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# Role of transgenic gene in conservation of major and minor fruit crops

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## Introduction

Fruits and vegetables are recognized for their health-promoting qualities due to the abundance of vitamins, minerals, antioxidants, electrolytes, and dietary fiber that they contain. As the world's population continues to rise, so does the demand for fruit, underscoring the need to enhance the commercially significant fruit crops. Since the 20th century, fruit crops have been improved through the use of classical breeding techniques, but these methods are still constrained by factors such as high heterozygosity, polyploidy, lengthy juvenile periods, self incompatibility, resources restricted to the parental genome, and openness to sexual combination. Recent developments in the field of biotechnology have opened up exciting new possibilities for modifying crops to have desired traits. Crop improvement supported by biotechnology has the potential to significantly alter the landscape of fruit breeding. Biotechnology can also be used to achieve important commercial properties like improved biotic (resistance to diseases caused by viruses, fungi, pests, and bacteria) or abiotic (stress tolerances caused by temperature, salinity, light, and drought), nutrition, yield, and quality (longer shelf life and delayed fruit ripening), as well as the ability to be used as a bioreactor to produce proteins, edible vaccines, and biodegradable plastics.

The idea behind horticulturally significant trait regulation through transformation is that superior cultivars can be enhanced for a particular trait without compromising the integrity of the clone. Transgenic varieties with genetic alterations and alterations in a broad range of characters that are not possible with traditional breeding techniques will be generated.

## Transgenic plants

Transgenic plants are genetically modified plants that have been created through a breeding process that uses recombinant DNA techniques to introduce desired genetic traits and create new characteristics. They belong to

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a class of organisms that have undergone genetic modification (GMO). Transgenic plants are those whose genomes have been altered by genetic engineering methods. These modifications may involve the insertion of foreign genes—which may come from a different species or even kingdom or the removal of certain harmful genes.

**Genetically modified crops**

A crop classified as genetically modified (GM) or biotech (biotech) is one whose DNA has been altered through genetic engineering methods. They typically carry one or more additional trans-species foreign genes that are expressed and stabilized. Transgenic animals have been produced and transformed with efficiency thanks to the integration of rDNA technology, gene transfer strategies, and tissue culture techniques.

**Features of gm plants/transgenic plants**

These days, a vast variety of organisms, including unrelated plant species, microbes, animals, and DNA synthesized in a lab, can have its genes transferred into plants. In the upcoming year, transgenic varieties with genetic alterations not possible through traditional breeding techniques and modifications in a broad range of characters will be created.

**Contain transgenes**

Foreign genes, or transgenes, are present in transgenic plants. It is possible to use the foreign genes from unrelated animals, microorganisms, and plants. Occasionally, transgenic plant development also uses genes from DNA synthesized in a lab.

**Involve Biotechnology**

Plant biotechnology, or tissue culture plus genetic engineering, is the process of creating transgenic plants. Tissue culture is necessary for genetic transformation, while genetic engineering aids in the manipulation of foreign genes (DNA). The entire plant cannot have the foreign gene inserted. It is limited to single cell insertion. Tissue culture is therefore necessary for the introduction of foreign genes into individual cells. Cell or protoplast culture can be used to accomplish the genetic transformation.

**Overcome crossing barriers**

Gene transfer between unrelated species and even between unrelated organisms is possible thanks to transgenic breeding. A gene that resists freezing, for instance, has been transferred from fish to tomatoes grown in culture.

**Bypass Sexual Process**

Transgenic plant development avoids the sexual process, or reproduction. To put it another way, the development of transgenic plants does not involve the sexual fusion of the donor and recipient parents.

**Transgenic research activities on various major and minor fruit crops**

- **Papaya (*Carica papaya*)**

The papaya ring spot virus (PRSV) frequently acts as a global constraint on papaya production. Using papaya embryonic tissues, the coat protein gene is transformed via the micro projectile bombardment technique. Excellent resistance to PRSV was demonstrated by the two transgenic lines that were developed: UH Sun UP from Sunset and UH Rainbow from Kapoho.

**Developing resistance to *Phytophthora palmivora***

*Phytophthora palmivora* can cause fruit and root rot in papaya when it is in its mature stage and during the rainy season, especially in soil that drains poorly. The Dahlia merckii defensin gene through particle bombardment in the papaya embryogenic calli. Leaf extracts of the transgenic lines inhibited *P. palmivora* mycelia growth by 35–50%. Furthermore, transgenic papaya plants expressing defensin had enhanced resistance against *P. palmivora*, according to inoculation experiments conducted in a greenhouse.

- **Apple (*Malus x domestica*)**

Genetic transformation has primarily focused on breeding goals related to resistance to fire blight (*Erwinia amylovora*) and scab (*Venturia inaequalis*). The extracellular polysaccharide (EPS)-depolymerase of the fire blight bacteriophage phi-Ea1h was altered into "Pinova" by Flachowsky et al. (2008), who then assessed the impact on the disease's susceptibility. Compared to the control plants, the regenerated transgenic plants exhibited greater fire blight resistance.

In transformed plants of "Galaxy" and M26, overexpression of the apple MdNPR1 gene—an Arabidopsis NPR1 homolog that is essential to the SAR response—reduced *E. amylovora* symptoms in comparison to the non-transformed control plants.

- **Banana (*Musa paradisiacal*)**

Plantains and bananas pose special challenges for traditional breeding. With the exception of a few genotypes, triploid dessert bananas (AAA) and cooking bananas or plantains (AAB and ABB) are both sterile. The use of biotechnologies, such as genetic transformation and mutation breeding, to target the breeding goals of particular cultivars has generated a lot of interest. The majority of transformation reports have addressed disease resistance, particularly the true threats posed by Black Sigatoka and Panama disease.

Electroporation of Musa protoplasts; however, Agrobacterium-mediated transformation of embryogenic culture and microprojectile bombardment have supplanted this technique.

An artificial analogue (MSI 99) of the gene encoding the antimicrobial peptide magainin, which is extracted from the skin of the African clawed frog Xenopuslaevis, has been inserted into Rasthali bananas (AAB). Transformation of "Rasthali" (AAB) embryogenic cultures with the hepatitis B surface antigen "s" gene (HBsAg).

- **Orange (*Citrus sinensis*)**

Resistance to Citrus Greening/Huanglongbing (HLB), a dangerous bacterial disease affecting phloem that is typically fatal, is absent from commercial sweet orange cultivars. Transgenic sweet orange cultivars "Hamlin" and "Valencia," which express an Arabidopsis thaliana NPR1 gene under the control of either a constitutive CaMV 35S promoter or a phloem-specific Arabidopsis SUC2 (AtSUC2) promoter, have been shown to develop persistent disease resistance to HLB.

**Applications of transgenic crop breeding**

Quick technique for improving crops: A stable transgenic plant can be created in 3–4 years, but it takes 12–15 years to create a new variety using traditional breeding techniques.

- Cold tolerance: In many fruit crops, a sudden frost can kill delicate seedlings. Guava plants that have undergone genetic modification to include the cold hardiness genes CBF1, CBF2, and CBF3 are able to withstand temperatures below freezing that would normally kill unmodified seedlings.
- Tolerance for drought and salinity: crops that can tolerate extended periods of drought or high salinity levels in soil and groundwater will enable farmers to grow crops in previously uninhabitable areas.
- Vaccines and pharmaceuticals: These are expensive to produce and occasionally need special storage conditions. Reaching that objective is becoming more likely with the aid of genetic engineering. In the last few years, scientists have created "edible vaccines," which are foods that, in order to be effective, must be consumed.
- Fragrance modification: important genes involved in the synthesis and control of fragrance have been found, raising the prospect of scent transmission between species. Regaining the fragrance in flowers that have "lost" it due to years of conventional hybridization and selection, or developing new scents in plants, has a lot of promise and appeal. Certain potted plants and bedding plants also benefit from fragrance, and there is one instance where the transformation process resulted in potentially better products.
- Resistance to abiotic stressors: Abiotic stressors, such as salinity, temperature, and water stress, are some of the most important factors that restrict crop yield and quality globally. The most widely employed abiotic stress management techniques in transgenic vegetables involve overexpressing LEA genes and overproducing glycine betaine. In addition

to raising the natural level of sucrose in the taproot, the overexpression of the Atnhx gene made sugar beet more resilient to drought stress. Warner's 2011 transfer of the CBF3 gene from Arabidopsis thaliana to Petunia hybrida may have increased the plant's resistance to frost, thereby expanding the range of environments in which it can be grown.

- Vase life and "keeping" quality: Ethylene causes climacteric fruits to rapidly increase their respiration rate, which sets off a series of biochemical and physiological alterations that lead to ripening. It is possible to increase the vase life of horticultural crops by either introducing resistance to ethylene or by suppressing the expression of the genes involved in endogenous ethylene biosynthesis. The orchid species *Oncidium* spp. and *Odontoglossum* spp. showed decreased ethylene sensitivity upon introduction of a mutated ethylene receptor gene. Flavr Savr$^{TM}$ was the first transgenic crop to be grown commercially.

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