

Genetic Engineering in Plants & Its Outcome

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Introduction

Increasing population is facing the challenge for food security and thus researchers are searching the convenient and fast ways for improving crop production. Plant genetic engineering has become one of the most important molecular tools in the modern molecular breeding of crops which mainly relies on genetic transformation approaches. Over the last decade significant progress has been made in the development of new and efficient transformation methods in plants. Although transformation of some plant species or elite germplasm remains a challenge, further advancement in transformation technology is expected because the mechanism of governing regeneration and transformation process are now better understood and being creatively applied to designing improved transformation methods or to develop new enabling technologies.

What is Genetic Engineering?

Genetic engineering is a set of technologies used to change the genetic makeup of cells, including the transfer of genes within and across species boundaries to produce improved or novel organisms. Simply, it is the directed transfer of a gene, or piece of DNA, into a cell. The technology also well known as genetic modification or genetic manipulation technique which could be pictorially summarized as show in figure 1.

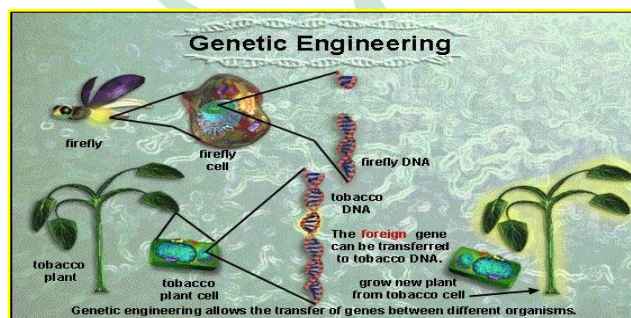


Figure 1: Summary of genetic engineering

Major requirements of plant genetic engineering procedure:

- A suitable transformation method
- A means of screening for transformants
- An efficient regeneration system
- Gene of interest with suitable vector

Genetic transformation

Genetic transformation involves the transfer and incorporation of foreign DNA into a host genome resulting in its genetic alteration. In order for this transferred DNA to be transmitted to later generations, transformation of germline or other appropriate cells of the recipient species is essential.

Transforming plants with foreign genes is known as plant transformation and has several benefits in area of crop improvement, crop protection, crop production as well as in pharmaceutical and nutraceutical approaches. For transforming plants, there are two major approaches: vector less (direct) or vector-mediated (indirect) method as listed in figure 2.

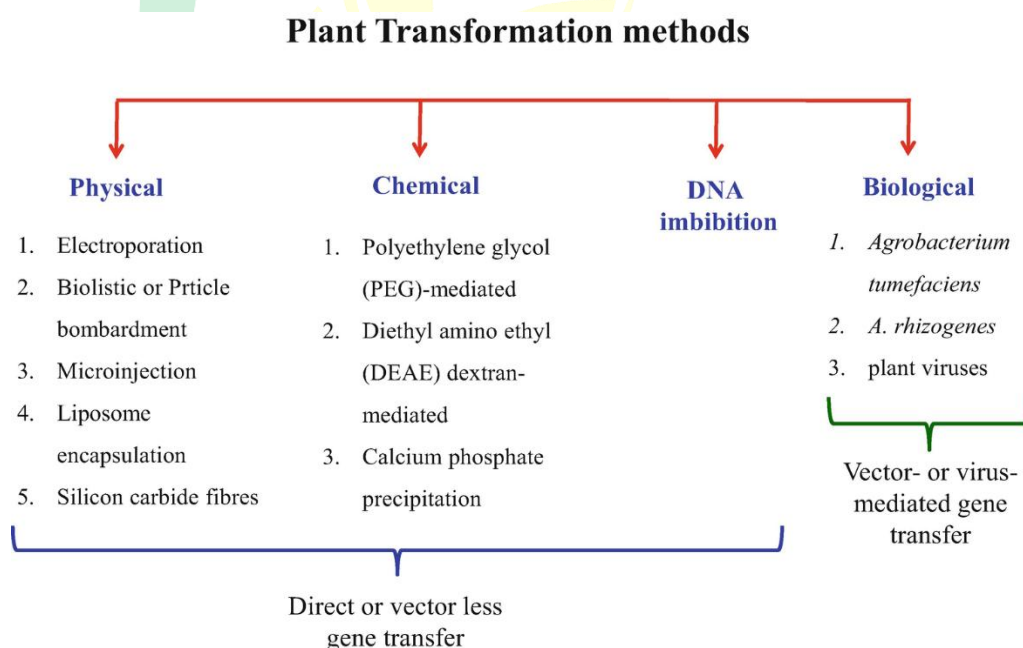


Figure 2: Methods for plant transformation

Most commonly used transformation methods in plants are particle bombardment and *Agrobacterium*-mediated method of which later one is used with several modifications namely Agro-injection, Agro-co-cultivation, Agro-infiltration with or without vacuum and floral dip method.

Examples of Some Genetically Modified Crops:

GM Crop	Trade Name
Alfalfa (<i>Medicago sativa</i>)	Roundup Ready™ Alfalfa
	HarvXtra™
Apple (<i>Malus x Domestica</i>)	Arctic™ "Golden Delicious" Apple
	Arctic™
	Arctic™ Fuji Apple
Argentine Canola (<i>Brassica napus</i>)	Laurical™ Canola
	Optimum® Gly canola
	Roundup Ready™ Canola
	Liberty Link™ Independence™
	InVigor™ Canola
	Phytaseed™ Canola
Bean (<i>Phaseolus vulgaris</i>)	BRS FC401 RMD
Carnation (<i>Dianthus caryophyllus</i>)	Moondust™
	Moonshadow™
	Moonshade™
	Moonlite™
	Moonaqua™
	Moonvista™
Chicory (<i>Cichorium intybus</i>)	Seed Link™
Cotton (<i>Gossypium hirsutum</i> L.)	WideStrike™ Cotton
	WideStrike™ Roundup Ready™ Cotton
	Widestrike™ Roundup Ready Flex™ Cotton
	Widestrike™ x Roundup Ready Flex™ x VIPCOT™ Cotton
	BXN™ Plus Bollgard™ Cotton
Creeping Bentgrass (<i>Agrostis stolonifera</i>)	Roundup Ready™ Creeping Bentgrass
Eggplant (<i>Solanum melongena</i>)	BARI Bt Begun-1, -2, -3 and -4

Maize (<i>Zea mays</i> L.)	32138 SPT maintainer
	Enogen™
	Agrisure® Duracade™
	Herculex™ RW
	Optimum™ GAT™
Potato (<i>Solanum tuberosum</i> L.)	Lugovskoi plus
	Elizaveta plus
	Starch Potato
	Atlantic NewLeaf™ potato
	New Leaf™ Russet Burbank potato
Rice (<i>Oryza sativa</i> L.)	BT Shanyou 63
	Golden Rice
	Liberty Link™ rice
	Huahui-1
Soybean (<i>Glycine max</i> L.)	Liberty Link® soybean
	Cultivance
	Conkesta Enlist E3™ Soybean
	Treus™, Plenish™
	Vistive Gold™
Wheat (<i>Triticum aestivum</i>)	HB4 Wheat
	Roundup Ready™ wheat

Conclusive Opinion:

Genetic engineering is a robust technology and solution to many problems faced in sector of agriculture. The technique with its advances can revolutionize the agriculture era though it is an expensive technology for developing countries. Several countries have commercialized GM crops (soyabean, cotton, canola, corn, alfalfa, *etc.*) after passing through biosafety checks and reported to no harm. However, there are still some ethical issues faced in some developing countries which hold the GM crop commercialization.