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Biotechnology: A Ray of Hope in Horticultural Crops

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Biotechnology has important potential in regeneration of plant. The biotechnological approach may likely have more significant impacts in cultivation, thereby practically minor changes such as in quality, smell, color and post-harvest conduct would make noticeable commercial impacts micro-propagation, hereditary change, virus-cleaning, in-vitro preservation of germplasm, synced innovation, bio-pesticides, bio-fertilizers and post-harvest biotechnology are imperative regions in biotechnology of horticultural crops.

Role of biotechnology in horticulture

The major achievements of biotechnology that adopted for improvement of horticultural crops are discussed briefly.

1. **Plant Tissue Culture (PTC)** – It is one of the major techniques associated with biotechnology. It is widest application of biotechnology in the area of micro propagation and tissue culture in particular. This is one of the most widely used techniques for rapid asexual in-vitro propagation. This technique is economical in time and space affords output. It also provides disease free and elite propagules. PTC also improves the quarantined and safer movements of germplasm across nations. When the traditional methods are not able to meet the demands of propagation material, this technique can produce millions of equally flowering and yielding plants. Micro-propagation of mostly all the vegetables and fruit crops is possible now. Production of virus free planting material by meristem culture has been made possible in huge horticultural crops.

2. **Micro-propagation** – Micropropagation is also known as clonal propagation. It is a modern commercial use of plant tissue culture methods. It is an *in-vitro* propagation used to produce clones of plants under a controlled environment. For this process a solid or a liquid medium is required for proper growth and multiplication of an explants under a controlled environment and these conditions include temperature, proper nutrient solution with plant growth regulators and proper liquid and gaseous environment with proper humidity.

3. **Cryopreservation** – Plant cryopreservation is a genetic resource conservation strategy that allows plant tissues and organs can be frozen and stored indefinitely in liquid nitrogen (LN) at -196˚C or -320.8˚F for long term storage of germplasm. This can be great importance in the conservation of germplasm of those crops that do not produce seeds normally, e.g., root and tuber crops, produce recalcitrant seeds, or where it may not be able to store seeds.

4. **Genetic Engineering (GE) of Plants** – By using of genetic engineering technique numerous valuable qualities have been presented into plants and also numerous transgenic plants have been created in which the remote DNA has been fastly coordinates and introduce about within the union of fitting quality item. Approx. 525 different

transgenic events in 32 crops have approved for cultivation in world. Adoption of transgenic technology has been shown to increase crop yield, reduce CO_2 emissions, reduce insecticide and pesticide use and decrease the cost of crop production. Transgenic plants secured about 190 million hectares in 2019 and 88 % of these were planted with glyphosate-resistance plants (ISAAA, 2019). Superior qualities for the taking after characteristics are presented to the edit plants. Now world has started GMO foods on large scale to available for huge population.

(a) **Herbicide Tolerance** – Weeds are terrible factor in horticulture. To face with such situation herbicides were introduced but these chemicals for weed control purpose but unfortunately plants were also affected along with weeds. So, transgenic plants are developed that resistance to herbicides allowing farmers to spray crops so as to kill only weeds or unwanted plants but not their crops. Many herbicide tolerant plants are developed in tomato, potato, soybean, tobacco, cotton, corn etc.

(b) **Pathogen/Disease Resistance –** Diseases caused by pathogens, such as fungi, nematodes, bacteria, viruses and biotic stress are the major problems of crop plants which cause yield losses. Plant diseases are often controlled by using application of agrochemicals. However, the environmental hazards caused by using agrochemicals warrant research of alternative strategies to control plant diseases. Many strategies are applied to control virus infection using satellite RNA and coat protein. Potato virus free seed is best example in this concern. So far, 29 transgenic events regarding to resistance to various diseases are available globally; of which 25 events provide resistance against viruses. Disease-resistance events are reported in potato (19 events) followed by 4 events in papaya, 2 events in squash and one event in tomato, bean, sweet pepper and plum each.

(c) **Insect Resistance –** Insect and pests are cause severe crop loss. There are approx 67,000 species of insects that cause economically loss to important crops. Insect and pests are damage crops by chewing plant parts like leaves, stems and roots and sucking sap. For control and management of insect and pests, farmers depend on expensive chemically synthesized insecticides. Use of insecticide for crop protection is not environment friendly. Therefore, to overcome the insecticide use, new technologies such as genetic modification of crops to enlarge their resistance against insects have get popularity. So far, 10 insect-resistant transgenic crops are commercialized for cultivation. Insect and pest resistant transgenic crops have second largest area under cultivation – 23.3 million hectares in 2017 (ISAAA 2017). In all, 304 events are approved worldwide for commercial cultivation. Out of this, 208 events include multiple IR genes in maize are approved for cultivation depends upon the prevalence of insect-pests. Other commercialized crops having different IR genes are cotton (49 events), potato (30 events), soybean (6), sugarcane (3), rice (3), poplar(2), tomato (1) and brinjal (1).

(d) **Abiotic Stress Resistance -** Genes are responsible for providing resistance against stresses such as to water stress cold, heat, heavy metals, salt and phytohormones have been identified. Abiotic stress exert a negative effect on growth and development of crop plants, leading to decrease in grain yield. Resistance against chilling was introduced in tobacco plants by introduce gene for glycerol-1-phosphate acyl-transferase enzyme from Arabidopsis. Arabidopsis is mainly a model plant for research purpose which argue results for other plants.

Table 1. Selected examples of fruit and vegetable crops under development using biotechnological tools

Trait	Genetic modification	Examples of fruit and veg. crops having the trait
Herbicide tolerance :		
Glyphosate tolerance	5' Enolpyruvylshikimate-3' phosphate synthase	Tomato
Sulfonylurea/chlorsulfuron tolerance	Acetolactate synthase	Tomato
Bromoxynil tolerance, 2,4-Dichlorophenoxy acetic acid tolerance	Nitrilase from *Klebsiella ozaenae, Alcaligenes eutrophus*/2,4-D mono-oxygenase	Potato
1. Insect and Pest Resistance :		
Lepidopteran insects	*Bacillus thuringiensis* delta endotoxin	Tomato, Potato, Apple
Viruses	Various viral coat proteins	Squash, Tomato, Potato
Bacteria	Cecropin	Potato
Rhizoctonia solani	Chitinase	Potato
2. Other properties :		
Stress tolerance	Stress-alleviating enzymes	Potato
Altered ripening	Polygalacturonase antisense gene	Tomato
3. Post-harvest properties :		
Simple sugar or starch increase	Metabolic enzymes	Potato
Increased solids or dry matter content	Pectin methylesterase antisense gene	Tomato, Potato

(Source: Federal Register notices published by the division of Biotechnology, Biologics and Environmental Protection. Animal and Plant health inspection service, U.S. Department of Agriculture)

5. **Genetic Modification of Microbes** – By using DNA recombination technique, it has been possible to genetically manipulate various strains of these bacteria appropriate to different environmental conditions and to develop strains with traits with the efficiency for superior competitiveness and nodulation.

(a) **Biopesticides** – Biopesticides are biological organisms on the place of pesticides for the control of pests. It is definitely a great achievement in plant science. Biopesticides are having importance in agriculture, horticulture and public health programs for control of pests.

(b) **Biocontrol Agents** – These are other microbes which are antagonistic to many pathogenic fungi and are good substitutes to insecticide or fungicide. They are Verticillium spp., Trichoderma, Pseudomonas fluorescens, Bacillus spp., Streptomyces spp. etc. These organisms are available commercially.

6. **Molecular Markers** – Now it become possible to identify genes and DNA segments and to find their proper location using by molecular markers. It has been possible to grow the plants for various traits or disease resistance at the seedling stage itself. The use of RAPD (Random Amplified Polymorphic DNA), RFLP (Restriction Fragment Length Polymorphism), AFLP (Amplified Fragment Length Polymorphism) and isozyme

markers in plant breeding are many. Molecular maps now available for crop plants including tomato, potato and brassica species.

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