

## Role of Biotechnology in Modernization of Horticulture

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The integration of biotechnology into fruit crop production represents a transformative approach to addressing the challenges of global food security, climate change, and sustainable agriculture. Genetic modifications target physiological processes such as ripening and ethylene production, enhancing resistance to postharvest diseases and improving nutritional profiles. The IPM strategies, grounded in biotechnological breakthroughs, have reduced the usage of chemical inputs, therefore promoting sustainable farming practices. The RNAi technology has found its most powerful expression in plant biology these days. Many genetically modified fruits and vegetables are already in the market in developed countries. Modern biotechnology encompasses broad areas of biology from utilization of living organisms or substances from those organisms to make or to modify a product, to improve plant or animal or to develop microorganisms for specific use.

### Introduction

Biotechnology is the life science, which generally deals with the study of living organisms. It is an application of biology and other different techniques to change or modify products for specific human use. Biotechnology is also known as biological technology. The use of genetically modified (GM) fruits and vegetables, they have demands in the market (Blagoevska et al., 2021). Biotechnology encompasses a suite of advanced techniques, including genetic engineering, genome editing, marker-assisted selection, and tissue culture, which can significantly enhance the efficiency and effectiveness of fruit crop breeding and cultivation. Consumption of horticultural crops reduces certain diseases including cancer and heart disease (Jaskani & Khan, 2021). Genetic engineering, for instance, has facilitated the development of transgenic fruit varieties that exhibit enhanced resistance to pests and diseases, thereby reducing the reliance on chemical pesticides and contributing to sustainable agricultural practices. Genetic engineering involves the alteration of specific genes responsible for natural aging and deterioration of plant tissues due to postharvest senescence (Paoletti & Pimentel, 1996).

### Biotechnology Tools and Techniques for Improvement of Horticultural Crops:

- Tissue culture: Tissue culture, a sophisticated laboratory technique, involves the cultivation and growth of plant fragments or organs. In many instances, plant organs are employed for tissue culture. The culture medium utilized for nurturing the growth of these tissues consists of both broth and agar, providing the necessary nutrients and conditions for development.
- Genetic engineering: It is a scientific technique that involves altering the genetic material of an organism to introduce specific desired traits or characteristics. This process allows scientists to manipulate the DNA (deoxyribonucleic acid) of an organism by adding, removing, or modifying genes.

- Molecular diagnostics and molecular markers:
- ✓ Molecular Diagnostics: Molecular diagnostics is a field of medical testing that involves the analysis of DNA, RNA, and other molecules to detect and identify specific genetic sequences or variations.
- ✓ Molecular Markers: Molecular markers are specific DNA sequences or variations that can be used to identify and track certain traits or characteristics in individuals or populations.
- Development of Beneficial Microbes in Biotechnology: It also known as beneficial microorganisms or probiotics, are microorganisms that confer positive effects on various aspects of human life, agriculture, and environmental sustainability. Biotechnology plays a crucial role in the development and application of these beneficial microbes to address diverse challenges and improve our quality of life.

### Biotechnological Tactics

The scientists were inspired by the DNA-based knowledge to successfully isolate the targeted gene of interest, transfer it, and integrate it into the host species.

**Transgenic strategies for biotic stress management Genetically engineered herbicide-tolerant (HT) crops:** In genetically engineered HT crops, a gene from the soil bacterium *Agrobacterium tumefaciens* is used. The broad-spectrum herbicide glyphosate becomes tolerable to the recipient plant as a result. HT crops can aid in weed control and lower production costs. Roundup Ready (RR) is the trade name for a HT crop. In 1996, RR soybeans were made available for purchase (James, 2002a).

**Transgenic strategies for abiotic stress Management:** Abiotic stress is a natural circumstance that reduces crop development and output in an ideal ratio. This includes extremes of heat, salinity, cold, drought, metal toxicity, and lack of nutrients. Abiotic stress is estimated to have reduced crop plants' output by more than 50%. (Holmberg and Bülow 1998).

### Future prospect

Biotechnology can address issues such as food waste by creating non-browning traits, aid in phytoremediation to clean up contaminated soils, and cater to consumer preferences with unique traits. However, challenges such as stringent regulations, ethical concerns, consumer acceptance, global trade barriers and the need for research funding must be addressed to fully realize the potential of plant biotechnology in horticulture. The future of these technologies will depend on scientific advancements, regulatory decisions and societal acceptance.

### Advantages of biotechnology in horticultural crop improvement

- Enhanced Crop Traits
- Disease and Pest Resistance
- Increased Yield
- Extended Shelf Life
- Stress Tolerance
- Precision Breeding
- Biodiversity Conservation
- Reduced Environmental Impact
- Utilization of Wild Relatives
- Customized Consumer Preferences

### Conclusion

Biotechnology plays a crucial and promising role in the improvement of horticultural crops. It has demonstrated significant potential in addressing various challenges faced by the agriculture sector. Through biotechnological approaches, horticultural crops can be enhanced with beneficial traits, such as improved nutritional content, disease and pest resistance, and stress tolerance. This can lead to increased crop yields, improved food security, and reduced environmental impact by minimizing the use of chemical inputs. There are challenges related

to the regeneration of large plant populations and the need for expertise and well-equipped facilities. Nevertheless, the genetic variability in vegetable species provides opportunities to introduce novel genes through biotechnology, leading to improved quality and shelf life of vegetables. Moreover, biotechnology enables precision breeding, allowing for faster and more targeted modifications to plant DNA compared to traditional breeding methods.