MEETING REPORT

Towards nutritional security through horticultural biotechnology*

Globally horticulture is the major source of food, nutrition and livelihood security. In India, it is the prominent agricultural sector that contributes to highest foreign exchange earnings for country's economy. However, Indian horticulture is beset with a myriad of problems in production, protection and post-harvest management as most crop commodities are low-yielding, susceptible to pests and are perishable. Challenging threats demand radical solutions. Precision farming, integrated intensive input use efficiency, farm mechanization and modern biotechnology are some of the attractive propositions, practiced globally in horticulture. In this direction, a seminar was held to take stock of the progress in horticultural biotechnology in India under the National Agricultural Research System. The seminar was deliberated under seven themes, viz. molecular markers and marker assisted selection (MAS), regeneration systems, transgenics, molecular diagnostics, gene cloning and allele mining, bioinformatics and microbial biotechnology, covering major fruit and vegetable crops of the country. Major horticultural crop research institutes spread throughout India under the aegis of the Indian Council of Agricultural Research (ICAR), New Delhi, participated in the deliberations, chaired by N. K. Krishna Kumar, Deputy Director General (Horticulture) and assisted by Amrik Singh Sidhu, Director, IIHR. In the opening remarks, Krishna Kumar appreciated the pivotal role of biotechnology in the field of horticulture towards nutritional security. He highlighted some of the intensely discussed current topics such as transgene flow, development of insect resistance in *Bt* cotton, quarantine requirement during trans-boundary movement of germplasm through molecular diagnostics, need of problem-centric core working groups, deliverable technologies and inter-institutional collaborations.

India being the centre of origin of many crops has been considered as a mega biodiversity hotspot of the world. Long-term impacts of the widespread cultivation of GM crops on this biodiversity need a critical evaluation in terms of horizontal (trans)gene flow. Similarly, successful commercialization of *Bt* cotton in India has also brought out the possibility of development of insect resistance towards *Bt* toxin, while hitherto minor pests, such as sucking pests have become major pests of cotton causing significant economic losses. Such large-scale phenomena should be studied in case of GM vegetable crops like *Bt* brinjal and *Bt* tomato, as many pests are common to both cotton and vegetable crops as in the case of *Helicoverpa armigera* which attacks both cotton and tomato. Further, the volume of international travel of people, cargo and germplasm has substantially increased in trans-boundary movement in recent times, paving the way for unintended entry of exotic insect pests, pathogens and weeds. Enhanced vigilance in terms of timely quarantine measures is required across major entry points such as airports and seaports. Instead of time consuming and vague conventional methods, biotechnological methods and molecular diagnostics can bring about quick, sensitive and verifiable solutions to enforcement of quarantine measures, thus avoiding potential disasters in the horticultural crop production.

Unlike grain crops, horticultural crops, especially perennial crops like fruits, suffer from major disadvantages in terms of application of biotechnology, including longer periods of crop durations, very high heterozygosity and inter-plant variability, less amenability to most genetic analyses and lack of genomic resources. These problems are more severe in the case of mango, coconut, banana, pomegranate, etc. which are the major fruits of India. Similarly, annual horticultural crops like vegetables, seem to be less researched as in the case of onion, okra, watermelon, melons and cucumbers whereas the scene is satisfactory in the case of solanaceous vegetable crops like tomato, potato and brinjal. Several problems in many horticultural crops of the country need to be addressed using biotechnology on priority. Some of the examples include bacterial nodal blight disease of pomegranate caused by *Xanthomonas axonopodis* pv. *punicii*; many viruses affecting vegetables and fruits; insect pests and insect vectors of plant viruses; abiotic stresses (mainly moisture, salinity and high temperature) and huge post-harvest losses. During the last 3–5 years, yield and quality of pomegranate have been severely affected by *X. axonopodis*, also affecting export earnings. So far, there are no verified sources of genetic resistance available against this pathogen. Careful analysis of wild species of pomegranate like *Daru* and *Nana*, that grow in the Himalayan foothills, may indicate possible resistant sources, which can be incorporated into many commercially important varieties through appropriate breeding schemes, ably assisted by molecular markers linked to the genes that offer resistance to this disease. Alternatively, applying transgenic route to develop GM pomegranate is also an attractive proposition, as there are resistant genes available in the form of *Xa21*, *Xa5* and *Xa13* in wild rice germplasms, which also are affected by similar pathogen (*X. oryzae*).

In addressing the menace of viral pathogens, much progress has been made and much more remains to be done. In tomato, important viruses like leaf curl and spotted wilt, wreak havoc globally. Lately, a number of varieties of tomato have been developed that are resistant to these viruses, because of the availability of resistant genetic markers such as *Ty1* to *Ty5*. Marker-assisted selection and breeding of resistance to leaf curl virus is a shining example of the application of molecular biotechnological tools in crop breeding. However, for many viruses like spotted wilt (tomato), bud necrosis (watermelon), ringspot (papaya), bunchy top and streak (banana), yellow vein mosaic (okra) and other fungal and bacterial pathogens such as early blight (solanaceous vegetables), late blight (potato), purple blotch (onion), Fusarium (banana)

---

*A report on the National Seminar on Horticultural Biotechnology, held on 14 June 2013 at the Indian Institute of Horticultural Research (IIHR), Hesaraghatta Lake Post, Bangalore by the Division of Biotechnology, IIHR, in association with the Society for the Promotion of Horticulture.

and wilts (most horticultural crops including coconut), the scenario is depressing, as there are either no resistant genes available globally or the breeding progress is slow. Innovative biotechnological interventions are the need of the hour to address these maladies.

Large-scale multiplication and commercialization of seed and planting material is another bottleneck in Indian horticultural research. Application of appropriate tissue culture and regeneration systems such as meristem culture (for virus and disease-free material), micropropagation through organogenesis and somatic embryogenesis (clonal multiplication), hybrid embryo rescue (to develop rare and potentially rewarding genetic recombinants) and plant bioreactors (directed intensive clonal multiplication) are some of the potential research initiatives discussed in the seminar. A clear and successful case in point is the revolution in the micropropagation of banana especially of *Grand Nain* variety. Millions of genetically uniform and disease-free micropropagated materials are currently being produced in India annually and exported too, mainly by private firms. Such success stories need to be replicated in other crops, where demand for quality planting materials far exceeds the supply, through non-GM biotechnologies. Examples like date palm, sandalwood, ornamental crops and saffron highlight this importance. In the absence of indigenous biotechnological methodologies, a large number of clones are being imported into India, draining our national funds, while also risking biosafety concerns. As the most prized spice, saffron demands repeatable and successful model of micropropagation which can not only improve farming communities from hilly terrains of Jammu and Kashmir, but also substantially contribute to India's foreign exchange earnings. Another area of interest in regeneration is the development of protocols for transgenic development in horticultural crops.

In the area of gene cloning and allele mining, the seminar deliberated on the novelty of genes and their utilisability in transgenics and molecular markers. Specifically, all efforts must concentrate towards complex traits such as abiotic stresses and disease syndromes. Abiotic stresses, mainly moisture stress and salinity, in the light of rapidly diminishing sources of irrigation coupled with climate change are the predominant factors that have been the principal concern in the sustainable crop production globally and more so in the Indian subcontinent. These traits are highly complex to address genetically as either no information is available on them or the available information is grossly inadequate and complex to arrive at any valid conclusions. Governed mostly by quantitative trait loci (QTLs) which are genetically tricky to manage, these traits also pose additional problems in the horticultural crops, which are less studied in this respect.

The seminar also acknowledged the different applicabilities of transcription factors and single genes towards abiotic stress tolerance. Search and deployment of specific crops like *Prosopis juliflora*, a crop which tolerates moisture stress, as sources of genes and genetic markers in breeding abiotic stress-tolerant horticultural crops was rightly suggested in the seminar. A curious case of the serious problem of coconut wilt syndrome was discussed. In absence of clear cut cause in terms of pathophysiology, management of this syndrome is becoming an uphill task coupled with its spreading across south India. A close collaboration of biotechnologists, physiologists, pathologists, biochemists and horticulturists was called for dealing with this menace by identifying the cause and effect and molecular genetics of this disease.

In the area of molecular diagnostics, field detection of important plant pathogens especially viruses and phytoplasmas followed by effective management strategies are priorities in India. Development of 'field detection kits' for viruses would enable proper diagnosis and subsequent management of the disease. It will also help scientific quarantine enforcement during trans-boundary movements of plant genetic resources. Such kits were also suggested to be shared with state agricultural universities and Krishi Vigyan Kendras for rapid implementation of technologies. Disease transmission through insect vectors like whiteflies, aphids and thrips in horticultural crops needs a thorough and unambiguous study facilitated by molecular diagnostics. On the lines of the National Bureau of Plant Genetic Resources (New Delhi), the National Bureau of Agriculturally Important Insects (Bangalore) and the National Bureau of Agriculturally Important Microorganisms (Mau), a National Facility for the deposition of gene constructs, kits, antisera and other biotechnology products is necessary for smooth management and exchange of such resources, through inter-institutional collaborations.

The seminar was conducted in the presence of experts in horticultural biotechnology as panel members and directors of various horticultural research institutes of ICAR. Proceedings of the seminar indicated both a general satisfaction towards the direction of current research on horticultural biotechnology in India and a sense of urgency and requirement of streamlining of research initiatives. Also, the importance of innovation-driven horticultural biotechnology research, as deliberated, to address present and future challenges indicated the much needed emphasis in lifting up the quality of research and corresponding positivity in the enhancement of contribution of Indian horticulture to the national nutritional security while keeping in view the Millennium Development Goals.

Vageeshbabu S. Hanur* and C. Aswath, Division of Biotechnology, Indian Institute of Horticultural Research, Hesaraghatta Lake Post, Bangalore 560 089, India.
*e-mail: vageesh@iihr.ernet.in