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Genetic Engineering: A Revolutionary Approach in Horticulture

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Horticulture is one of the important sectors of agriculture, which consists of fruits, flowers, vegetables, species, tuber crops, mushrooms, bamboo, plantation crops and aromatic plants. Biotechnological tools have revolutionized conventional plant breeding methods by providing new genotypes for breeding purposes supplying healthy and disease-free planting material, improving fruit quality, enhancing shelf-life, increasing availability of bio-pesticides, bio-fertilizers, etc. The major areas of biotechnology include tissue culture and genetic engineering.

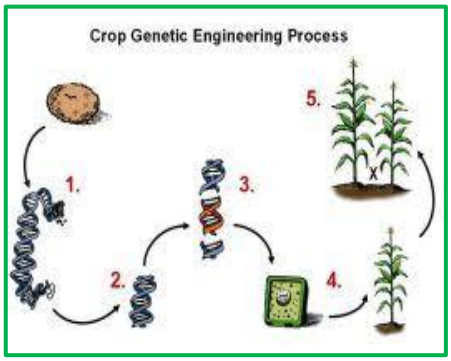
Genetic engineering is a set of techniques that enable target DNA identification from different sources, its isolation and recombination, to introduce new characteristics that are not available in nature in an organism. Genetic engineering offers numerous potentially useful genetic manipulations for the improvement of horticultural crops.

It is also known as biotechnology, has transformed the field of horticulture by enabling scientists to develop crops with desirable traits. This innovative technology involves the manipulation of an organism's DNA to introduce beneficial characteristics, enhancing crop productivity, disease resistance, and nutritional value.

Benefits of Genetic Engineering in Horticulture Crops

- **Improved Nutrition:** Genetic engineering can enhance the nutritional content of crops, such as vitamin-enriched fruits and vegetables.
- **Increased Yield:** Genetic modification can improve crop yields by enhancing photosynthesis, water usage, and nutrient uptake.
- **Climate Tolerance:** Crops can be engineered to withstand extreme temperatures, drought, and other environmental stresses.
- **Disease Resistance:** Scientists can introduce genes that confer resistance to specific diseases, reducing pesticide usage and environmental impact.
- **Reduced Pesticide Use:** Genetic modification can introduce pest-resistant traits, minimizing pesticide application.

Techniques Used in Genetic Engineering



1. Agrobacterium-mediated Transformation: A bacterium transfers DNA to plant cells, enabling genetic modification.

2. Particle Bombardment: DNA-coated particles are shot into plant cells using a gene gun.

3. Microinjection: It involves the transfer of the gene through a micropipette into the cytoplasm or nucleus of a plant cell or protoplast.

4. Electroporation: It involves the creation of pores in

the cell membrane using electric pulse of high field strength. If DNA is present in the buffer solution at sufficient concentration, it will be taken up through these pores.

5. CRISPR-Cas9: A precise gene-editing tool allowing scientists to edit specific genes.

Transgenic research in horticultural crops

Fruit Crops:

- **Papaya:** Designing transgenic resistance against papaya ring spot virus by using replicate gene.
- **Apples:** Engineered for resistance to fire blight disease.
- **Bananas:** Genetically modified for resistance to black sigatoka disease.
- **Strawberries:** Enhanced with drought tolerance and improved shelf life.
- By transgenic technology in Banana, pineapple, mango and apple improving the shelf life and delayed ripening by Acc Synthase.

Vegetable Crops:

- **Tomato:** The first commercially grown genetically modified crop was Flavr Savr Tomato. Which was released by Calgene in 1994 for its delayed ripening or enhancing shelf life.
- **Broccoli:** Transgenic broccoli plants with reduced ethylene synthesis were also produced by silencing ACC Oxidase and ACC Synthase genes of the ethylene biosynthesis pathway. (Higgins *et al*, 2006)
- **Potato:** By using transgenic methods, it is possible to alter plant genomes to improve the nutritional value of crops such as starch composition in potato. (Takaha *et al*., 1998)
- **melon fruit:** Transgenic technology appears to be favorable for improving the sensory traits and shelf life of melon fruit. (Li *et al*.,2006)
- **cauliflower:** Transgenic cauliflower developed with β-carotene accumulation. (Lu *et al*., 2006)
- Several horticultural crops such as sweet potato resistant to sweet potato feathery mottle virus and sweet potato chlorotic stunt virus, Cassava resistant to Gemini viruses, Potato resistant to potato virus Y, tomato resistance to poty viruses and Gemini viruses, lettuce resistant to lettuce tospovirus and watermelon resistant to Zucchini yellow mosaic viruses have been generated using transgenic technology.

Other Crops:

- **Bt Cotton:** Produces a toxin to control pests, reducing pesticide use.
- **Genetically Modified (GM) Canola:** Engineered for herbicide tolerance.
- **Drought-Tolerant Wheat:** Developed for improved water efficiency.
- **Soybeans with Improved Fatty Acid Profile:** Enhanced for better oil quality.

Thus, by using transgenic technology in horticultural crops, obtained crops free from biotic and abiotic stress virus resistance and insect resistance.

Conclusion

Genetic engineering has revolutionized horticulture by providing innovative solutions to enhance crop productivity, disease resistance, and nutritional value. As research continues to advance, this technology holds promise for addressing global food security challenges and promoting sustainable agriculture practices.

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