AGRIALLIS
Science for Agriculture and Allied Sector: A Monthly e Newsletter
Volume 2 – Issue 3
Online ISSN: 2582-368X
www.agriallis.com

A GLANCE ON GENETICALLY ENGINEERED (GE) CROPS

Article Id: AL202049

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Any technology like modern biotechnology has its associated benefits and risk. Accordingly, products of modern biotechnology are biopharma & genetically engineered (GE) crops. Conventionally, the genetic variation necessary for crop improvement are generated through hybridization; mutagenesis and polyploidy but more recently, biotechnological approaches have become available for the creating genetic variation. The most potent biotechnological approaches are the transfer of specifically constructed genes assemblies through various transformation techniques. This constitutes genetic engineering. The organism obtained through genetic engineering contain genes usually from an altered organism such genes are called transgene and organism containing transgene or transgenes are known as genetically modified organisms (GMOs) or transgenic organisms, and the plants containing transgene are known as transgenic plants.

The first transgenic plant was produced in 1983 when a tobacco line expressing kanamycin resistance was produced. This technology also finds application in pharmaceuticals and production of seeds food and animal feed. In these products, LMOs (living modified organisms) or GMOs are used directly. The introduction of GMOs into the environment may have an impact on the receiving ecosystem such as the possible transfer of genes and subsequent modification of native species. The cultivation and spread of GE crops all over the world have been a subject of controversy in the recent past at both the national and international levels (Prakash, *et al.* 2011).

Technique to develop the Biotech Crops

In vitro gene transfer is the technique of transferring desirable gene across taxonomic boundaries into plant and animals from the other sources such as plant, animals, and microbes. The gene transfer technique classified into three basic methods (i) biological gene transfer (ii) Physical gene transfer and (iii) Chemical gene transfer methods.

In the biological mediated gene transfer methods used Agrobacterium vectors, cointegrated vectors, binary vectors and as well as used some viral-mediated gene transfer virus namely caulimo virus, geminivirus, TMV etc. In some case the physical gene transfer methods likely Electroporation, Particle bombardment, Microinjection, Macro-injection, Liposome mediated, Ultrasound mediated DNA transformation as well as DNA transfer via Pollen. In other hands, the chemical transformation likely PEG mediated gene transfer, Calcium phosphate, and Polycation DMSO technique used for the transfer of foreign DNA in Bacteria, fungi, plant as well as Animal cells (fig. 1).

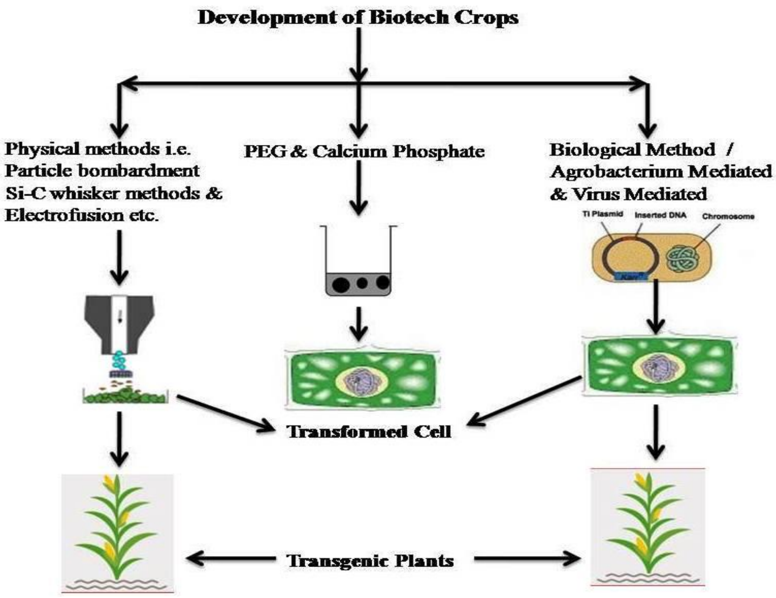

Fig. 1. The overview of the physical, chemical and biological transformation methods of the plant cell.

Current state of transgenic crops

It seems appropriate to spend a little time reflecting on the current status of the GM plant in broad terms. Despite public opposition and political difficulties in some region of the world, particularly in Europe, the area of land cultivated with the transgenic crop continues to increase. Figures the International Service for the Acquisition of Agribiotech application (ISAAA) clearly show the importance of transgenic crop in both developed and developing countries.

The biotech crops are considered as the fastest adopted crop technology in the history of modern agriculture. In 2018, the 23rd year of commercialization of biotech crops, 191.7 million hectares of biotech crops were planted by ~17 million farmers in 26 countries. From

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the initial planting of 1.7 million hectares in 1996 when the first biotech crop was commercialized, the 191.7 million hectares planted in 2018 indicates approximately ~113-fold increase.

Transgenic crop cultivation by country

Seven countries are responsible for 94.37 % of the area cultivated with transgenic crops.

Country	2018 – GM planted area (million hectares)	Biotech crops
USA	75.0	Maize, Soybean, Cotton, Canola, Sugar beet, Alfalfa, Papaya, Squash, Potato
Brazil	51.3	Soybean, Maize, Cotton
Argentina	23.9	Soybean, Maize, Cotton
Canada	12.7	Canola, Soybean, Maize, sugar beet, Alfalfa
India	11.6	Cotton
Paraguay	3.8	Soybean, Maize, Cotton
China	2.8	Cotton, Poplar, Papaya, Tomato, Sweet pepper

*Area is in millions of hectares. (Source ISAAA, 2018).

Distribution of Biotech Crops in Developed country and Developing country

In 2018, the 21 Developing countries cultivated 54% (103.1 million hectares) of the global biotech hectares, while five industrial countries took the 46% (88.6 million hectares) contribution of the total biotech crop production globally.

Transgenic crop cultivation by crop

The commercial use of GM varieties still focuses on soybeans, maize, cotton and rapeseed. The proportions of the total area dedicated to transgenic crop made up of the particular crop are given below:-

Crop	Area* (conventional + Biotech crop)	Area of GM*	Proportion GM
Soybean	123.5	95.94	78 %
Maize	197.2	59.16	30 %
Cotton	32.9	25.0	76 %
Rapeseed	34.7	10.06	29 %

* Cultivation worldwide in millions of hectares

The field area of GM soybean has been compared to the total soybean production per cent and stands now at 78 per cent. The driving force behind the growth in floor space in Brazil. Other producers are the USA, Argentina and Canada.

In the case of maize, the field areas are used for GM varieties 59.16 million hectares, primarily in the USA, Argentina, Brazil and Canada. Maize production across worldwide is 30 per cent of the present production, based on GM maize.

The field areas for GM rapeseed are present 10.06 million hectares. Those fields are found primarily in Canada and Australia.

The field areas for GM cotton at present time are a total of 25 million hectares. Across Worldwide 15 countries (including India, USA, China, Brazil and Argentina) use GM cotton.

Transgenic crop cultivation by trait

Herbicide resistance is the trait found in by far the largest area of transgenic crop accounting for 77 %. With insect resistance, these two traits account for effectively all the area cultivated with transgenic crops.

Trait	Area*	Percentage
Herbicide resistance	40.6	77 %
Insect resistance (Bt)	7.8	15 %
Insect resistance (Bt)+	4.2	8 %

*Area is in millions of hectares (Source ISAAA, 2018).

The global value of the biotech crop market

In 2018, the global market value of biotech crops, estimated by Cropnosis was US$18.0 billion (up by 9% from US$15.8 billion in 2016); this represents 23% of the US$70.5 billion global crop protection market in 2016, and 30% of the US$56.2 billion global commercial seed market (Aldemita and Hautea, 2018).

Farmers benefited by transgenic crops

Agricultural crops are mainly cited paradigms of GMOs. Some benefits of genetic engineering in agriculture crops are improvement in Yield, reducing the costs for food or drug production, low or no need for pesticides in agriculture, improved nutrient composition and quality of food, developed pests and disease resistance plants, greater food security, and medical benefits to the world's growing population. Advances have also been made in developing crops that mature faster and tolerate the biotic stress as well as drought, salt, metal, and other environmental stress, (Phillips, 2008). The other benefit of genetic engineering in the field of research, rapid and accurate technique and no barrier for gene transfer.

Volume 2 – Issue 3
Online ISSN: 2582-368X
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Conclusion

The constant growth in the adoption of genetics modified crops is attributed to the technology's positive impact on the environment, human and animal health, also as on the development of socioeconomic health of farmers and the general public.

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