

Division: **Biotechnology**

Designation: **Senior Principal Scientist**

Specialization: **Plant tissue culture and its application in conservation and improvement of commercially important plants of western Himalayas**

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Qualification: **Ph.D.**

Research Focus:

Major focus of the group is conservation and improvement of commercially important plants of western Himalaya. Therefore, studies are being undertaken to gain basic understanding of the biology of medicinal plants, saffron, bamboo and ferns using transcriptome, proteome biochemical and *in vitro* approaches with an aim to:

- Develop *in vitro* systems for plant regeneration.
  - Produce and modulate secondary metabolites in alternative systems.
  - Genetically modify and develop transgenic crop plants for abiotic stress tolerance.
  - Mass multiply and rehabilitate high value endangered/critically endangered medicinal plants of mainly, alpine/sub-alpine Himalayas like *Fritillaria roylei*, *Nardostachys jatamansi*, *Picrorhiza kurroa*, *Dactylorhiza hatagirea* for their conservation and sustainable utilization.
- ✓ In addition, micropropagation and macropropagation of commercially important plants like potato, saffron, apple scion and rootstock, bamboos, lavender, large cardamom, coleus, scented rose, ferns etc. are catering to the demands of the industry and farmers.
- ✓ Other major activities of the group include incubation of entrepreneurs and training of young graduates/post-graduate students in plant tissue culture in order to increase their employability.

### **Achievements of the group**

Societal and Industrial

- Fifteen trainees are being skilled for Diploma in 'Advanced Plant Tissue Culture' under Skill Development Programme of DBT, Gov. of India.
- More than thousand growers, forest officials and people from NGOs were trained in nursery practices of bamboos
- A total of 04 Material Transfer Agreements signed with various plant tissue culture industries for bamboos (03 nos.) and medicinal plants (01 no.) between 2016-2018.
- MoU was signed with Dhauladhar Bioplant, Trilokpur, H.P. for tissue culture and aeroponic cultivation of potato.
- Tissue culture raised plantlets of *Picrorhiza kurroa* (>10,000) at Bharmour, Chamba and several hundred *Fritillaria roylei* and *Nardostachys jatamansi* were rehabilitated in natural habitats and Lahual & Spiti.
- More than four lakhs of quality planting material of commercially important bamboos were raised and supplied to different agencies of Himachal Pradesh, Haryana and Punjab.
- Systems (tissue culture and agro-practices) have been developed for promoting Palampur region as a hub for production of quality corms of saffron in marginal farmers field.
- A collector of medicinal plants from wild was transformed into a cultivator of endangered medicinal plants of western Himalaya.
- The collector of medicinal plant signed an MoU for establishing a firm for sale of tissue culture raised plants of *P. kurroa*.
- Imparted trainings on 'plant tissue culture' to entrepreneurs, academia and industry every year.



- Earned 40% of the total expenses incurred by the group through sale of planting material and trainings for entrepreneurship.

### Individual Achievements

- Work on development of transgenic tea plants has drawn international attention and has been discussed in the article '[Engineering a better beverage' in Nature \(2019\) vol. 566: S12-S13.](#)
- A total of 08 Patents granted including 06 from US.
- [Work on bamboo featured on cover page of Proteomics 15: 1291-1306](#)
- Member of DBT Task Force for “Value-added Biomass & Products from Natural Resources”
- Faculty member of CSK HPKV and AcSIR.
- Course coordinator for Skill Development Programme in Plant Tissue Culture (2018-2021).
- [Associate Editor, Plant Cell Tissue and Organ Culture w.e.f. January 2020](#)

### Awards:

- National Merit Scholarship for second position in B.Sc. (Hons.)
- Chinese Government Scholarship (1994-1996) under bilateral exchange program, Human Resources Development, Govt. of India
- Raman Research Fellowship (2005 to 2006), CSIR.

### The research group:

#### Students

- Bhuvnesh Sareen (ICMR Senior Research Fellow) is trying to understand the biology of fern gametophytes and its use as potential resources of genes and proteins.
- Nisha Dhiman (UGC NET Senior Research Fellow) is developing alternative *in vitro* systems for *N. jatamansi* as an effort towards its conservation.
- Neetu Gautam (ICMR Senior Research Fellow) is developing alternative systems for secondary metabolite production in saffron.
- Priya Brat Shethi (PA level I) is attempting micropropagation of endangered and critically endangered medicinal plants of Himalayas.
- Ishu Sharma (PA level II) is developing micropropagation systems of commercially important bamboos for industrial applications.

#### Technical Staff

- Dr. Kiran Devi (Senior Technical Officer) is working on tissue culture of commercially important plants including alpine/sub-alpine plants of western Himalaya.
- Parveen Sharma (Senior Technician) and Shri Ajay Kumar (Field Assistant) are catering to industrial and societal demands through mass multiplied plants of commercial importance.

### Recent publications:

1. Sareen B., Thapa P., Joshi R., **Bhattacharya A.** (2019) proteome analysis of the gametophytes of a western Himalayan fern *Diplazium maximum* reveals their adaptive responses to changes in their micro-environment. *Frontiers in Plant Sciences. Plant Proteomics* <https://doi.org/10.3389/fpls.2019.01623>.
2. Dhiman N., Sharma N.K., Thapa P., Sharma I., Swarnkar M.K., Chawla A., Shankar R., Bhattacharya A. (2019) De novo transcriptome provides insights into the growth behaviour and resveratrol and trans-stilbenes biosynthesis in *Dactylorhiza hatagirea* - An endangered alpine terrestrial orchid of western Himalaya. **Scientific Reports** 9: 13133 | <https://doi.org/10.1038/s41598-019-49446-w>.
3. Dhiman N., Bhattacharya A. (2019) *Nardostachys jatamansi* (D.Don) DC.-Challenges and opportunities of harnessing the untapped medicinal plant from the Himalayas. **Journal of Ethnopharmacology** <https://doi.org/10.1016/j.jep.2019.112211>.

A few significant publications in the area of:

### Transgenic crops (Tea)

1. Sandal I., Koul R., Saini U., Mehta M., Dhiman N., Kumar N., Ahuja P.S., **Bhattacharya A.** (2015) Development of transgenic tea plants from leaf explants by the biolistic gun method and their evaluation. **Plant Cell Tiss Organ Cult.** DOI 10.1007/s11240-015-0828-x.
2. **Bhattacharya A.**, Sharma M., Gulati A., Joshi R., Chanda S.K., Ahuja P.S. (2014) Histochemical evaluation of catechins in PEG stressed transgenic tea plants by catechin-specific-diazotized sulfanilamide reagent. **Biotechnic & Histochemistry.** 90(1):45-54, DOI: 10.3109/10520295.2014.942369
3. **Bhattacharya A.**, Saini U., Joshi R., Kaur D., Pal A.K., Kumar N., Gulati A., Mohanpuria P., Yadav S.K., Kumar S., and Ahuja P.S. (2014) *Osmotin* expressing transgenic tea plants have improved stress tolerance and quality parameters. **Transgenic Research** 23(2): 211-223, DOI: 10.1007/s11248-013-9740-5.
4. Kumar N., **Bhattacharya A.**, Gulati A. (2013) L-glutamine and L-glutamic acid facilitate successful *Agrobacterium* infection of recalcitrant tea cultivars. **Applied Biochemistry and Biotechnology.** DOI 10.1007/s12010-013-0286-z.
5. Saini, U. Kaur. D, **Bhattacharya A.**, Kumar, S., Singh, R. D., Ahuja P. S. (2012) Optimising parameters for biolistic gun-mediated genetic transformation of tea [*Camellia sinensis* (L.) O. Kuntze]. **The Journal of Horticultural Science & Biotechnology** 87 (6): 605-612.
6. Sandal I, **Bhattacharya A.**, Saini U, Kaur D, Sharma S, Gulati A, Kumar, JKK, Kumar N, Dayma J, Das, P, Singh B, Ahuja PS (2011) Chemical modification of L-glutamine to alpha-amino glutarimide on autoclaving facilitates *Agrobacterium* infection of host and non-host plants: A new use of a known compound. **BMC Journal of Chemical Biology** 11:1-13. DOI:10.1186/1472-6769-11-1.
7. **Bhattacharya A.**, Saini U., Sharma P., Nagar P.K. and Ahuja P. S. (2006) Osmotin-regulated reserve accumulation and germination in genetically transformed tea somatic embryos: A step towards regulation of stress tolerance and seed recalcitrance. **Seed Science Research** 16: 203-211.
8. Sandal I., Saini U., **Bhattacharya A.**, Lacroix B., Kumar S., Ahuja P. S. and Citovsky V. (2006) *Agrobacterium*-mediated genetic transformation of tea leaf explants: Effects of counteracting bactericidity of leaf polyphenols without loss of bacterial virulence. **Plant Cell Reports.** 26(2): 169-176.
9. Mondal T. K., **Bhattacharya A.**, Ahuja P. S., Chand, P. K. (2001) Transgenic tea (*Camellia sinensis* (L.) O. Kuntze cv. *Kangra jat*) plants obtained by *Agrobacterium* mediated transformation of somatic embryos. **Plant Cell Reports** 20(8): 712-720.

### Endangered plants of Himalayas:

1. Patial V, Devi K, Sharma M, **Bhattacharya A.**, Ahuja PS (2012) Propagation of *Picrorhiza kurrooa* Royle ex Benth.: An important medicinal plant of western Himalaya. **Journal of Medicinal Plant Research** 6(34): 4848-4860; DOI: 10.5897/jmpr12.115.
2. Kushwaha, R., **Bhattacharya A.**, Singh B., Singh R.D. (2012) Factors affecting podophyllotoxin yield in the *ex situ* grown plants of *Podophyllum hexandrum*, an endangered alpine native of western Himalaya. **Journal of Natural Medicine**. 66: 1-7; DOI 10.1007/s11418-011-0541-y.
3. Kushwaha R., Chanda S, Ogra R.K. **Bhattacharya A** (2010) Cryopreservation criteria of *Podophyllum hexandrum* and *Aconitum heterophyllum* seeds based on storage behavior. **Seed Technology** 32 (2) 117-127
4. Kushwaha R., Pandey S., Chanda S., **Bhattacharya A.**, Ahuja P. S. (2008) Temperature dependant growth and emergence of functional leaves: an adaptive mechanism in the seedlings of the western Himalayan plant *Podophyllum hexandrum* syn. *P. emodi*. **Journal of Plant Research** 121(3):299-309.
5. Kharkwal A., Kushwaha R., Prakash O., Ogra R.K., **Bhattacharya A.**, Nagar P.K. and Ahuja P. S. (2008) An efficient method of propagation of *Podophyllum hexandrum*: an endangered medicinal plant of Western Himalayas under ex situ conditions. **Journal of Natural Medicine** 62(2): 211-216.
6. Kushwaha R., Pandey S., Chanda S., **Bhattacharya A.**, and Ahuja PS. (2007) GA<sub>3</sub> induced changes in the slow growing endangered Himalayan plant *Podophyllum hexandrum* and hastening of vegetative growth. **Plant Growth Regulation** 51(3): 207-215.

### **Bamboo**

1. Kaur D., Dogra V., Thapa P., **Bhattacharya A.**, Sood A., Sreenivasulu Y. (2015) *In vitro* flowering associated protein changes in *Dendrocalamus hamiltonii*. **Proteomics** 15: 1291-1306.
2. Kaur D, Thapa P, Sharma M, **Bhattacharya A.**, Sood A (2014) In vitro flowering – A system for tracking floral organ development in *Dendrocalamus hamiltonii* Nees et Arn. ex Munro. **Indian Journal of Experimental Biology**. 52: 825-834.
3. Sood. P., Joshi R., Chanda S., **Bhattacharya A.**, Gulati A., Sood A. (2013) A method to overcome the waxy surface, cell wall thickening and polyphenol induced necrosis at wound sites - the major deterrents to *Agrobacterium* mediated transformation of bamboo, a woody monocot. **Journal of Plant Biochemistry and Biotechnology**. DOI: 10.1007/s13562-013-0189-7.