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Success of Transgenic Bt-hybrid Cotton in Andhra Pradesh State of India

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Abstract

Cotton is a major commercial fiber crop in India and important crop in countries like USA, Australia. The advent of molecular biology and plant genetic engineering have developed transgenic crop plants which express Bt-insecticidal proteins to agronomically important levels. Such crop though works effective against bollworms especially the American bollworm with 30% higher yield and 60% reduction on chemicals use on cotton plants but also needs agronomic measures. Cotton plant contains a toxic pigmented chemical Gossypol in various plant parts and seed and is said to act as a deterrent against certain pests. Moreover, 20% of non-Bt-cotton is to be grown in the periphery of Bt-cotton as refugea crop to reduce chance of development of resistance.

1. Introduction

Bio-technology has gained great momentum in the last two decades and some tangible advances have occurred in the areas of crop protection. Cotton is a major commercial fiber crop in India and it was consuming abundant pesticides because of high and serious pest attacks and its commercial importance. Different lepidopteron pests attack the crop and the most important one was American cotton bollworm *(Helicoverpa armigera)*.

2. Release of Transgenic Bt-hybrid Cottons

Bacillus thuringiensis (Bt) is a gram positive soil bacterium, which synthesizes insecticidal proteins depending upon the strain. The advent of molecular biology and plant genetic engineering has made it possible to develop transgenic crop plants which express Bt-insecticidal proteins to agronomically important levels. The genes (cry 1Ab, cry 1Ac, cry 2Ab and cry 1F) extensively modified for plant expression were introduced into cotton cultivars (Coker series). The benefits of Bt-cotton cultivation is that it reduces insecticidal usage and controls target pests and improve yield out-put. The production cost also will be reduced and pave way for profitability. The first set of Bt-cotton released were by the major seed company Mahyco-Monsanto, Mumbai of which MECH Bt-162 and MECH Bt-184 were released and occupied larger area under transgenic Bt-cotton hybrids. The major benefits from Bt-cotton included effective control of bollworms especially the American bollworm leading to significant yield increase by 30% with reduction of chemical sprays by 60% and substantial increase in net-profit by several thousand Rupees per hectare to progressive farmers.

Extensive cultivation of Bt-transgenic cotton has become a reality and in the near future imposition of selection pressure on target insects in a continuous mode will encourage the development of resistance in insects towards Bt-cotton. In addition, unregulated cultivation of transgenic cotton without proper refugea growing and other unwanted plant protection will encourage resistance development in insects.

3. Success of Transgenic Bt-cotton Hybrids

The success of transgenic cotton cultivation mainly depends upon its integration as part of IPM. Bt-cotton alone will not solve all problems. Many secondary and tertiary pests can only be controlled by proper agronomic practices like crop rotation, crop sanitation, pest monitoring etc., which will not only enhance the durability of Bt-effects on pests, but also would make the transgenic crop an integral part of safe and healthy environment. To make this successful every effort should be made to educate the farmers in Bt-cotton cultivation.

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Bio-technology has gained great momentum in the last 15 years all over the major cotton growing areas of the world and some tangible advances have occurred in the areas of crop protection. There are many other aspects like drought tolerance and improvement of fibre quality parameters are being researched upon and the fruits of which may be available after a few years.

Cotton is a major commercial fibre crop in India. Cotton is well known for abundant consumption of pesticide and cotton growers need to manage different insect pests because of its commercial importance. Various lepidopteron pests attack the crop and the most important one is the American bollworm (*Helicoverpa armigera*). Unfortunately some of these pests have developed resistance to virtually every known pesticide. It is necessary to adopt eco-friendly technologies to manage insect pests and drastically reduce the consumption of pesticide towards a safe and sustainable agriculture.

The first Bt-transgenic crop that was commercialized in cotton was in USA. The developing countries like China and South Africa are much benefited as a consequence of Bt-cotton cultivation (Anand Kumar, 2004). Benefits of Bt-cotton cultivation include: reduced insecticidal usage, improved control of target pests, improved yield, reduced production costs and improved profitability with the least environmental pollution.

The first set of Bt-cotton transgenic hybrids were developed by Mahyco seed company, Mumbai by importing 100 g of transgenic cotton-312 (USA cultivar) containing Bt-cry 1 Ac gene. By back crossing the selection, three Bt-cotton hybrids were developed namely MECH162-Bt, MECH184-Bt and MECH12-Bt. These were cultivated along with non-Bt-cotton hybrids along with national and local checks. Of these two hybrids, MECH Bt-162 and MECH Bt-184 were released in 2002 *kharif* for general cultivation in central and southern cotton growing areas. In 2003 a larger area was cultivated under transgenic Bt-cotton hybrids with better enlightenment of farmers regarding Bt-cotton cultivation. The Bharathi seeds R & D unit at Nandyal (A.P) has developed two Bt-cotton hybrids Atal and Brahma Bt which are high yielding and prolific. Atal Bt-cotton hybrid has recorded a cotton yield of 3400 kg ha^{-1} followed by 3250 kg ha^{-1} of Brahma Bt-cotton hybrid as against 2650 kg $^{-1}$ of non-Bt-cotton hybrids. Due to cultivation of hybrid cottons India is in a safe position to export cotton and also satisfy local demand by textile industry

4. Contribution of Bt-cotton Hybrids in India

India is probably the only country to commercially grown Bt-cotton in a hybrid genotype form. Normally one of the parents, usually, the male of a specific cotton hybrid combination is a cry 1 Ac bearing genotype obtained through back crossing with the original Bt-cotton stock. The female parent is a non-Bt-

Plate: *Atal*- a prolific high yielding Bt-cotton

genotype and by crossing the two parents, the hybrid seed is produced and given out for commercial cultivation as Bt-cotton hybrids. In the cotton Bt-varieties, the mortality of cotton boll worm- *Helicoverpa armigera* in USA was 75-90%, in china 90% and in Australia it was 80-90 %. In India, the existing hybrids did not record that high level of control. Today in India, several hundred Bt-cotton hybrids developed by several private seed companies are marketed and grown with advantage. Bt-cottons have helped the textile industry to get clean cotton for their mill use. The acid de-linted seeds are also given value addition with small amounts of chemicals to give season-long protection against sucking pests and also against seed- borne diseases. In the last few years, the Bt-hybrid cotton cultivation almost doubled the cotton production in India.

5. Gossypol Removal- a Future Goal in Cotton

The genus *Gossypium* (cotton) contains a toxic pigmented chemical Gossypol in various plant parts and seed and is said to act as a deterrent against certain pests. Gossypol that is a toxic phenolic compound has to be removed from oil for consumption by scientific processing techniques. MS Barbara Triplett, a Plant Physiologist of USA has evolved a technique to produce clumps of prolific hairy roots that can be primed to produce gossypol. There are new avenues for using gossypol and any biotechnological approach to have it in parts including roots and not in seeds may be useful for controlling pests. This also has recently been reported in Texas USA through an RNAi technique and seeds made almost free of gossypol. But the methods need to be further perfected to achieve hundred per cent success.

6. Precautions for Successful Growing of Bt-cotton

Pest populations exposed to Bt-crops continuously for several years have the potential to develop resistance to cry-proteins. This phenomenon is not an exception to Bt-cotton. Hence, productive insect resistance management strategies have been developed and are put in place so as to prevent or delay

resistance development. Hence, 20% of non-Bt-cotton is to be grown in the periphery of Bt-cotton as refugea crop and take necessary plant protection measures against bollworms in refugea crop.

Planting refugea is mandatory in India. In India *Helicoverpa armigera,* by far the most predominant bollworm besides cotton has large number of alternative host crops like chickpea, pigeon pea, tomato, sunflower, maize and sorghum which are substantially grown around the same area at the same time as cotton.

7. Agronomic Practices

The success of transgenic cotton cultivation mainly depends upon its integration as part of IPM and IRM. Bt-cotton is not the only potential solution for all problems. Many secondary and tertiary pests can only be controlled by proper agronomic practices like crop sanitation soil health, crop rotation, use of Neem products, pheromone traps for pest monitoring etc., and these measures will not only enhance the durability of Bt-protection to cotton against bollworms, but also make the transgenic crop on integral part of safe and healthy environment.

8. Conclusion

The various speakers at the recently held World Cotton Research Conference-5 also gave numerous suggestions and reported the great success achieved all over the World and India since 1996 and 2002 respectively. Many countries like Pakistan, Egypt, Sudan etc are also in the process of adopting the new gene technology in a greater measure. Several new gene technologies are likely to be available for yield and quality improvement by 2020.

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