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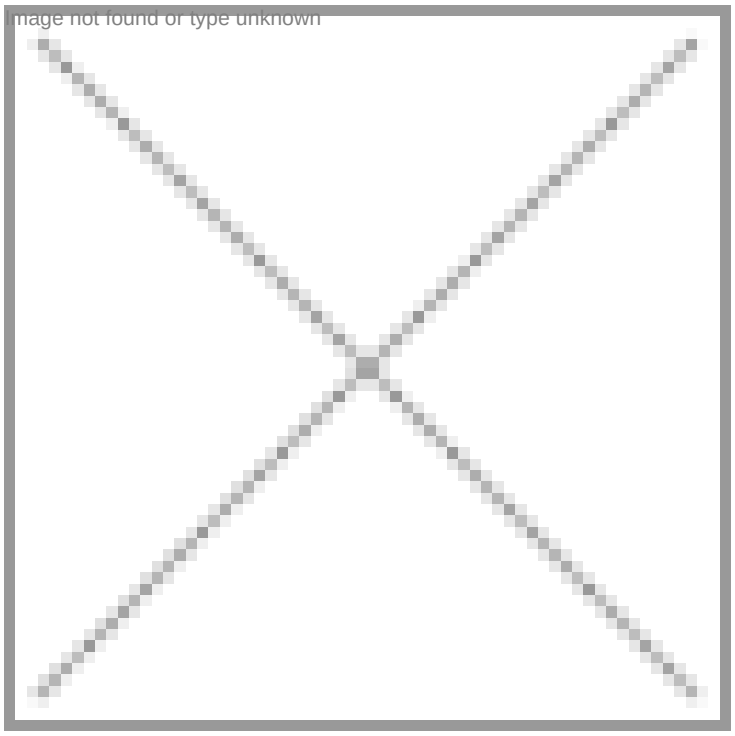
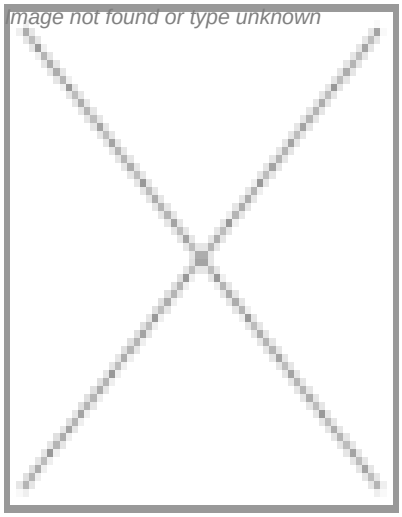


How safe is Bt-cotton? Facts allay fear

The success story of Bt cotton has opened the doors wide for the Bt crops in india. T M Manjunath, Consultant, AgriBiotech and IPM, explains about the scientific process involved in developing Bt crops, their speciality and the safety regulation processes.

Bt-cotton is a well-researched product and any science-based, rather than aggressive and emotional, debate is welcome. Blind opposition and creating suspicion and fear through unsubstantiated allegations have no place in science. An attempt is made in this article to put across certain biological and regulatory facts so as to clear any doubts about the safety of Bt-cotton

and other Bt-crops.



Why is Bt safe to non-target organisms?

Bt-cotton, incorporated with the insecticidal gene(s) derived from the soil bacterium, bacillus thuringiensis, has been specifically developed to control cotton bollworms - not sucking pests, diseases, etc. - which have haunted cotton growers for several decades.

Specificity: The cry (crystalline) proteins expressed by the introduced genes in cotton tissues are lepidopteron (moth and butterfly group) that are unique and require certain specific conditions for their activity. These include:

The protein has to be ingested by the target insects as it has no contact effect; ingestion takes place when caterpillars feed on any part of Bt-cotton plant. The protein requires an alkaline intestine with a pH of at least 9.5 for its activation and effective processing; and there should be specific receptors in the mid-gut epithelium cells of the target insect for protein-binding that eventually leads to death of the incumbent caterpillars.

All these conditions are available in bollworms and therefore the caterpillars succumb when they feed on Bt-cotton plants. The protein cannot act in human or animal intestine because it is acidic, pH is very low and lacks specific receptors. This has been demonstrated during regulatory tests in India and other countries. Experimental animals like mice, rats, rabbits, sheep, etc. fed with unusually high doses (500, 1000 and 4300 mg/kg body weight) of Bt protein showed no acute toxic effect on their health. These animals were found to be substantially equivalent to those not fed with cry protein in respect of body weight, food consumption and other respects. Based on such scientific data, the US Environmental Protection Agency (EPA) has concluded “toxicity and infectivity risks of cry proteins to non-target organisms like avian, freshwater fish, freshwater aquatic invertebrates, estuarine and marine animals, arthropod predators/parasitoids, honey bees, annelids, and mammalian wildlife will be minimal to non-existent…”

In spite of such clean certification by responsible bodies, serious allegations continue to be made by a select group against the safety of Bt-crops. Bt-cotton was implicated for mass mortality of sheep purported to have fed on the foliage of this crop in Warangal, Andhra Pradesh. However, GEAC, which examined the data submitted by the Centre for Sustainable Agriculture (CSA), opined during its 68th meeting held in May 2005, that the report was highly exaggerated and was based more on hearsay than on scientific facts. In spite of this, the reactionaries continue to quote such examples and try to scare the farmers.

Bt-protein in soil: The cry proteins produced in Bt-cotton are found to degrade when crop residues are incorporated into the soil. Thus, the impact of these crops on environment, soil flora or fauna is negligible. This is further supported by the long history of safe use of Bt microbial spray formulations to control insect pests on a variety of crops all over the world for more than 50 years.

Cross pollination and gene flow:

The potential movement of transgenes from Bt-crops into related weeds through pollen flow is one of the concerns. This issue has been addressed for Bt-cotton and experimentally demonstrated that there is no significant risk of such gene transfer.

In India, cotton has only one close weed relative. It is Gossypium stocksii. It is found in northern Gujarat where cotton is not cultivated. Besides, there is no record of bollworms feeding on this weed and also there is no other major lepidopteron common to both cotton and this weed. Further, the cotton pollen is heavy and cannot move beyond a few meters away from cotton fields. Therefore, the possibility of gene transfer and the development of ‘super weed’ is a remote possibility. Even in other countries and with other Bt-crops, there is no evidence that ‘super weeds’ have ever developed over the past decade.

In India, we have two types of cotton: the American cotton (Gossypium hirsutum and G barbadense) and the ‘desi’ (local) cotton (Gossypium herbaceum and G arboreum). All the Bt-cotton hybrids developed in India are G hirsutum. The American

cotton is tetraploid in genetic makeup whereas the 'desi' cotton is diploid. There is no reproductive compatibility between the two. Even if cross pollination occurs between the tetraploid and diploid cotton plants, the zygotic embryo will not develop. This holds good for other unrelated plant species as well. The terms such as 'gene pollution' and 'gene contamination' are mere jargons in this case.

The potential for horizontal gene transfer from Bt-crops was also considered and evaluated. Various sub-species or strains of Bacillus thuringiensis naturally occur in soil and therefore various cry genes have been available for long periods of time for any potential horizontal transfer from this bacterium to other soil species. Therefore, Bt crops, including cotton, are not adding anything new to the already existing flux of cry genes among the soil microorganisms. There is no evidence that horizontal gene transfer has occurred from plants to microbes.

Insect Resistance Management:

Pest populations exposed to Bt-crops continuously for several years have the potential to develop resistance to cry proteins. Resistance is not unique to Bt-crops. In view of this, proactive insect resistance management strategies have been developed and are in place. A key element of these plans is that growers should plant sufficient acreage of non-Bt crops to serve as a refuge for producing Bt-sensitive insects. The refuge strategy is designed to ensure that Bt-susceptible insects will be available to mate with Bt-resistant insects. The offspring of these mating will be Bt-susceptible, thus mitigating the spread of resistance in the population. Gene pyramiding, optimum dose and deployment of Bt-crops as one of the components of integrated pest management are the other options for Insect Resistance Management (IRM).

Growing refuge has been made as one of the conditions while giving approval for Bt-cotton in India. In India, Helicoverpa armigera, besides cotton, has a large number of alternative hosts like chickpea, pigeonpea, tomato, sunflower, maize and sorghum, which are grown in the same area at the same time as cotton. These would serve as natural refugia, thereby helping IRM. The fact is that although Bt-cotton has been under large scale commercial cultivation for many years, there has been no indication of any pest resistance to Bt protein expressed within the plant. This is very encouraging.

Concluding Remarks:

The above scientific information clearly indicate that Bt is safe to non-target organisms and environment. Yet, the reactionaries continue to hurl allegations, question the competence of regulators, confuse politicians, scare the farmers and demand a ban on a well-researched scientific product! It is a puzzle what would satisfy them! Those who demand a ban owe a responsibility to furnish supporting scientific data to GEAC, for scrutiny and appropriate decision. Mere public agitation and press statements have no credibility in science.

An annotated bibliography of more than 200 peer reviewed world literature on biosafety and related issues associated with GE/GM crops was prepared and reviewed way back in 2003. There was hardly any scientific paper that found Bt-crops as unsafe to humans or environment. In subsequent years, many more scientific papers have been published in reputed journals in support of this technology. The anti-biotech papers are mostly published in newspapers and magazines without being reviewed by experts.

Bt-technology has already lasted for more than a decade in several countries and in India since 2002, bringing substantial environmental and economic benefits to farmers with no negative consequences whatsoever. It is the responsibility of the scientists and regulators to sustain these benefits. If we close the doors for new technologies, fearing the opposition and speculated risks, we cannot make any progress and solve our problems.

Highlights

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Those who demand a ban owe a responsibility to furnish supporting scientific data to GEAC, for scrutiny and appropriate decision.

If we close the doors for new technologies, fearing the opposition and speculated risks, we cannot make any progress and solve our problems.

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