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Tissue Culture Technology: Its Utilization in Crop Improvement

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Plant tissue culture methods offer a rich scope for the creation, conservation and utilization of genetic variability for the improvement of field, vegetable and horticultural crops. Micropropagation of selected ornamentals, fruit and forest plants species, is one of the best and most successful examples of the commercial application of tissue culture technology. This technique has great potential for rapid, large scale and true-to-type multiplication. For instance, in strawberry millions of plants can be produced from 1mm explant in one year Now scores of multimillion dollar industries around the world propagate a variety of plant species through tissue culture. Tissue culture technology offer environmentally friendly industries to flourish. There are more than 200 laboratories in the World including about 50 in India, and 7 in Punjab and Chandigarh each producing more than 1 million plants per annum. USA is the largest producer followed by Asia, The Netherlands, other European countries, Australia and New Zealand, France, Italy and Israel. It is estimated that more than 500 million plants belonging to different plant species are being produced through micropropagation, annually in the different parts of the world. The clean planting material can certainly improve the yield potentials of our vegetatively propagated crops like sugarcane, potato, strawberry, mint, sweet potato, banana and tapioca. It is likely that automation of multiplication systems will be commercially feasible within the next few years for several species including potato micro tubers, lily bullets and gladiolus corms. Improvement of somatic embryogenesis, coupled with embryo desiccation and encapsulation technology may lead to the utilization of artificial seeds for mass cloning of plants (Redenbaugh et al., 1988). We at the Department of Biotechnology have micropropagation protocols for sugarcane, potato, strawberry, mentha, gladiolus, carnation and chrysanthemum which are now being commercially exploited in the state for rapid mass multiplication of these plants.

Soma clonal variation - the variation among the callus derived plants is a potent emerging aspect for broadening the genetic base and thus obtaining incremental improvement in the commercial cultivars, more particularly, in the vegetatively propagated species (Evans and Sharp, 1986). Using the technique of in vitro selection many million cells/protoplasts (cell without cell wall can be screened against various biotic and abiotic stress factors in a single Petri dish which is more efficient as compared to the screening of similar number of plants in the field which required more time and space as well. Several interesting and potentially useful traits have been recovered using this method in sugarcane, potato, tomato, corn, rapeseed and mustard, rice and alfalfa. However, under several situations, the lower plant regeneration ability and the lack of correspondence in expression of the trait in vitro and in plants are the major problems. We have induced soma clonal variation in sugarcane and potato. Selected soma clones are under field evaluation.

Production of haploids through bulbosum, anther/pollen culture methods, has been exploited for the early release of varieties (Foroughi, Wehr and Weinzel, 1989). For instance, production of haploids/doubles haploids through another culture from F_1 plants, results in true breeding plants in less than one year, which are otherwise obtained after 7-8 generations through conventional methods. In rice, the anther culture breeding has been and would be highly rewarding in early release of new varieties. The largest number of cultivars has come from barley, using `bulbosum' maternal haploid method. Seven barley varieties have been released in Canada alone. Besides, using the technique of another culture haploids have been produced in more than 50 genera. Several cultivars are either in test or have been released in rice, wheat, maize, rapeseed and mustard in China, Canada, Denmark, USA and France. But in many instances, the poor androgenesis, occurrence of

mixoploids and albino plants have been the recurring problems. Using anther culture, we have developed a population of doubled haploids from an elite cross involving high yielding rice x super rice. Besides wheat x maize crosses are being exploited for production of wheat haploids.

Since the possibility of producing useful secondary products in plant cell culture was first recognized in 1970s, considerable progress has been made and a number of plant species have been found to produce secondary products such as shikonin, diosgenin, caffeine, gutathion and anthraquinone. Large scale

production of such compounds in increasingly becoming popular with the industry where some physical and chemical conditions for growth and product formation have been optimized.

Embryo culture is the practical approach to obtain interspecific and intergeneric hybrids among otherwise hard to cross parents (Gosal and Bajaj, 1983). It has been successfully used to transfer desirable genes from wild relatives into cultivated varieties of several field and vegetable crops. Somatic cell hybridization involving fusion of protoplasts from different species is considered an important approach to combine characteristics even from otherwise sexually incompatible species and to obtain cybrids (cytoplasmic hybrids) and organella recombination, not possible through conventional methods (Hinnisdaels et al., 1988). Earlier efforts were to combine full genomes from both the parents and develop symmetric hybrids. However, the somatic hybrids thus produced, particularly among the phylogenetically remote species, have exhibited somatic incompatibility, genetic instability and sterility. It is, now obvious that these monsters cannot be incorporated into the breeding programmes. Therefore, the interest has moved from creation of novel hybrids to production of cybrids, chromosome transfer and gene introgression.

As a consequence, some useful agronomic traits like male sterility, herbicide and disease resistance have been transferred from wild species into cultivated varieties of potato, tomato and brassica. Furthermore, the development of gene transfer systems has now greatly expanded the gene sources which may come from wild relatives, unrelated plants, bacteria, viruses, fungi, animals or even from chemical synthesis in the laboratory. Using various vector systems (Agrobacterium and viruses) and vector less systems (liposomes, microinjection, laser microbeam and particle gun), the transgenic plants have been produced in more than 100 plant species. It has been demonstrated that biotechnology can produce plants that contain their own pesticide and resist lethal doses of weed-killers and plant diseases (Dale et al., 1993). Transgenic plants, carrying agronomically useful genes such as herbicide resistant, virus resistant and insect resistant of several field crops are in field trials in many countries and commercial releases have also been made in tomato, cotton corn etc. We have developed Bt. basmati and the transgenics are under glass house evaluation.

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