

Transgenic Cotton / Bt Cotton

Nolen sb.

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- ⇒ A genotype or an individual which is developed by genetic engineering is called transgenic^(G.M). A transgenic may be a plant, an animal or a microbe (fungus, bacteria or virus)
- ⇒ Transgenic plants contain foreign gene or genetically modified genes of the same species.
- ⇒ Transgenic plants are developed by tissue culture and genetic engineering.
- ⇒ G.E. helps in manipulation of foreign gene and T. culture is essential for genetic transformation. Genetic transformation can be achieved either through cell culture or protoplast culture.
- ⇒ Tissue culture is essential for regeneration of genetically transformed single cell into whole plant.

What is Bt?

Bt is a short form of soil bacterium Bacillus thuringiensis

This bacterium produce/synthesize crystalline protein called endotoxin - which is highly toxic to certain insects. These proteins kill the insects. These proteins are often appear microscopically.

These proteins are grouped into 4 classes depending upon their insecticidal activity.

- i) Lepidoptera - specific (Cry-I) (Boll worms)
- ii) Lepidoptera and Diptera-specific (Cry-II) (Boll worms & house flies)
- iii) Coleoptera-specific (Cry-III) (Beetles)
- iv) Diptera-specific (Cry-IV) (Flies, house, fruit etc.)

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⇒ Different Bt produce more than 25 different insecticidal proteins.
⇒ Cotton Boll worms belong to order Lepidoptera and therefore are sensitive to Bt Cry-I and Cry-II Proteins. Beneficial insects are un-affected by these proteins.

What is Bt Cotton?

Genetically engineered organisms are called transgenics. Bt cotton refer to transgenic cotton which contain "endotoxin" protein inducing gene from Bacillus thuringiensis.

- First transgenic plant - Tobacco in 1983 in USA.
- First transgenic cotton plant - developed in 1987 in USA by Monsanto, Delta & Pine Companies.

Transgenic ^{cotton} plants are of two types.

- i) Ballgard Cotton - have resistance against boll worms. It is cultivated in USA, China, Mexico, South Africa, India and Pakistan.
- ii) Roundup ready Cotton. It is resistant to herbicides and is grown only in USA.

Why Bt Cotton? The boll worms cause significant yield losses in cotton. B. Worms are three types.

- 1 - American B.W. (*Helicoverpa armigera*)
 - 2 - Pink B.W. (*Pectinophora gossypiella*)
 - 3 - Spotted B.W. (*Earias vitella*) (45% in India)
- 10% insecticide used on global basis and more than 70% is used in Pakistan to control ~~Bt~~ ^{insects} only in cotton crop. We don't have any source of resistance against B. Worms in germplasm of cotton the world over.

How Bt Cotton is developed? (3)

For the development of transgenic of any crop there are five important steps.

and isolation

- 1- Identification of effective gene(s).
- 2- Gene transfer technology.
- 3- Regeneration ability from protoplast, callus or tissues.
- 4- Gene expression in regenerated plant at desired level.
- 5- Proper integration of genes so that they are carried for generations by means of reproduction (Sexual or asexual)

There are four important methods of gene transfer in crop plants.

- 1- Plasmid method
- 2) particle bombardment
- 3) direct DNA uptake
- 4) micro injection.

(Polyethylene glycol) (Electroporation)

Currently two DNA delivery system viz. 1) Agrobacterium mediated gene transfer and 2) Insertion of DNA using particle gun, are widely used for the development of transgenic plants in cotton. More than 37 transgenic plants have been developed in cotton so far by these two methods.

Traditional breeding methods deal with blocks of chromosomes based on sexual hybridization and recombination. GE deals with a very limited no. of defined genes designed to impart traits to a crop that are not present in the traditional germplasm breeding pool.

Advantages of Bt Cotton

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- 1- The Bt Cotton has inbuilt genetic resistance to boll worms and is very effective in controlling the yield losses caused by boll worms. Resistance is governed by a single dominant gene.
- 2- Reduce cost of ^{crop} production.
- 3- It promotes ecofriendly cultivation of cotton and allows multiplication of beneficial insects, i.e. parasites and predators of boll worms.
- 4- It also reduces environmental pollution and risk of health hazards, associated with use of insecticides.

Impact of Bt Cotton:

- 1- The feeding of Bt cotton seed to animal has not been reported to have any adverse effect.
- 2- Bt cotton seed and its cake do not have any adverse effects on digestion of animals. No toxic or allergic effect of Bt cotton seed & meal has been reported.
- 3- The oil extracted from seeds of Bt cotton has not been found to have any adverse effect on human health.
- 4- No adverse effect of Bt cotton on beneficial insects.

Handwritten signatureCotton Variety maintenance.

Cotton

P.B.G. 302

Variety maintenance in cotton may be carried out in numerous ways.

- 1- Roughing out off-type plants.
- 2- Mass selection
- 3- Progeny selection
- 4- Maintaining seed stocks of the original seed increase.

Breeding methods in cotton:

Breeding methods differ from the methods used with self-pollinated crops such as wheat & soybean.

- 1- Introduction, acclimatization, and germplasm utilization.
- 2- Selection. Mass selection \rightarrow ^{was} utilized in past, but is seldom. Pure line selection \rightarrow is not generally practiced in cotton because it leads to homozygosity, reduce vigor & lower yield. However modified pure line may be used.

Progen selection ⁽²⁾ may be used in existing varieties

- i) Maintain the purity of variety
- ii) Progressively improve the variety.
- iii) used to generate new lines in a segregating pop. after hybrid

Hybridization in cotton breeding :-

It is the most common breeding method for producing new cotton varieties.

Procedure

A. ^{Selection} pedigree method is generally followed during segregating generation. Selection may be terminated at early generation while some heterozygosity still remains.

Lines genetically different, yet uniform for plant type, disease & insect resistance and fiber properties are ~~found~~ pooled to form a variety.

⇒ Back cross method is used to transfer genes for disease resistance or some other inherited characters.

⇒ Male sterility or fertility restoring genes may be incorporated by B-crossing.

Recurrent Selection :- may be used in cotton to concentrate genes for a quantitatively inherited character. Source pop. may be created by crossing among groups of varieties, breeding lines or exotic germplasm.



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Hybrid variety development

A, B & R ~~lines~~ lines.

Male sterility is obtained by transferring *G. hirsutum* chromosomes into *G. harknessii* cytoplasm.
Receptive ms₂ ~~Gen~~

Fertility restoration is ^{also} obtained ^{from} *G. harknessii* (single partially dominant gene (Rf)).

Fertility restoration is improved by presence of Σ dominant fertility enhancer gene "E" from Pima Cotton.

Population improvement Approaches:

- i) Recurrent selection → A breeding approach in which both
- ii) Disruptive selection → the extremes for a character are selected in a segregating population and intermated is called disruptive
- iii) Biparental ~~select~~ mating → crossing of randomly selected plants in F₂ or later subsequent segregating pop.
- iv) Diallel Selective mating: - A breeding approach in which selected F₁ crosses from a diallel is used to cross again in a diallel fashion and also used to produce F₂ population is referred as DSM.