्रविष्टियां एवं अद्यतन किया। उच्चाधिकारियों द्वारा समय–समय पर सौंपे गए अन्य कार्य निष्पादित किए गए।

संस्थान द्वारा आयोजित किए जाने वाले विभिन्न समारोहों जैसे सतर्कता जागरुकता सप्ताह, कौमी एकता सप्ताह, सद्भावना दिवस, सीएसआईआर स्थापना दिवस, आईएचबीटी स्थापना दिवस, विभिन्न कार्यशालाओं के आयोजनों, निमंत्रण पत्र, विज्ञापन, प्रेस नोट आदि को तैयार करने करके इसे प्रैस–मीडिया को उपलब्ध कराया।

वार्षिक प्रतिवेदन का सार

अनुकूलन जीवविज्ञान एवं जलवायु परिवर्तन

वर्ष के दौरान जैवसंपदा प्रलेखन, पादप फिनालॉजी से संबन्धित क्षेत्र के अध्ययन किए गए। साथ ही 500 पादप प्रजातियों की सूचना को एकत्रित करके हिमाचल प्रदेश के वनस्पति संसाधनों को समृद्ध किया। एक उच्च तुंगता ढाल में शोध प्रखंडों को चिन्हित किया गया तथा एपिफाइट पोरोफाइट संबन्धों के प्रलेखन के कार्य को भी शुरु किया गया।

जैवसंपदा के संरक्षण और प्रबन्धन के लिए काम किया जा रहा है। हम जमीनी हकीकत को जानने के लिए सर्वेक्षण किए तथा दीर्घकालीन पारिस्थिकीय अनुसंधान के लिए स्थायी भूखंडों को स्थापित किया है। हिमाचल प्रदेश की 60 फर्न प्रजातियों के स्थानिक वितरण मानचित्र को जीआईएस डोमेन में तैयार किया। हिमाचल प्रदेश के 18 प्रजातियों के पेड़ों पुनर्जनन पद्धति का अध्ययन किया। हिमाचल प्रदेश के कांगड़ा क्षेत्र में नदी के कटाव से मिट्टी के नुकसान का अनुमान लगाने के लिए RUSLE मोडलिंग का उपयोग किया गया। वर्ष 2014 के दौरान MODIS उपग्रह डाटा का उपयोग करत हुए वृहद हिमालयन राष्ट्रीय उद्यान शुध्द प्राथमिक उत्पादकता का अनुमान लगाया गया। हिमाचल प्रदेश रोहडू चांलस क्षेत्र में जलवायु परिवर्तन अध्ययन के लिए हिमाद्री क्षेत्र को विकसित किया। हिमाचल प्रदेश की वनस्पतियों की एक डिजिटल निर्देशिका को भी तैयार किया गया।

वर्तमान समय हो रहे जलवायु परिवर्तन को अनुमानित करने के लिए विभिन्न प्रकार के पारिस्थितिकी तंत्रों में निहीत कार्बन की मात्रा/घनत्व एवं उसकी गतिशीलता को प्रभावित करने वाले घटको का अध्यन वैज्ञानिक समुदाय का ध्यान आकर्षित किया है। चाय बागान अपने लम्बे जीवन चक्र के कारण कार्बन घनत्व के अध्यन की दृष्टि से काफी महत्वपूर्ण है। इसलिए, हमने इस अध्यन में चाय फसल के विभिन्न घटक जैसे की मृदा, जड़, तना, शाखा एवं पत्ती में निहीत कार्बन की मात्रा/घनत्व का अध्यन किया है। यह अध्ययन हिमालय जैवसंपदा प्रध्योगिकी संस्थान, पालमपुर के चाय बागान में निष्पादित किया गया। इस शोध से यह पता चला की चाय के विभिन्न घटको में कार्बन संचित करने क्षमता अन्य फसलों के अपेक्षाकृत कहीं अधिक है। इस शोध से यह निष्कर्ष निकाला की चाय की फसल का जीवन चक्र लगभग 100 वर्षों तक का है, इसलिए इसकी कार्बन धारण कर के रखने की क्षमता भी वन पारिस्थितिकी तंत्र के समतुल्य है।

जैवप्रौद्योगिकी

संस्थान ने हिमालय के उच्च पर्वतीय जीवविज्ञान पर कार्य करते हुए 10000फुट से अधिक उंचाई पर एक सर्वेक्षण के दौरान बर्फ के नीचे उगने वाले पोटेन्टिला में खोजे गए सुपर ऑक्साइड डिस्म्यूटेज (SOD) इन्जाइम को विकसित किया है। इसका उपयोग एंटीऐजिंग क्रीम, फलों और सब्जियों को अधिक समय तक तरोताजा रखने के लिए होता है। सुपर ऑक्साइड डिस्म्यूटेज (SOD) क्रायो–सर्जरी के दौरान एवं अंगो के परिरक्षण के लिएभभी उपयोगी है। अपने उच्च एंटीआक्सीडेंट गुणों और अनेक उपयोगों के कारण सुपर ऑक्साइड डिस्म्यूटेज (SOD) की बहुत मांग है इसीलिए वैश्विक बाजार में उसका मूल्य भी ऊँचा है। यह शून्य से 40 डिग्री सेंटीग्रेट तक के तापक्रमों में अत्यन्त स्थायी होता है। इस प्रौद्योगिकी के उपयोग के लिए संस्थान ने एक समझौता करके मै. फाइटो बायोटेक प्रा. लि. कोलकाता को औद्योगिक उत्पादन के लिए लाइसेंस दिया। यह कम्पनी अब अमेरिका तथा जर्मनी में भभी इसका विस्तार कर रही है। हिमालय के उच्च पर्वतीय क्षेत्र के अन्य पौधे एरॉबिडाप्सिस में भी कार्बन संचारित करने की विधि की खोज कर ली है।

स्टीविया के SrKA13H के cDNA के अस्थानिक अतिप्रकटन द्वारा पराजीनिक अरेबिडोप्सिस में स्टीविओल के महत्वपूर्ण संग्रहण का पता चला। वे जिब्रालिन–न्यून उत्परिवर्तियों के समलक्षणी थे। आंतरिक जिब्रालिन की मात्रा में कमी इन पराजीनियों के बौनेपन के लिए उत्तरदायी पाया गया। बाहरी GA3 के प्रयोग से पराजीनियों को बौनेपन से बचाया जा सकता है। पराजीनियों के हाइपोकोटाईल, पुष्प भाग व तने की लम्बाई में अत्यधिक कमी पाई गयी। परागकणों की जीवन क्षमता में विचारणीय कमी पायी गयी, उसी प्रकार परागकणों के अंकुरण अनुपात में भी गतिरोध पाया गया। स्टीविओल के बाहरी प्रयोग का भी परागकणों की अंकुरण क्षमता पर कोई प्रभाव नहीं हुआ।

फ्लेवन–द्व–ऑल चाय की पत्तियों में पाये जाने वाले फ्लवोनोडिस हैं। कृत्रिम रूप से यह अपनी ऑक्सीकरणरोधी एवं मुक्तमूलकों को साफ़ करने जैसे गुणों के लिए जाने जाते हैं। फ्लेवानोन3- हाइड्रोक्सीलेज फ्लेवोनॉयड प्रणाली का महत्वपूर्ण किण्वक माना जाता है। जो कि चाय में फ्लेवन–¼- ओल्स के संग्रहण का नेतृत्व करता है। लवण–तनाव की स्थिति की अभिव्यक्ति विश्लेषण द्वारा कैमेलिया साइनेन्सिस के F3H किण्वक को कोडित करने वाले जीन के प्रतिलिपि स्तर में उपनियंत्रण पाया गया। इस अध्ययन द्वारा तम्बाकू (निकोटियाना टबेक्म सी वी जेंथी) में जीन के अतिप्रकटन द्वारा CsF3H के जैवप्रोद्योगिकी संभाव्यता का मूल्यांकन किया गया है। CsF3H के cDNA के अतिप्रकटन ने तम्बाकू में फ्लेवन–3 ओल्स की मात्रा एवं लवण–तनाव के प्रतिसहनशीलता। इसे साथ–साथ अल्टलेरिया सोलेनी के संक्रमण के लिए प्रतिरोधक क्षमता को भी बढ़ाया गया है।परीजनिक पौधों पे पेक्टिन मिथाइल एस्टरेज के स्ता को कम करके अधिक मात्रा में पेक्टिन मिथाइल एस्टरीकरण किया।

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

इस अध्ययन का लक्ष्य यह उजागर करना है कि लवण–तनाव की स्थिति में फ्लेवोनॉयड व ऑक्सीकरणरोधी प्रणालियों को कोडित करनेवाले जीनो के पश्चजनन विशेषरूप से डी एन ए मेथाइलेशन द्वारा नियंत्रण में है। इसके लिए अरेबिडोप्सिस के ROS1 जीन को पराजीनिक तम्बाकू के पौधो में अतिप्रकटित किया गया। उत्पन्न पराजीनियों में फ्लेवोनॉयड व ऑक्सीकरणरोधी प्रणालियों के किण्वको को कोडित करने व जीनों के प्रोमोटरों व कोडित भागों के मेथाइलेशन स्तर पर AtROS1 के प्रभाव का विश्लेषण किया गया। उत्पन्न आंकड़े पौधों में फ्लेवोनॉयड व ऑक्सीकरणरोधी प्रणालियों के लवण–तनाव की स्थिति में पश्चजनन नियंत्रण को दर्शाता है ।

पौधों के अर्क का उपयोग कर संश्लेषित चांदी नैनोकणों के मजबूत जीवाणुरोधी गतिविधि: एन पी एस बिश्लेषन करने के लिए तीन पौधों पॉपुलुस अल्बा, हिबिक्स अर्बोरेउस और लैंटाना कमारा का पता लगाया गया था। संश्लेषण की दर एल ई के एल कमारा के साथ सबसे ज्यादा थी के फिर एच. अर्बोरेउस, पॉपुलुस अल्बा के पतों का अर्क में पाया गया। एल कमारा के पतों का अर्क से बने चांदी नैनो कण सबसे छोटे जबकि एच. अर्बोरेउस के अर्क से बने नैनो कण सबसे बड़े पाये गए टीम बिश्लेषन से 5% एल कमारा के पत्तों के अर्क से बने नैनो कणों के औसत अकार 17 ± 9.5 नैनोमीटर पाया गया। E. Coli के खिलाफ 2% एल कमारा से बने चांदी नैनो कणों ने बेहतर जीवाणु रोधी गतिविधि दिखाई। इसलिए ऐसा संभावित किया जा सकता है की इनकी जैव चिकित्सा में बहुत क्षमता है।

घाव की मरमत्त के लिए सेल्यूलोस नैनो क्रिस्टल और चांदी जैव नैनोकणों : पौधों से सेल्यूलोस नैनो क्रिस्टल को अलग करने के लिए रासायनिक और यांत्रिक तरीकों का उपयोग किया गया। चांदी नैनो कणों को सी एन सी मैट्रिक्स में संचयन करने के लिए हरित प्रौद्योगिकी का उपयोग किया गया जिससे नैनो कंपोजिट बनाये गए हैं। सी एन सी तथा एन सी की विशेषता जीटा पोटेंशियल यु वी – वी आई एस स्पेक्ट्रोस्कोपी, एस ई एम, टी ई एम, एफ टी आई आर और एक्स ऑर डी द्वारा की गयी। सी एन सी की पानी लेने की क्षमता घाव की मरहम पट्टी के लिए अच्छी मानी गई। इस से यह पता चलता है की उपरोक्त बनाये गए एन सी घाव ठीक करने के लिए एक अच्छा साधन बन सकते हैं।

बेटुलिन कॅप्सुलेटेड पीएलए नैनो कण : बेटुलिन हिमालयन बर्थ की छाल में सर्वाधिक पाया जाने वाला एक तृतर्पणे है। पानी में घुलनशीलता काम होने के कारण इसका कृत्रिम परिवेशीय उपयोग बहुत काम है। इसकी घुलनशीलता, जैव उपलब्धता, चिकित्सीय प्रवाभकारिता बढ़ाने के लिए इसके पीएलए एनपीएस बनाये गए जिसमे पोलु विनाइल अल्कोहल और एल जपनीका के प्रति उद्धरण का स्टेब्लिज़र की तरह उपयोग किया गया। बेटुलिन के नैनो कण ने बेहतर जैव अनुकूलता, उत्कृष्ट स्थिरता एवं बढ़ा हुआ प्रदर्शन दिखाया।

हमारे शोध समूह का मुख्य ध्येय पश्चिमी हिमालय की जैवसंपदा का मूल्यवर्धन करना है। इस कार्य के लिए हमने 1) पादप कोशिका संवर्धन प्रौद्योगिकी का प्रयोग करते हुए इन–विट्रो सेकेन्डरी मेटाबोलाइट का उत्पादन की तथा 2) पश्चिमी हिमालय के स्थानीय निवासियों द्वारा स्वास्थ्य प्रणाली में पारम्परिक रूप से प्रयोग होने वाले संसाधनों की संभावना को खोजने का कार्य कर रहे हैं। इससे एक तो प्राकृतिक संसाधनों विशेषकर लुप्तप्रायः पादप प्रजातियों पर निर्भरता कम होगी दूसरा पादप सेकेन्डरी मेटाबोलाइट को पोषक

खाद्य के विकल्प तथा मानव स्वास्थ्य के लिए न्यूट्रास्यूटिक्ल के विकास के लिए भी मूल्यवर्धित किया जाएगा। इसके अतिरिक्त इन जैवसक्रिय अणुओं का खाद्य पदार्थों को अधिक समय तक तरोताजा रखने के लिए भी मूल्याकंन किया जा रहा है।

सुपर ऑक्साइड डिस्मयूटेज (SOD) नामक प्रोटीन की डायनामिक प्रकृति और इसके अभियांत्रिक उत्परिवर्ती रूपों का अध्ययन किया जा रहा है। यह प्रोटीन पोटेंटिला नाम के पौधे में पाया जाता है और अपनी थर्मोडायनेमिक प्रकृति के कारण बहुत उपयोगी है हम प्रयोगशाला मे SOD प्रोटीन के नए उत्परिवर्ती रूपों को बनाते है, जिससे की प्रोटीन की डायनामिक और काइनेटिक स्वभाव को बढ़ाया जा सके। इन उत्परिवर्ती रूपों के नए स्वभाव को गहराई से जानने के लिए और इसके आकर और कार्यशैली में सामजस्य को समझने का कार्य हो रहा है। चाय और हिमालय में पाए जाने वाले पोडोफिलम जैसे विशेष पौधों के ट्रांसक्रिपटोम का कम्यूटेशनल अध्ययन किया और तापमान और शीत पुसुप्तावस्था के प्रभाव का अध्ययन किया। इसके अतिरिक्त एरोबिडॉप्सिस ट्रांसजेनिक पर भी काम किया तथा लिग्निफिकेशन के प्रक्रिया को समझने हेतु नेक्टस जनरेशन सिक्वेंसिंग डेटा का प्रयोग किया। इस समूह ने पहली बार दिखाया कि किस प्रकार के miRNAs पौधों में एपीजेनेटिक रेगुलेशन और DNA मेथेलेशन के प्रक्रियाओं को संचालित करते हैं।

नेनो मेटिरियल को संश्लेषित करके मोलिक्यूलर इमेजिंग और सेंसिग के उपयोग में लाया गया। इस दिशा में हमने मेग्नेटो फलोरोसेंट नेनोमेटिरियल को संश्लेषित किया हुआ है। जो कि विशेष केन्सर कोशिकाओं को लक्षित करता हैं। इस सामग्री का केंसर सेल की इमेंजिंग के लिए उपयोग किया जा सकता है। अध्ययन से पाया गया कि यह मेटिरियल जैव माध्यम में उपयोग के लिए सुरक्षित है। एक अन्य अध्ययन में फलोरोसेंट को कीटनाशकों को चिन्हित करने के लिए प्रयोग किया गया। जिसकी सुग्राहता बहुत अधिक है। न्यूक्लोसाइड दृश्यों, प्रोटीन दृश्यों और संरचनाओं, माइक्रोएरे के साथ ही अगली पीढ़ी के अनुक्रमण (NGS) डेटा सहित, सॉफ्टवेयर को विकसित करने के साथ–साथ विश्लेषण करने के लिए सांख्यिकीय मशीन सीखने, बायोमोलिक्यूलर के सिमुलेशन और सूचना पुनः प्राप्ति लागू करने और जैविक डेटा की खदान सभी प्रकार शामिल जीव विज्ञान की खोज को सुविधाजनक बनाना हमारे शोध का लक्ष्य है। हमने अत्यधिक कड़े कम्प्यूटेशनल विधियों का उपयोग कर 1015 NBS-LRRs के शामिल हिमालय संयंत्र, मेलस डोमेस्टिका ¡सेब में से NBS-LRR जीन परिवार की पहचान की है। ये NBS-LRRs संरक्षित प्रोटीन रूपांकनों, जीन दोहराव घटनाओं, गुणसूत्र स्थानों, वंशावली रिश्तों को और डिजिटल जीन अभिव्यक्ति के विश्लेषण के आधार पर विशेषता थे। इस अध्ययन से सेब में रोग प्रतिरोध के सुधार की दिशा में भविष्य के प्रयासों के लिए प्रदान करेगा।

खाद्य न्यूट्ररस्यूटिक्ल एवं गुणवत्ता नियंत्रण

मूल्य संवर्धित काठू (Buckwheat) उत्पादों को विकसित किया गया है। क्योंकि काठू (Buckwheat) के कई स्वास्थ्य लाभभ होने के कारण यह उच्च तुंगता हिमालय क्षेत्र की एक पारंपरिक फसल है। कुपोषण से निपटने के लिएविज्ञान और प्रौद्योगिकी केहस्तक्षेप मेंभाग लेकर स्थानीय जैवसंपदा का उपयोग कर समृद्ध खाद्य उत्पादों का विकास किया। जो क्रमशः 40% लोहा और 60% कैल्शियम पोषक तत्वों की आरडीए (RDA) की परिपुर्ति करता है। खाद्य प्रसंस्करण सुविधा की स्थापना CeHAB, Tandi केलांग (लाहौल एवं स्पीति) में की और कार्यात्मक खाद्य विकास पर कई उद्यमिता विकास कार्यशालाएं आयोजित कराई गयीं।

केलिस्टमोन सिट्रीनस पेड़ के पत्तों तथा फूलों से निकले गए सगंध तेलों का मनुष्यों के तथा मुशकों के कैंसर कोशिकाओं पर परिक्षण किया गया। परीक्षणों के नतीजों का अध्ययन करने के बाद यह पाया गया की उपरोक्त सगंध तेल मनुष्यों के फेफड़ों तथा मुशकों के मस्तिष्क के कैंसर के कोशिकाओं को नष्ट करने में कारगर है जिसकी और सखोल अध्ययनों से भी पुष्टि की गयी है। एक अन्य अध्यन में टीनोस्पोरा कोर्दिफोलिया पौधे से निकासी किये गए अशोधित सत्त, अंशों तथा शुद्ध यौगिकों का परिक्षण विभिन्न कैंसर कोशिकाओं पर किया गया। नतीजों में यह पाया गया की उपरोक्त नमूनों जिनका की परिक्षण किया गया मनुष्यों के विभिन्न मौखिक, पेट, तथा ग्रीवा के कैंसर कोशिकाओं को नष्ट करने में कारगर है।

हम प्राकृतिक दवा अणुओं, न्यूट्रास्यूटिकल और नैनोसामग्री की सुरक्षा और विषाक्तता मूल्यांकन करते हैं। ये अध्ययन ओईसीडी, आईसीएच आदि अंतरर्राष्ट्रीय स्तर पर स्वीकृत दिशा निर्देशों का उपयोग करके किये जाते हैं। इन अध्ययनों को करने से हम पता

लगाते हैं कि विचाराधीन पदार्थ सुरक्षित है या नहीं। इसके अलावा हम जैव रासायनिक, हिस्तोपैथोलोजी और इम्मुनोहिस्तोकेमिस्ट्री तकनीकों का उपयोग करके कैंसर विरोधी, घाव भभरने, गुर्दे और जिगर के लिए लाभकारी पादप अणुओं के मूल्यांकन में भी सम्मिलित हैं।

मानव में रोगग्रस्त स्तर को संशोधित करने के लिए न्यूरोप्रोटेक्टिव विकसित करने के प्रयास किए जा रहे हैं। इस संबंध में पिक्रोराइज़ा एक्सट्रेक्ट तथा शुद्ध अणुओं की इन–विट्रो कोशिका संवर्ध मॉडल में उपयोग करते हुए सबसे अधिक सक्रिय घटक बाहर स्क्रीन करने के लिए स्क्रीनिंग की गई। इस कार्य के लिये टेस्ट कंपाउंड को सी6–ग्लाएओमा कोशिकाओं द्वारा हाइड्रोजन पेरोक्साइड प्रेरित कोशिकीय क्षति के खिलाफ अध्ययन किया गया है। क्रोकस के वनस्पति भागों को बड़े पैमाने पर विभिन्न सीएनएस(केन्द्रीय कोशिका तंत्र) रोगों के उपचार में इस्तेमाल किया जा रहा है। व्यापक खोज जटिल तंत्रिका रोगों में इसके संभावित क्षमता का उपयोग पता लगाने के लिए नयूरोफार्मकोलोगिकल पहलुओं, रसायन विज्ञान और सुरक्षा पर खंडित जानकारी को समझने के लिए व्यापक खोज की गई। सेल लाइन पर प्रारंभिक इन विट्रो अध्ययन में इसके सुरक्षात्मक प्रभाव को दिखाया गया। इसके अलावा मस्तिष्क संबंधी बीमारियों के जीर्ण हेतु पशु मॉडल में अध्ययन प्रक्रिया में हैं। क्रूड एक्सट्रेक्ट, विलायक भिन्न और शुद्ध अणुओं की विषरोधक गतिविधि भभी इन विट्रो प्रोटीएस, फोस्फोलाइपेस A_2 हयालयुरोनिडेज, न्यूक्लिओटीटेंस, ATpase और एल–अमीनो ऑक्सीडेस गतिविधि का अध्ययन किया गया।

उच्च तुंगता जीवविज्ञान

संस्थान की ओर से एनएचपीसी की दस डम्पिंग साइटों पर उच्च जलवायु क्षेत्रों में उगने वाले पौधे लगाए गए। जिनकी वृद्धि इर बहुत अच्छी रही। टनल के मलबे से उस क्षेत्र में वातावरण के अनुसार असुन्तुलन हो गया था जो अब इन पौधों से ठीक हो गया है। क्रैटेगस आक्सीकैंथा (पड़ाखल) एक प्रमुख औषधीय पौधा है। हमने संस्थान में शोध के लिए एक परीक्षण गया है। हालांकि यह पौधा 4 से 40 डिग्री सें. पर उगता है। यह हमें रोगों से बचाने में सहायक है। प्रत्येक वर्ष इसके बीजों का उत्पादन बढ़ रहा है। यह हृदय रोगों के उपचार में सहायक है।

जिंको बाइलोबा भी एक जीवित जीवांश पौधा है। इसे भी संस्थान में परीक्षण के लिए लगाया हुआ है। इसमें खाद अंतराल के हिसाब से बहुत अच्छे परिणाम हैं। यह विचित्र पौधा भी लोगों को स्वस्थ रखने में उपयोगी है। यह मस्तिष्क तथा याददास्त को सही रखने में मददगार है।

हिमाचल प्रदेश के उच्च तुंगता वाले क्षेत्र का पादप विविधता एवं कार्यात्मक गुण लक्षणों का ऊँचाई के साथ होने वाले परिवर्तन का अध्ययन किया गया। इस संदर्भ में 08 स्थानों पर नीचे से ऊपर की ओर 3000m से 5000m तक सर्वेक्षण किया गया। इस प्रकार से इन क्षेत्रों में अजैव छनन के कारण कार्यात्मक गणों में चयन देखा गया। पादप प्रजातियों की विभिन्न किस्मों में कमी देखी गई और specific leaf area (SLA), पत्ता क्षेत्र, क्षेत्र परिधि अनुपात, पादप लम्बाई एवं रसीले (succulent) पौधों में वृद्धि पाई गई । इन्हीं स्थानों पर पेड़ सीमा क्षेत्र में स्थायी निगरानी वाले क्षेत्र (वनस्पति संरचना एवं कार्बन मात्रा के लिए) निशानदेह किया गया। यहां इसके अतिरिक्त डेक्टीलोराइजा की ऊँचाई वाले क्षेत्र में पादप संख्या के लिए मुल्यांकन किया गया जिससे कि इनका संरक्षण किया जा सके। इन स्थानों पर डेक्टीलोराइजा अच्छे परिग्रहण एकत्रित किए गए और मृदा के नमुने भी लिए गए एवं वही स्थानों की जलवायु की जानकारी भी ली गई ।

प्राकृतिक पादप रसायनिकी एवं प्रक्रम विकास

भारतीय चिकित्सा पद्धति में, विभिन्न औषधीय पौधों का प्रयोग कई प्रकार के विकारों का इलाज करने के लिए किया जा रहा है। इस अवधि के दौरान टाइनोस्पोरा कॉर्डिफोलिआ, सीसामपेलस परीरा, जेफीरेन्थेस ग्रान्डीफ्लोरा, ब्रासिका जनसियाना, अरुका स्टाइवा और टेरिडोफाइटस (फर्न) आदि औषधीय पौधों की रासायनिक और उनके जैविक उपयोग की जांच की गयी। इन औषधीय पौधों से बायोएक्टिव यौगिकों को पृथक कर उनका चित्रणप्रारुप भी किया गया है। पूरी रासायनिक रूपरेखा यू.पी.एल.सी/ एम.एस–एम.एस का प्रयोग कर प्राप्त की गई। टाइनोस्पोरा कॉर्डिफोलिआ से साइटोटोक्सिक यौगिक, इम्युनो मोडूलेटर, सीसामपेलस परीरा से

क्यूरिन, मगनोंक्यूरारिन जो कि विषरोधक होते हैं, का चित्रणप्रारुप किया गया है । ग्लूटामाइन की तरह के एंटी–कैंसर अणुओं को भभी जेफीरेन्थेस ग्रान्डीफ्लोरा से लक्षणचित्रण किया गया है। टाइनोस्पोरा कॉर्डिफोलिआ, सीसामपेलस परीरा और जेफीरेन्थेस ग्रान्डीफ्लोरा से प्राप्त जैवसक्रिय यौगिक प्राकृतिक अणुओं के संश्लेषण के लिए संश्लेषित विधियां विकसित की जा रहीं हैं, ताकि जैवसंपदा से पौधों की निष्कर्षण पर दबाव कम हो पाए।

इस वर्ष 5278 कि.ग्रा. ताजे दमस्क गुलाब के फूलों से 1309 ग्राम गुलाब का तेल(0.025%) निष्कर्षित किया गया। सुपरक्रिटीकल CO_2 तकनीक का प्रयोग कर लेवेन्डर से तेल का निष्कर्षण किया गया। GC व GC-MS से विश्लेषण करने पर इस तेल में लिनालायल एसिटेट (44.4–59.8%) व केरियोफाइलिन (6.3–9.3%)की मात्रा अधिक पाई गई। इस वर्ष स्टीविया की पत्तियों से स्टीवियॉल ग्लाइकोसाइड की प्रक्रिया को सरल व मितव्ययी बनाने के लिए स्टीविया निष्कर्षण से रंगीन अशुद्धियों को हटाने की प्रक्रिया की। काली गाजर से रंगों से नमी का शोषण न करने वाले रंगों के निष्कर्ष भी संस्थान द्वारा विकसित किया गया।इस वर्ष इस विधि को उच्च स्तर पर मानकित किया गया।

इस वर्ष जेन्थोजाइलम अरमाटम से एक नवीन यौगिक के साथ आठ ज्ञात यौगिकों का पृथक्करण किया गया । एडहाटोडा वेसिका की पत्तियों से प्राप्त एक्केलायड, वेसीसिन को ओर्ग्रेनोकेटालिस्ट की तरह प्रयुक्त किया गया । इस एल्केलायड का प्रयोग नाइट्रोएरीन्स के अपचयन तथा C-H को क्रियाशील कर बाइएराइल यौगिकों के संश्लेशण में किया गया । वर्तमान में बायोएक्टिव अणुओं व उनके एनालॉग्स के संश्लेषण में विद्यमान समस्याओं को हल करने के लिए उनके उत्प्रेराकीय व्यव्हार एवं उपयोगों के परीक्षण करने के लिए विषम नैनो उत्प्रेरक के विकास में कार्य किया जा रहा है। विस्तार से उत्प्रेरक का परीक्षण करने पर यह निर्दिष्ट होता है कि नैनो उत्प्रेरक का उपयोग किसी भी लिगेंड, अक्रिय वातावरण एवम् परिष्कृत उपकरण का उपयोग किये बिना कई प्रकार की रासायनिक अभिक्रियाओं में प्रयोग किया जा सकता है। उत्प्रेरक का परीक्षण करने पर यह पार–युग्मन, ऑक्सीकरण एवम् अपचयन अभिक्रियाओं में अति प्रतिक्रियाशील पाया गया। नैनो उत्प्रेरक का ओक्सिड़ेटीव एस्टरीफिकेशन प्रतिक्रियाओं में असामान्य व्यव्हार होने के कारण यह अपनी तरफ विषय में होने वाले परीक्षण के लिए ध्यान आकर्षित करते हैं ।

इस साल कुठ Saussurea lappa जंगली हल्दी Curcuma aromatic तथा Stevia rebaudiana के यौगिकों के संभावित उपयोगों का पता लगाया था। इसके अलावा हमने ताजे पानी के शैवाल और टेरिडोफाइटस मे काम करने की संभावनाओं का भी पता लगाया है। प्रायः यह ताजे पानी के शैवाल विषाक्त होते है, तथा यह ताजे पानी के स्रोतो को एवं वहा के वातावरण को विषाक्त बनाने के लिए जिम्मेदार हैं। सीएच एक्टिवेशन के माध्यम से या पश्चिमी हिमालय क्षेत्र में प्राकृतिक संसाधनों से मलेरिया रोधी एजेंटों की खोज करने का प्रयास किया जा रहा है। डब्ल्यूएचओ द्वारा अनुमानित केवल 2013 में लगभग 200 मिलियन नैदानिक मामलों और 584000 लोगों की मृत्यु मलेरिया के कारण दर्ज की गई। प्रमुख समस्या मौजूदा दवाओं के लिए मलेरिया परजीवी द्वारा प्रतिरोधकता होना है। नए मलेरिया रोधी एजेंट को दवाओं के साथ स्वतंत्र तरीके से या संयोजन में इस्तेमाल किया जा सकता है।

एक निष्क्रिय सीएच बंधन का एक्टिवेशन चालू कार्बनिक संश्लेषण में क्रांतिकारी परिवर्तन का लुत्फ उठाया है और यह निकटता के केंद्र के लिए ही सीमित नहीं है। ऑर्थो सीएच एक्टिवेशन मे पिछले दो दशकों में उल्लेखनीय प्रगति की गई है। हालांकि किसी भी कार्य समूह की निकटता से परे सीएच सक्रियण हमेशा एक चुनौती बनी हुई है। संस्थान में सीएच एक्टिवेशन के माध्यम से महत्वपूर्ण बायोएक्टिव अणुओं के संश्लेषण के लिए कुशल उत्प्रेरक के तरीके विकसित करने पर ध्यान दिया जा रहा है। संस्थान दूरदराज के सीएच सक्रियण के माध्यम से नई क्विनोलिन आधारित अणुओं के संश्लेषण की दिशा में काम कर रहा है।

आदिम युग से ही स्वास्थ्य की गंभीर विकारों का उपचार करने के लिए पौधों और मरीन स्त्रोतों को उपयोग किया जाता रहा है और अभी भी ये बहुत महत्वपूर्ण है। उनके व्युत्पन्न उत्पादों को नई दवाओं की खोज करने के लिए टेम्पलेट के रूप में भी प्रयोग किया जाता है। औषधीय पौधों व उत्पादों के रसायन विज्ञान, मेटाबोलाइट रचना और परिवर्तन को समझना एवं गुणवत्ता और गुणवत्ता नियंत्रण कि दिशा मे शोध कार्य वर्तमान समय की माँग है।

इसलिए संस्थान वर्तमान में NMR, UPLC-MS/MS और HPTLC तकनीकों का उपयोग उतर–पश्चिम हिमालय के कुछ महत्वपूर्ण औषधीय फसलों की मेटाबोलाइट रूपरेखा एवं रचना और उनके गुणवत्ता नियंत्रण पर काम कर रहे हैं। इसके अतिरिक्त लिपिडोमिक्स और मेटाबोलोमिक्स अध्ययन के माध्यम से क्रेटेगस की भूमिका का हृदय पर सुरक्षात्मक एवं विपरीतात्मक प्रभाव का पता लगाने कि दिशा मे काम किया जा रहा है। 600 MHz NMR तकनीक के माध्यम से हमने पिक्रोराइजा कुरूआ का मेटाबोलाइट

रचना की जांच की है। हमने पत्तियों और प्रकंदों मे उपस्थित प्राथमिक और माध्यमिक मेटाबोलाइटस की पहचान की और इनके माध्यमिक मेटाबोलाइट में महत्वपूर्ण गुणात्मक अंतर देखा।

गुणवत्ता पादप उत्पादन

जरबेरा की नई किस्मों के विकास के लिए नियंत्रित प्रजनन कार्यक्रम द्वारा तैयार संकर पौधों में पुष्प विशेषताओं जैसे कि फूलों के आकार, उच्च उपज तथा गुणवत्ता में बदलाव पाया गया। विकसित संकर पौधों का मूल्यांकन खेत में दो वर्षों तक किया गया एवं चयनित संकर पौधों को व्यवसायिक खेती के लिए उपयुक्त पाया गया।

स्टीविया में नई किस्मों के विकास के लिए प्रजनन कार्यक्रम द्वारा चयनित पौधे (सी.एस.आई.आर.–आई.एच.बी.टी.–एस.टी.–01) की पहचान की गई जिसमें स्टीवीओल ग्लाइकोसाइड गुणवत्ता में बदलाव पाया गया। सी.एस.आई.आर.–आई.एच.बी.टी.–एस.टी.–01 के पौधों का मूल्यांकन खेत में दो वर्षों तक किया गया एवं चयनित पौधों को व्यवसायिक खेती के लिए उपयुक्त पाया गया।

कारनेशन (*Dianthus caryophyllus* L) दुनिया के व्यावसायिक रूप से महत्वपूर्ण कर्तित पुष्पों में से एक है। कारनेशन अपने गुणवत्ता रंग और लंबी दूरी के परिवहन को झेलने की क्षमता के कारण निर्यात के लिए पसंद किया जाता है। इस दिशा में हमने डॉ. वाई एस परमार बागवानी एवं वानिकी विश्वविद्यालय नौणी, सोलन, हिमाचल प्रदेश से कारनेशन की 16 किस्मे एकत्र की जो कि इस प्रकार हैं: रोबीसको, पिंक डोवर, डोवर, तस्मान, लिबर्टी, विक्टोरिया, पिराण्डेल्लो, येल्लो स्टार, कीरो, मास्टर, आइआइएचपी–1 टीकर, लाइट स्टार, बाल्टिको, व्हाइट वैडिंग और डोमिंगो। कारनेशन की इन किस्मों को 2015 के दौरान मूल्यांकन के लिए बढ़ाया जा रहा है।

कैला लिली *Zantedeschia aethiopica* (L.)(Spreng.) कर्तित पुष्पों में एक बारहमासी, कंदीय पौधा है। हमने इस दिशा में विभिन्न वातावरण जैसे पॉली हाउस, शेडनेट और खुले क्षेत्र में इसके प्रदर्शन पर अध्यन कर रहे हैं। आगे के लिए हम कैला लिली के प्रजनन, पोषण, रखरखाव, बीमारी, कीट और पोस्ट हार्वेस्ट मैनेजमेंट पर ध्यान केंद्रित कर रहे हैं।

पादप स्वास्थ्य प्रबन्धन

इस वर्ष के दौरान चेरी और सेब के वायरस विषाणुओं पर ध्यान केन्द्रित किया गया। उनका निदान और जीनोम चित्रण एक चुनौती है इस पर कार्य किया गया। एम्पलीफिकेशन और पूर्ण जीनोम की क्लोनिंग की प्रक्रिया को स्थापित कर लिया गया है। इन विषाणुओं के नए प्राकृतिक परपोषियों की पहचान कर ली गई है। बाँस, जंगली चेरी और जंगली गुलाब को CNRMV के लिए नए परपोषी के रूप में पहचान की गई जबकि किवी asgv परपोषी पाया गया। अब तक इन विषाणुओं को सीमित परपोषी के रूप में जाना जाता है।

हम पौधों और सूक्ष्मजीवों पर आधारित कीटनाशक बनाने के संदर्भ में एक फर्न को ऐफ़ीड और प्लुटेल्ला जायलोस्टेल्ला के विरुद्ध सक्रिय पाया गया। साथ ही में हम कीड़ों की विविधता का भी अध्ययन कर रहें हें। इस दिशा में हमने एक ऐफ़ीड्, लियासोमाफिस ओरनेटा को पहली बार भभारत से रिपोर्ट किया। यह ऐफ़ीड् हमें कुल्लू के नग्गर गाँव में बर्बेरिस लाईसीयम पौधे पर मिला। इसी प्रकार एक और ऐफ़ीड्, फोर्डा ओरीयंटेलिस पहली बार एक पौधे, अरीनेरिया फेस्ट्युकोयाइडस से रिपोर्ट किया गया। यह ऐफिड हमें लाहौल स्पीति जिले में मिला।

संस्थान एटोमोपेथोजनिक फंगस (EPF) पर आधारित कीटनाशक बनाने के लिए कार्य कर रहा है।इसके लिए हम भारतीय पश्चिमी हिमालय क्षेत्र से मृत कीटों व मिट्टी के नमूने से (EPF) के पृथक्करण व उनके लक्षणचित्रण कर रहे हैं। इसी प्रकार विभिन्न पौधों के अर्क / अंशों / शुद्ध यौगिकों / सगंध तेलों से परीक्षण करके कीटनाशकों के विकास के लिए कार्य किया जा रहा है। इसके अतिरिक्त हम कीट जलवायु परिवर्तन का कीटों पर पड़ने वाले प्रभाव का अध्ययन भी कर रहे हैं ।

सेब (मैलस डोमेस्टिका) की फसल हिमाचल और कश्मीर के हिमालयन क्षेत्र के लिए अत्यंत महत्त्वपूर्ण है. प्रतिवर्ष सेब की फसल कई प्रकार की बिमारियों का शिकार हो जाती हैं जिससे उत्पादन पर प्रतिकूल असर पड़ता है तथा अत्यधिक आर्थिक नुक्सान होता है. ऐसा ही एक रोग सेब स्कैब के नाम से जाना जाता है जो अत्यधिक आर्थिक नुक्सान पहुंचाती है. इसके कारण को जानने के लिए संस्थान प्रतिबद्ध है और इस दिशा में अग्रसर है। ट्रांस्क्रिप्टोम आंकड़ों के विश्लेषण से हमें उम्मीद है की कुछ अति महत्त्वपूर्ण

ट्रांसक्रिप्शन फैक्टरस की खोज हो सकेगी। महत्त्वपूर्ण मुख्य विनियामक को ट्रांसजेनिक विधि के द्वारा विषय में उपयोग किया जा सकता है। इसके लिए आवश्यक किस्मों को सी आई टी एच, कश्मीर से उपलब्ध कराया जा रहा है।

आभूषक पौध गृहीकरण एवं भूदृष्य

अन्तर जातीय एवं अन्तर प्रजातीय संकरणों द्वारा खुशबू वाले तथा अलंकृत गुलाबों में नई प्रकार की विभिन्नता उत्पन्न करने के लिए उनमें संकरण किया गया। गुलाब की चार विभिन्न जातियों जैसे रोज़ा डेमसीना, रोज़ा ब्रौनोनीयाई, रोज़ा हाइब्रिड़ा और रोज़ा इंडिका को वांछित विभिन्नता जैसे पौधों की किस्म, फूलों व फलों में गुणों तथा तेल की गुणवत्ता को उत्पन्न करने के लिए कार्यक्रम में सम्मलित किया गया। कैला लिली की दो जातियों का पोलिहाऊस व खेतों में समारंभभ किया गया ताकि उन की हिमाचल प्रदेश में पुष्प उत्पादन की संभावनाओं का अध्ययन किया जा सके। इसके बहुत सारे पौधे संस्थान में बीजों द्वारा तैयार किये गये। बर्ड औफ़ पैराडाइज कर्तित पुष्प व्यवसाय के लिए एक मुख्य पुष्प है। इस की पौध सामग्री की समस्या अत्याधिक है क्योंकि बीजों के जमने की समस्या के साथ इसका पौध प्रबर्धन भी काफी धीमा है। बीजों से अधिक पौधे उत्पन्न करने के लिए इस के बीजों का विभिन्न प्रकार से अध्यन किया गया जिस के परिणाम उत्साहवर्धक हैं।

ग्रामीण विकास गतिविधियां

संस्थान अपने शोध उपलब्धियों को प्रसार एवं परामर्श सेवाओं के माध्यम से मूल्यवर्धित कृषि तथा गैर कृषि क्षेत्र में ग्राम स्तर तक पंहुचाने के लिए अग्रसर है। कृषि उत्पादन के बदलते परिवेश में भूमि क्षमता के आधार पर फसल चयन और कृषि पद्धति तथा भूमि उपयोग की योजना किसानों के लिए महत्वपूर्ण मूद्दे हैं। जलवायु परिवर्तन, प्रक्षेत्र उत्पादन, जैवविधिता, वन्य प्राण और मानव संघर्ष स्वास्थ्यवर्धक खाद्य पदार्थों की बाजार मांग और सजावटी पौधे आदि फसलों तथा फार्म आय को प्रभावित कर रही हैं। इसलिए पौधे, प्रक्षेत्र के लिए इसके प्रक्रम, मूल्यवर्धन, गुणवत्ता नियंत्रण, बाजारयुक्त उत्पाद आदि पर प्रसार एवं परामर्श सेवाएं संस्थान की प्रमुख गतिविधियां हैं। अकाडमी सीएसआईआर के स्कॉलर ने इसके लिए विविध प्रकार के सर्वेक्षण करके जल गुणवत्ता, ग्रीनहाउस की कार्यक्षमता, महिलाओं में अनीमिया, महत्वपूर्ण सब्जियों में रोग और हि.प्र. में मार्गों की दशा का विश्लेषण किया गया है। ताकि ग्रामीण लोगों के जीवन यापन में सुधार के लिए एक आधार तैयार हो सके। औषधीय पौधों के संग्रहण, सुखाने, सगंध तेल निष्कर्षण, पुष्प कला, मशरुम उत्पादन और बाँस उत्पादन क्षेत्रों में संस्थान द्वारा प्रशिक्षण प्रदान किए गए।

वर्ष के दौरान हिमाचल प्रदेश के कांगड़ा, चम्बा, मंडी, कुल्लू, और शिमला जिलों के 280 ग्रामीणों व किसानों को प्रक्षेत्र सर्वेक्षण, प्रशिक्षण और परामर्श सत्रों के दौरान पंजीकृत किया गया। हिमाचल प्रदेश के किनौर और कल्पा और जम्मू कश्मीर के 9 विभिन्न समूहों को बांस, आभूषक, औषधीय एवं सगंध फसलों का प्रशिक्षण दिया। चम्बा, मंडी और कुल्लू जिलों में स्टीविया, दमस्क गुलाब, जंगली गेंदा, लेवेन्डर, रोजमेरी, जिन्को व मुश्कबाला फसलों के लिए 11 हैक्टेयर क्षेत्र के लिए रोपण सामग्री व प्रसार सेवाएं उपलब्ध करवाईं। भारतीय चाय बोर्ड के क्षेत्रीय केन्द्र के साथ मिलकर हिमाचल प्रदेश के कांगडा क्षेत्र के चाय उत्पादकों के लिए परामर्श एवं प्रसार सेवाएं लगातार जारी रखीं। इस वर्ष 12 प्रशिक्षण कार्यक्रमों का आयोजन किया गया जिसमें से एक उतराखंड के चाय उत्पादकों के लिए था। इसमें 100 से अधिक चाय उत्पादकों ने भाग लिया। बड़ी इलाइची एक नगदी फसल है और प्रदेश के मध्यम पहाड़ी क्षेत्र इसकी खेती के लिए बहुत उपयुक्त है। इस वर्ष उपयुक्त किस्मों के 480 पौधे इस क्षेत्र में के लिए उपलब्ध कराए तथा दो प्रशिक्षण कार्यक्रम आयोजित किए गए। गेंदे की बहुत अधिक मांग है इस वर्ष पुसा नारंगी किस्म के 4 प्रदर्शन इकाईयां प्रौद्योगिक गांव गोपालपुर में स्थापित किए गए। बाँस की विभिन्न प्रजातियों के 17015 पौधे हिमाचल, पंजाब, हरियाणा तथा जम्मू व कश्मीर में भेजे गए। ग्राम पंचायत राख में बाँस की दो प्रजातियों के 1000 पौधे लगाए गए तथा ग्रामीणों को बॉस की खेती और इसके प्रबन्धन के लिए प्रशिक्षित भी किया गया। गोपालपुर क्षेत्र में 10 प्रदर्शन इकाइयॉ स्थापित की गई और 15 महिलाओं को प्रशिक्षित किया गया। मध्यम हिमालयी क्षेत्र के लिए जंगली गेंदे की खेती बहुत ही लाभदायक सिद्ध हुई है। चम्बा की एक संस्था के माध्यम से किसानों के खेतों में प्रदर्शन प्रक्षेत्र स्थापित किए गए।

संस्थान के उच्च तुंगता जीवविज्ञान केन्द्र में चाइनिज जिनसेंग, पिक्रोराइजा कुरुआ, केसर जैसी व्यावसायिक दृष्टि से महत्वपूर्ण फसलें किसानों के खेतों में लगाई गई। इसी केन्द्र में हर्बल गार्डन और पौधशाला स्थापित की गई जिसमें 42 औषधीय एवं लुप्तप्राय

पौधों का रोपण किया गया।

संस्थान द्वारा 6 उतक संवर्धन इकाइयों को सहयोग दिया तथा 8.78 लाख पौधों को तैयार करने में सफलता पाई। कृषि विभाग, हिमाचल प्रदेश के सहायोग से 'कांगड़ा घाटी में चाय बागानों के मशीनीकरण' के लिए एक कार्यशाला का आयोजन 14 मार्च 2015 को किया गया। विधानसभा अध्यक्ष श्री बीबीएल बुटेल ने इस कार्यशाला का शुभारम्भ किया। 125 प्रतिभागियों ने इसमें भाग लिया। भारत सरकार के सहयोग से 'मूल्यवर्धित खाद्य उत्पाद' पर एक जागरुकता सेमिनार का आयोजन 30 दिसम्बर 2014 को किया गया। स्टीविया की खेती हेतु 'हिम स्टीविया' व जरबेरा फूलों की खेती के लिए संस्थान द्वारा विकसित 'हिमग्लो' और 'हिम पीस' नाम की किस्मों को विमोचित किया गया।

योजना, परियोजना, अन्वेक्षण और मूल्यांकन इकाई

सी.एस.आई.आर. तथा आई.एच.बी.टी. के वार्षिक प्रतिवेदन के लिए सूचना को एकत्रित किया तथा प्रतिमाह परिषद मुख्यालय को उपलब्ध कराया गया। 22–23 मार्च 2015 को संपन्न हुई कार्यशाला के लिए वेबपेज तैयार किया गया ताकि ऑनलाइन पंजीकरण किया जा सके। 16–17 अक्तूबर 2014 को स्कूल अध्यापकों के लिए प्रशिक्षण कार्यक्रम का आयोजन किया गया। क्रय पक्रिया को सरल करने के उद्देश्य से वेब आधारित कार्यक्रम तैयार किया गया। पूरी हुई 12 परियोजनाओं की सूचना को संकलित किया। अब 174 परियोजनाओं की जानकारी उपलब्ध है। 51वीं अनुसंधान परिषद बैठक का आयोजन 9 जून 2014 को किया गया। संस्थान परिसर में विभिन्न संस्थानों के 49 छात्रों को प्रशिक्षण दिलाया गया। संस्थान की गतिविधियों को बताने तथा स्कूली छात्रों में विज्ञान के लोकप्रियकरण के लिए समय–समय पर संस्थान में शैक्षणिक भ्रमण कराया गया। सूचना के अधिकार अधिनियम के अन्तर्गत 16 मामलों की जानकारी प्रदान की तथा उक्त जानकारी को आरटीआई पोर्टल पर लगाया। 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। संस्थान की वेबसाइट और इंटरनेट को नियमित रुप से अद्यतन किया गया।

पेटेंट एवं प्रकाशन

वर्ष के दौरान संस्थान ने भारत में 3 तथा विदेशों में 4पेटेंट फाइल किए तथा 4 विदेश में प्राप्त/पंजीकृत हुए। वर्ष के दौरान संस्थान ने स्तरीय जर्नल में 127 शोध पत्र प्रकाशित कराए। पुस्तकों में 6 लेख/पाठ प्रकाशित हुए। 2 तकनीकी ब्रोशर भी प्रकाशित हुए। संस्थान के वैज्ञानिकों ने तथा 32 बैठकों, संगोष्ठियों तथा कार्यशालाओं में प्रतिभागिता तथा 12 में प्रस्तुतिकरण किया। वैज्ञानिकों ने वर्ष के दौरान 12 दूरदर्शन शिमला से कृषि दर्शन कार्यक्रम के अन्तर्गत व अन्य चैनलों 2 कार्यक्रम प्रसारित किए।

पुरस्कार एवं सम्मान

डा. संजय कुमार को पतिष्ठित वास्विक पुरस्कार प्राप्त हुआ।

डा. परमवीर सिंह आहूजा, महानिदेशक को बीरबल साहनी जन्मशताब्दी मेडल व फाउंडेशन सम्मान प्राप्त हुआ।

डा. परमवीर सिंह आहूजा को इंडियन फर्न सोसायटी का मानद फेलो चुना गया।

डा. अनिल सूद को इंडियन फर्न सोसायटी का मानद फेलो चुना गया।

डा. सुदेश कुमार को हरियाणा राज्य विज्ञान, प्रौद्योगिकी परिषद से हरियाण युवा विज्ञान रत्न सम्मान प्राप्त हुआ।

डा. राकेश कुमार सूद को राष्ट्रीय प्रौद्योगिकी संस्थान, हमीरपुर के डीएसटी नवोन्मेष और उद्यमिता विकास केन्द्र का सदस्य बनाया गया।

संस्थान ने 14 विश्वविद्यालयों/ संस्थानों के 38 छात्रों को प्रशिक्षण प्रदान किया। 8 शोध छात्रों ने पी.एच.डी. प्राप्त की, 39 छात्रों ने स्नातकोत्तर तथा 10 ने बी.टेक. डिग्री के लिए शोध–प्रबन्ध विभिन्न विश्वविद्यालयों में जमा किए। संस्थान ने अपनी प्रौद्योगिकी के ज्ञान के प्रसार के लिए 6 संस्थानों से अनुबन्ध किए।

कम्प्यूटर इकाई

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

आई.एच.बी.टी. ज्ञान संसाधन केन्द्र

आई.एच.बी.टी. का ज्ञान संसाधन केन्द्र में विज्ञान एवं प्रौद्योगिकी से संबन्धित पंद्रह हजार दस्तावेज जैसे की पुस्तकें, इबुक्स, हिंदी पुस्तकें, साजिल्द वाल्यूम जर्नल, शोध प्रबन्ध, सीडी आदि है, जो कि संस्थान ज्ञान संसाधन केन्द्र के वैज्ञानिकों तथा तकनीकी कर्मियों तथा पालमपुर के आस–पास के शैक्षणिक केन्द्रों को लगातार सेवाएं प्रदान कर रहा है। लिबसिस का उपयोग करते हुए ज्ञान संसाधन केन्द्र पूरी तरह से कम्प्यूटरीकृत है तथा वेब आधारित कोहा में परिवर्तित कर दिया गया है। इसे http://library.ihbt.res.in द्वारा देखा जा सकता 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 नवीनतम पुस्तकों, पत्रिकाओं आदि की जानकारी सभी को उपलब्ध कराई जाती है। राष्ट्रीय ज्ञान संसाधन केन्द्र कन्जोटियम के अन्तर्गत 2000 से अधिक इ–जर्नल और डेटाबेस को देखा जा सकता है। हजारों उपयोगकर्ताओं ने केन्द्र की सेवाओं का लाभ उठाया। पठन–पाठन के लिए पुस्तकें पाठकों को जारी की गई। फोटोकापी सेवा प्रदान की गई। ऑनलाइन जर्नल को देखने के लिए पाठकों को प्रशिक्षण भी प्रदान किया गया।

STAFF

Scientific

Director
Dr. P. S. Ahuja*
up to 31 December 2014)
Dr. Sanjay Kumar
from 11 June 2015

Chief Scientist
Dr. Anil Sood (Acting Director, 02.02.2014 to 30.04.2015)
Dr. Arvind Gulati
Dr. Bikram Singh
Dr. Virendra Singh

Sr. Principal Scientist
Sh. D Dhyani
Er. KK Singh
Dr. Ashu Gulati
Dr. Brij Lal
Dr. RK Sud

Principal Scientist
Dr. Aparna Maitra Pati
Er. GD Kiran Babu
Dr. Amita Bhattacharya
Dr. Gopi Chand
Dr. SK Vats
Dr.Vipin Hallan

Senior Scientist
Dr. Sanjay K Uniyal
Dr. RK Sharma
Er. Amit Kumar
Dr. Y Sreenivasulu
Dr. Sudesh Kumar
Dr. Sanat Sujat Singh
Dr. Rakesh Kumar
Dr. Som Dutt***
Dr. Shashi Bhushan
Dr. Rituraj Purohit**
Dr. S. K. Maurya**

Scientist
Dr. Gireesh Nadda
Dr. Neeraj Kumar
Dr. Pralay Das
Dr. Vijai Kant Agnihotri
Dr. Ravi Shankar
Dr. Probir Kumar Pal
Dr. Anil Kumar Singh
Dr. Amit Chawla
Dr. SGE Reddy
Dr. Partha Ghosh
Dr. Mahesh Gupta
Dr. Yogendra S Padwad
Er. Mohit Sharma
Dr. Ashok Kumar
Dr. Yogesh B Pakade
Dr. Amitabha Acharya
Dr. Dinesh Kumar
Dr. Vikram Patial
Dr. Manoj Kumar
Dr. Damanpreet Singh
Dr. Vishal Acharya**
Dr. Ashok Singh**
Dr. Upendra Sharma**
Dr. Bhavya Bhargava**
Dr. Kunal Singh**

Technical

Principal Tech. Officer
Dr. Raja Ram
Sh. Mukhtiar Singh

Sr. Technical Officer (3)
Sh. Om Prakash
Dr. Kiran Kaul*
Sh. RS Shekhawat

Sr. Technical Officer (2)
Sh. Sukhjinder Singh
Sh. Robin Joshi

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
Sh. Khirod Sahoo***
Dr. Rajneesh
Dr. Pankaj K Markand
Sh. Shiv Kumar

Technical Officer
Sh. Rakesh Kumar
Sh. Anil Kumar
Sh. Vivesh Sood
Sh. Mahesh S
Sh. Ramjeelal Meena
Sh. Sanjay Kumar
Sh. Mohit K. Swarnkar
Sh. Jasbeer Singh
Sh. Mukesh Gautam
Sh. Om Parkash
Sh. Prashanta K Behera***
Ms. Vijay Lata Pathania
Sh. Pabitra Gain

Technical Assistant
Ms. Meenakshi
Sh. Arvind Kumar Verma
Sh. Anil K Choudhary
Sh. Dharmesh Kumar
Sh Pawan Kumar

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

Technician(2)
Sh. Bhushan Kumar
Sh. Harmesh Chand
Sh. Ramesh Kumar
Sh. Dharub Kumar
Sh. Parveen Kumar
Sh. Kuldip Singh
Sh. Sanjay Kumar
Sh. Avinash C Rana

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

Lab Assistant
Sh. Naresh Kumar
Sh. Amar Singh

Lab Attendant Gr. I(2)
Sh. Baldev Singh

Ms. Rajni Devi Chettri
Sh. Rakesh Chand
Ms. Anupama Saini
Sh. Shamsher Singh

Lab Attendant Gr. I(1)
Sh. Uttam Chand
Sh. Balak Ram
Sh. Girja Nand
Sh. Deepak Sood
Sh. Kuldip Singh
Sh. Balwant Raj

Administration

Administrative Officer
Sh. JK Prashar

Section Officer (G)
Sh. SD Rishi
Sh. Amarjeet

Assistant (GEN) Gr. I
Sh. Shanti Kumar*
Sh. Raj Kumar
Sh. Parveen Singh
Sh. Devraj Nagina
Sh. Ved Prakash
Sh. Keerti Raj

Assistant (GEN) Gr. II
Ms. Santosh Kumari
Sh. Baldev
Sh Kiran Kumar
Ms. Pooja Awasthi

Senior Stenographer
Sh. Didar Singh Patial

Senior Hindi Translator
Sh. Sanjay Kumar

Security Assistant
Sh. Trilok Nath

Coupon Clerk
Sh. Anand Sharma

Staff Car Driver
Sh. Om Prakash
Sh. Pratap Chand
Sh. Braham Dass

Cook
Sh. Oman Singh
Sh. Karan Singh

Chowkidar
Sh. Baleshwar Prasad
Sh. Jagat Ram*
Sh. Bahadur Ram
Sh. Ramesh Kumar
Sh. Kuldip Singh
Sh. Bhawani Ram

Tea/Coffee Maker
Sh. Bipan Gurang

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

Finance & Accounts

Finance & Accounts Officer
Sh. Ishwar Dass

Section Officer (F&A)
Sh Darshan Singh transferred from CSIR-IIIM, Jammmu on 29.09.2014

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

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

Store & Purchase

Store & Purchase Officer
Sh. SP Prabhakar

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

Assistant (S&P) Gr. II
Sh. Ashish Sobti***

Transferred from CSIR Laboratories

Sh Darshan Singh from CSIR-IIIM, Jammmu on 29.09.2014

Superannuation*
Sh. Janak Singh, Sr. Tech (2), 31.07.2014
Sh. Gian Chand Sr. Tech (2), 31.08.2014
Sh. Jagat Ram, Group 'C'(Non Tech), 31.07.2014
Dr. P. S. Ahuja, Director on 31.12.2014
Sh. Shanti Kumar, Assitt (Gen) Gr.1, 31.01.2015.
Ms. Krishna Devi, Gr. 'C' Non Tech, 31.03.2015.
Dr Kiran Kaul STO (2) on 31.03.2015

****Newly joined staff during 2014-15**
Sh. Devendra Singh (02.08.2014)
Dr. Vishal Acharya(20.08.2014)
Dr. Ashok Singh(21.08.2014)
Dr. Upendra Sharma (01.09.2014)
Dr. Bhavya Bhargav(02.09.2014)
Dr. Kunal Singh (03.09.2014)
Dr. Rituraj Purohit(26.12.2014)
Dr. Sushil Kumar Maurya (16.02.2015)

*****Resigned**
Sh. Ashish Sobti, Asstt(S & P) on 17.09.2014
Sh. Khirod Sahoo, S.T.O. (I) on 10.04.2014
Sh. Prashanta Kumar Behra, T.O., 02.07.2014
Dr. Som Dutt, Sr. Sct., 30.05.2014

Principal Investigators/ Scientist Fellow/ NAM Research Fellow/ Sr. Research Fellow/ Jr. Research Fellow

Scientist Emeritus
Dr. S.K. Sharma
Dr. O.P. Sharma

Scientist Fellow
Dr. (Ms.) Kiran Devi
Dr. (Ms.) Alka Kumari
Dr. Dharam Singh

DST INSPIRE Faculty Awardee
Dr. Rakshak Kumar

DST Young Scientist
Dr. Sandeep Rawat

Principal Investigators

Dr. Ugir Hossain
Dr. (Ms.) Tanuja Rana
Dr. (Ms.) Dipali Katoch
Ms. (Ms.) Nidhi Sharma

SRF
Mr. Himanshu Sharma
Ms. Ruchi Sharma
Mr. Sunny Dhir
Mr. Rahul Mohan Singh
Mr. Saurabh Sharma
Mr. Gulshan Kumar
Ms. Amita Kumari
Mr. Surinder Kumar
Mr. Nitul Ranjan Guha
Ms. Prithu Pratibha
Ms. Shashi Kiran
Ms. Mrigaya Mehra
Ms. Sushila Sharma
Mr. Aditya Kulshresta
Ms. Vandna Chawala
Mr. Jai Parkash
Mr. Sandeep Kumar
Ms. Shikha
Ms. Parul Goel
Mr. C.Bal Reddy
Mr. Manoranjan Kumar
Mr. Vishal Sharma
Ms. Preeti
Ms. Monika Bhuria
Mr. Ajay Kumar
Ms. Poonam Roshan
Ms. Indu Gangwar
Ms. Shivalika Pathania
Ms. Kiranman Singh Rawat
Ms. Madhu Kumari
Ms. Vandna Thakur
Ms. Bharti Lalhan
Mr. Vinod Bhatt
Mr. Saurabh Sharma

JRF
Mr. Ganesh P Panzade
Mr. Dinesh Thakur
Mr. Sourabh Soni
Ms. Rubbel Singla
Mr. Roushan Kumar
Mr. Maheshwar Singh Thakur
Ms. Tanvi Sharma
Ms. Nisha Dhiman
Mr. Aridam Ghosh Majumdar
Mr. Manpreet Sharma
Mr. Rakesh Kumar
Mr. Inder Singh

Death/ Expired
Dr. RD Singh, Chief Scientist on 08.10.2014
Sh. Kewal Chand, Sr. Technician(2) on 16.01.2015
Sh. Yam Bahadur Chettri, Lab Attendt. On 05.02.2015
Sh. Puneet Kumar, Asstt. (S&P) Gr-II on 11.02.2015

STAFF SUPERANNUATED

Sh. Janak Singh, Sr. Tech (2)
on 31.07.2014

Dr. P. S. Ahuja, Director
on 31.12.2014

Sh. Jagat Ram, Group 'C' (Non Tech)
on 31.07.2014

Sh. Gian Chand, Sr. Tech (2)
on 31.08.2014

Sh. Shanti Kumar, Assistant
on 31.01.2015

Dr. Kiran Kaul, STO (2)
on 31.03.2015

Ms. Krishna Devi
on 31.03.2015

ADMINISTRATION

Administration is responsible for providing services to scientific and technical staff for their service matter like personnel, maintenance of service records, payment of salary, upkeep & security of the institute's property, and recruitment of staff. For the disposal of waste at the institute, an arrangement has been made with the local administration. Also have liaison with the state administration on different matters related to the institute. Implement the policies concerning administrative procedures for smooth functioning of the institute, liaison with CSIR on matters related to administration. Provide healthy working environment at the institute by correct interpretation of rules and regulations.

FINANCE & ACCOUNTS DIVISION

Finance & Accounts is playing vital role in catering to the financial needs of the institute by providing support to scientific, technical and administrative officials of the institute. The division manages the activities related to the budgetary control and taking care remedial measures for effective monitoring and utilization of budget according to the guidelines issued by CSIR. In addition to maintaining the accounts of the institute it provides services for effective planning; utilization and post utilization of grants received for technical services and sponsored grant-in-aid projects.

Glimpse of broad activities and functions of the division:

- To assist and advise the Director on all financial matters including inputs relates to other matters.
- Preparation and compilation of Budget estimates, revised estimates and supplementary grants.
- Management of the financial resources received in the form of CSIR Grant and Externally Funded Projects & Lab Reserve of the Institute.
- Ensuring that the economy instructions of the Govt. of India are scrupulously followed and also exercising necessary budgetary control.
- Financial concurrence of proposal relates to various Divisions of the Institute.
- To keep liaison with CSIR Hqrs. on matter related to finance/accounts/audit etc.
- Coordination the works related to Internal Audit and External Audit (CAG) and furnishing replies to the concerned authorities.
- Authorization of payment to all suppliers/contractors for their supplies/services.
- Making payment to all staff for their personal claims and official advances etc.
- Maintenance of Vouchers and Accounts Registers/Ledgers.
- All matters related to Banks collecting debits, credits, Bank statement, DDs, NEFT & RTGS transfers etc.
- Maintenance and monitoring of loans and advances paid to staff, govt. departments and private parties etc.
- Finalization of pension & family pension including issuance of pension payment orders and timely payment of pensionary benefits.
- Submission of periodical financial statements to CSIR Hqrs like Monthly Account, Annual Accounts, Transfer of funds, Monthly progressive receipt & expenditure, OB, Bank reconciliation, EMR expenditure, property, GPF/CPF etc.
- Investing the funds from sponsored projects & Lab Reserve.

COMPUTER CELL

IHBT campus has wide network facilities over the fiber backbone with a fleet of servers from HP, IBM and Supermicra. Under National Knowledge Network dedicated 1Gbps leased line has been provided for Internet facility throughout the campus including hostel and faculty residences.Implemented centralized wireless solution in the Institute enabling users an easy access to internet irrespective of location within the campus including hostel and residences.

Staff: Vikrant Gautam

Network security hardware like Unified Threat Management Solutions, IDS, IPS, Centralized wireless controller, anti-virus on client server based model and SMTP spam/virus protection software etc, and its policies have been deployed to protect IHBT resources centrally.

Constant support was lent for in-house management of IHBT DNS (Domain Name Server), WEB, Email and Proxy servers on Linux. Also facilitated Virtual Classroom and Video-Conferencing facilities for the Institute. This cell constantly extended services related to network, computers and peripherals over Local Area Network in the campus.

IHBT-KNOWLEDGE RESOURCE CENTRE (IHBT-KRC)

Library of the Insitute has a collection of relevant books, bound journals, theses and compact discs of the Science and Technology especially concerning to the field of plant sciences. It includes a good collection of Hindi language books covering the field of science, technology, computer science, social science journalism, religion, etc. Catalogue of library collection with necessary bibliographical details has been maintained in KOHA software of Library Management. Library page can access at http://library.ihbt.res.in.

The Web based catalogue Online Public Access Catalogue (OPAC) of the Library collection has been made available on internet as maintained in KOHA. It has the facilitiels like, on-line reservation for a desired document, renewal for document already issued and recommendation for new titles in addition to present status of a particular document.

Being a participating library to the National Knowledge Resource Consortium (NKRC) institute has access to >2000 e-journals of major publishers in science and technology area and researchers have accessed eighty thousand research papers from online journals in addition to physical visitors including scientists, students, research scholars, faculty members from several academic and R&D institutions consulted library resources. Services were rendered from library to scientists for preparation citation report and publishing of

Staff: Rujala Devi, Jasveer kaur, Mukhtiar Singh, Naresh Kumar

research papers in journals.

Bibliographies on specific topics were provided to researchers and research papers were also made available from the other libraries. Services for printing, photocopying and binding of various documents and activities of publications research reports, technical folders were facilitated from library.

Photography Unit

This unit provides a comprehensive photographic and videography services in the Institute, which includes recording research activities both in the labs as well as in the demonstration plots for all the scientists and scholars. It strives to achieve the highest standards using traditional skills and modern technologies with high production values and commitment to quality to ensure best reproduction in theses and publications.

The collection and preservation of photographic images includes photographs of field trials at different intervals as well as special videography of the field experiments. In addition to providing direct support to research and development activities, the unit covers activities of all the official functions, trainings, workshops, conferences and symposia organised in the Institute.

It also caters to the requirement for television programmes by scientists depicting their field and lab activities, demonstration/experimental plots and field surveys along with interviews with farmers and entrepreneures those are provided with the technologies from the Institute.

Staff: Pabitra Gian

IMPORTANT EVENTS

National Technology Day

National Technology Day was celebrated on 11th May, 2014. Dr. C.R. Bhatia, Former Secretary, DBT GoI delivered the Technology Day lecture on "Development of Technology". Prof. S.K. Joshi, Former DG CSIR and Vikram Sarabhai Professor presided over the function.

CSIR-IHBT Foundation Day

IHBT Foundation Day celebrated on 10th June 2014. Dr. Samir Bhattacharya, Chairman, IHBT Research Council delivered Foundation Day lecture on the topic entitled *"Lipid links inflammation, insulin resistance and immunity"*. Dr. Ram A. Viswakarma, Director CSIR-IIIM, Jammu and Dr. Siddharth Roy, Director CSIR-IICB, Kolkata was the Guest of Honors. Dr. P.S. Ahuja, DG CSIR presided over the function.

CSIR Foundation Day

CSIR Foundation Day celebrated on 26th September, 2014 at this Institute. Dr. K.C. Bansal, Director, NBPGR, New Delhi delivered Foundation Day lecture on the topic entitled "Utilization of genetic resources for ensuring food security in the changing climate". Prof. V.L. Chopra, Former Member, Planning Commission, Govt. of India presided over the function.

National Science Day

National Science Day celebrated on 28th February, 2015 at CSIR-IHBT. Prof. R.S. Sangwan, CEO, CIAB, Mohali delivered Science Day lecture on "New waves of attraction in Plant Sciences: Food to Phytochemistry, Flavor and Phytotherapy". Dr. P.S. Ahuja, Former Director General, CSIR was the Guest of Honour and Dr. K.K. Katoch, Vice Chancellor, CSK HPKV was the Chief Guest of the function.

National Conference on Modern Approaches to Pteridophytes: Biology, Biodiversity, Bioresource" during 20-21st December, 2014.

An awareness seminar on "Value added food products" for MSME Sector Development organized on 30th December, 2014 which has participants from industry partner, entrepreneurs and state authorities.

Obituaries

Dr. RD Singh, Chief Scientist
on 08.10.2014

Sh. Kewal Chand, Sr. Technician(2)
on 16.01.2015

Sh. Yam Bahadur Chettri, Lab Attendant
On 05.02.2015

Sh. Puneet Kumar, Asstt. (S&P) Gr-II
on 11.02.2015

CSIR products a major attraction for visitors

कांगड़ा

लेह लद्दाख में किया जा रहा बीजों का संरक्षण

- राह को आने ने आने के लिए चुनौतियों को स्वीकार करें: डॉ. अमित
- आईएचबीटी में मनाया वीएआर-इंडार का स्थापना दिवस

आईएचबीटी पालमपुर में सीएसआईआर के स्थापना दिवस के अवसर पर पौधरोपण करते हुए महानिदेशक मोहपात्रा, सचिवालयी निदेशक डॉ अमित सूद व अन्य।

धुरगुणा में मधुमेह मिटाने का गुण

आईएचबीटी पालमपुर ने बाजार में उतारे स्टीविया के उत्पाद

जड़ी-बूटियों के बारे में दी जानकारी

विज्ञान अध्यापक न जाने वैज्ञानिक गतिविधियां

फनें पर शोध को जुटेंगे देशभर से वैज्ञानिक

एंजाइम पर आईएचबीटी का कोलकाता कंपनी से करार

कार्यालय संवाददाता, पालमपुर

■ सौंदर्य प्रसाधन उद्योग में होगा इस्तेमाल

उच्च पर्वतीय क्षेत्र के एक पौधे से खोज निकाले गए सॉड एंजाइम को प्रौद्योगिकी को हस्तांतरित करने को लेकर पालमपुर स्थित हिमालयन जैव संपदा प्रौद्योगिकी संस्थान ने मै. फाइटो बायोटेक, कोल

दिए। बायोइन्फोटमेटिक के ज्ञान का उपयोग करते हुए इस एंजाइम में थर्मोस्टेबिलिटी को चढ़ाने के लिए तैयार किया गया है। इस सॉड को

एक करार किया है। अनुसार कई वर्षों के के बाद ऑटोक्लेव डिस्मयूटेज (सॉड) रहस्यों को खोज प्राप्त हुई है। इसके जीन को क्लोनों

बुढ़ापे को दूर रखने वाले एन्जाइम का होगा उत्पादन

प्राकृतिक जड़ी-बूटियों का खजाना है स्पीति घा

केलंग सहित कई लाहुलाज वीमारियों के लिए रामबाण हैं यह जड़ी-बूटियां

CSIR conference in Palampur on Dec 20-21

कांगड़ा चाय अब नए फ्लेवर में

मूल्यवर्द्धित खाद्य उत्पादों

बारे किया जागरूक

हरित क्रांति से जमीन की उर्वरता में आई कमी

New varieties of stevia, gerbera developed

जंगली जानवरों के लिए फांस बनेगा बांस

अब लंबे समय तक सुरक्षित रहेंगे खाद्य पदा

आईएचबीटी पालमपुर का कोलकाता की फर्म के साथ हुआ करार

आईएचबीटी ने कांगड़ा चाय को दिया जीवन

नाम-आईएचबीटी
स्थान-पालमपुर
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