

WHAT SHOULD BE THE STRATEGY FOR BT TECHNOLOGY

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The Indian research agenda on GM crops is ad hoc and arbitrary, if it is anything. Research has been funded, not with any great understanding of the needs of Indian agriculture but merely because certain (proprietary) genes happened to be available in the repertoire of the multinational companies. Since that seems to be the dominant criterion for funding research, it is not surprising that there is an unacceptable reliance on the Bt gene. According to data given in a recent paper by Manju Sharma, Secretary, Department of Biotechnology (DBT), over 42 percent of the research projects in biotechnology research, use the Bt gene. Ranging from cotton to potato, rice, brinjal, tomato, cauliflower, cabbage, even tobacco, to maize, the Bt gene is everywhere. It's quite another matter that the Department of Biotechnology is spending scarce research funds supporting research on tobacco! As India and the rest of the world try to curb the menace of nicotine and various arms of the Indian government launch an intensive anti-tobacco campaign, what is one to make of this research sponsored by the DBT using public money?

As for Bt crops, what does the scenario look like? Assuming that the crops that are being researched are targeted to reach the fields one day, we are facing a situation when a wide range of crops growing in both the Rabi and Kharif season will contain the Bt gene. So throughout the year, there will be standing crops containing Bt endotoxin. Not just that, in the same season, there will be various Bt crops juxtaposed with each other in small fields when farmers grow a variety of different crops, for example vegetables. When the bollworm is exposed to the endotoxin, constantly, season in and season out, so that there is some form of Bt staring it in the face every side it turns, the bollworm is going to build up resistance very fast. We saw this happen with DDT, which was used in such profusion everywhere that the mosquitoes quickly acquired resistance and DDT became ineffective in controlling mosquito populations.

What should be the rational approach to Bt mediated disease resistance? The current situation is ridiculous so we need to see what could be a better approach. And we need to question whether the Bt approach is workable in a developing country situation. The decision to use the Bt route to disease resistance should be taken only after all the other factors that would operate under Indian conditions, are evaluated. The first Bt cotton harvest came earlier this year and several scientific and socio-economic concerns have arisen already. The next crop will be ready in another few months and will provide further data to increase our understanding of whether or not the Bt route is viable.

If the Bt strategy were indeed selected as a viable path of disease resistance, surely it cannot be used in all crops. Since cotton uses more pesticides than any other crop, perhaps the use of the Bt technology should be reserved solely for the cotton crop, to be managed with extensive farmer education and monitoring of insect refuges. This could allow the bollworm to remain susceptible for as long as possible. Only then can this approach make any sense. However, there are many outstanding concerns that exist which pose a serious challenge to the efficacy and applicability of this technology for cotton farmers in India.

Science Issues

Field data collected by Gene Campaign in selected locations in Andhra Pradesh and Maharashtra flagged a serious scientific issue. The study found that the Bt cotton planted

does not offer protection against pink bollworm (*Pectinophora gossypiella*). Pink bollworm attack was found to be severe after 60 to 70 days. It would appear that the pink bollworm is not susceptible to the Bt endotoxin.

This is supported by scientific literature. Morin et al, (2003), report that field populations of pink bollworm harbour three genetic mutations that confer resistance to Bt toxin. Normal pink bollworm caterpillars die when they eat bolls of genetically modified cotton plants that produce Bt. toxin, but resistant caterpillars survive. This resistance is inherited as a recessive trait, so caterpillars with two mutant versions of the gene are resistant, but those with one or none are susceptible.

In another study Liu et al, (1999) show that the development of *Bt.*-resistant pink bollworm larvae into adults takes longer than the development of susceptible larvae. This difference makes it more likely that resistant bollworm moths would mate with each other rather than with susceptible individuals. In this case, all their offspring would be resistant to the *Bt.* cotton, as they would inherit two copies of the resistance gene. So the *Bt.* resistance would persist and spread in the bollworm population.

Pink bollworm is emerging as a major pest in the cotton belt, specially in Andhra Pradesh and Gujarat according to field observations so far. The toxin in Bt cotton is proving to be ineffective against pink bollworm and does not kill it, it kills only the green bollworm. There was a growing concern expressed about the future of Bt cotton varieties in the situation developing with pink bollworm. Scientists confirmed that the incidence of pink bollworm was on the rise and the pest attack was getting stronger every year. Substantial savings in pesticide use could not be expected in such a situation despite the Bt toxin in Bt cotton since farmers would have to continue to spray to control pink bollworm.

Probably the most important reason for the increase in pink bollworm populations is the spread of the illegal Navbharat 151 variety over the last few years. Because of the constant exposure to Bt toxin without any implementation of refuges, the green bollworm is under pressure, creating a favourable space for the pink bollworm to multiply. Farmers and breeders have created their own Bt cotton varieties by crossing the Navbharat 151 with locally adapted cotton varieties. These varieties have spread too many states through an informal sales network. Cultivation of a variety of illegal Bt cotton is now widespread. This is posing a serious challenge to the cotton scientists and their strategy of Bt pest management.

In India, apart from the bollworm, sucking pests like aphids and whitefly are serious pests. A strong attack of either can wipe out the cotton crop whether it contains the Bt gene or not. In this situation, is the Bt technology an effective and affordable protection for the cotton farmer? Should one not seriously explore the route of Integrated Pest Management (IPM)? IPM is not just affordable, it is also sustainable and it is a technology which the Indian farmer can absorb well. The farmer in this case can rely on his wisdom and does not need to be literate to comprehend instructions in a pamphlet. Perhaps this technology for disease / pest control will work altogether better than the strange new Bt approach.

***There are studies conducted by ICAR that show pest control by IPM is

Socio-economic issues

The economics of cultivating Bt cotton is clearly not in favour of farmers. The seed carrying the proprietary Bt gene is very expensive, about four times more expensive than the good local cotton hybrids available to the farmers. The difference in the price of seed with the

Monsanto Bt cotton varieties worked out to approximately Rs. 1200 per (450 gm) bag which is needed to plant an acre. As against this outlay, savings on pesticide were meagre, averaging Rs. 217 per acre. This situation will not improve if pink bollworm becomes a major pest, as it is threatening to do.

Tilting the balance further is the fact that Bt cotton must be grown with a refuge, necessary for resistance management. This is recommended as 20 % of the cultivated area by the GEAC. "Wasting" 20 % of the land on managing resistance makes the Bt cotton even more nonviable, especially for small farmers. Apart from its economic implications, the refuge poses another problem. The fact is that compliance with the refuge requirement is poor to almost non-existent. Apart from the economic aspect, this is also because the farmer has not internalised the importance of planting the refuge and does not really comprehend the consequences of not planting it. This is an alien technology; nothing in the farmers' experience has prepared him for it and the government has not conducted any training programs. This task has been left to the company.

Field visits reveal that the training offered by Monsanto consists of distributing pamphlets which require the farmer to count the bollworm in his fields and if they exceed a certain number, then to spray pesticides. For illiterate farmers, spreading information through such pamphlets has been grossly inadequate and has resulted in much misinformation and rumours. In the absence of a credible help line, farmers are doing their own thing, which does not bode well for maintaining resistance. If resistance cannot be maintained, the technology will be worthless very soon.

In the US with its large tracts of monocultures and the large landholdings, setting aside 20 percent and even more as a refuge, is not an economic issue. Yet even under these conditions, with educated farmers who have engaged in mechanised and standardised agriculture since long, compliance with refuge maintenance is not efficient. Up to 30 percent of American farmers do not follow the refuge requirement.