PERFORMANCE OF BT COTTON IN INDIA: DATA FROM THE FIRST COMMERCIAL CROP

Suman Sahai and Shakeelur Rahman

GENE CAMPAIGN, Aug 2003: http://www.genecampaign.org/btcotton.htm

Introduction

Bt cotton is the first genetically modified crop to be cultivated in India. Gene Campaign conducted a small field study to collect data on Bt. cotton and non-Bt. cotton performance.

Methodology

The survey was conducted in selected locations in Maharashtra and Andhra Pradesh, which are two of the six states that have been granted permission to commercially cultivate Bt. cotton. The survey included a total of 100 farming families selected by random sampling from those who had chosen to grow Bt. cotton on a portion of their landholding. These were farmers who were also growing non-Bt. cotton simultaneously. Of the total of 100 families surveyed, 25 were from Maharashtra and 75 from Andhra Pradesh. Scientists from the Agricultural University in Hyderabad accompanied the Gene campaign researchers.

Bt. and non-Bt. varieties: a comparison

The Bt cotton varieties compared were Bt. 162 and Bt. 184 belonging to Mahyco-Monsanto and the non-Bt cotton varieties were the local hybrids Brahma and Banny.

The Bt cotton was found to be a shorter duration crop (90-100 days) than the non-Bt cotton (100 to 120 days) but the plants showed less vigorous growth, with fewer branches and smaller leaves. A major problem reported everywhere was the premature dropping of bolls in Bt cotton.

Table 1: comparison between bolls and fibre of non-Bt. and Bt. cotton

Item	Non-Bt.	Bt.
Number of bolls/plant	95 (70 - 120)	50 (25 - 75)
Boll size	6 - 8 gm	3.5 - 5 gm
Fibre length	34.5 mm	30.5 mm
Cotton Quality (grade)	A & B	B & C

A comparison of bolls and fibre in non-Bt. and Bt. cotton in Table 1, showed that the number of bolls per plant was higher in the non-Bt. cotton variety. Whereas the non-Bt. variety averaged 95 bolls per plant in the Bt. variety the average was only 50 bolls. Fibre length was also longer in the non-Bt varieties, which had better grade cotton. Non-Bt. cotton was graded as A and B quality whereas Bt. cotton was graded as B and C.

Although both cotton types demonstrated a range of small to large bolls, more Bt cotton bolls were of a smaller size than the non-Bt cotton. Cotton traders admitted that because of the poor

quality, demand for Bt cotton was low and they were mixing Bt cotton with non-Bt to dispose the Bt cotton stocks.

Pest	Non-Bt. Cotton	Bt. Cotton
Leaf Sucker	Moderate	Moderate
Stem borer	Low	Low
Bollworm	Moderate	Moderate
Pink bollworm	Heavy	Heavy

One of the most significant findings of this study was the indication that this Bt cotton variety does not offer protection against pink bollworm (Pectinophora gossypiella). Pink bollworm attack was found to be severe after 60 to 70 days. There are two possible reasons for this. The first is that the period of _expression of the Bt endotoxin does not coincide with the time of the bollworm attack. This would mean that when the pest attacks the cotton, it is not expressing the endotoxin gene and therefore not offering any protection against the pest. The other explanation is that the pink bollworm is not susceptible to the Bt endotoxin.

The latter theory receives support from 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 in the laboratory, the larval stage of the pink bollworm gets prolonged to 21 days when it is feeding on Bt cotton. When feeding on non-Bt cotton, it is about15 days. 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 in India has probably been exposed to Bt toxin from the field trials that have been conducted these past years and from the use of Bt pesticide sprays.

Table 3: Yield comparison of Bt. and non-Bt. Cotton in quintal/acre

Field Type	Non-Bt. Cotton	Bt. Cotton
Low Yielding	3.25 (2.5 - 4.0)	2.75 (2 - 3.5)
Stem borer	5.50 (5 - 6)	4.75 (4 - 5.5)
Medium Yielding	9.00 (7 - 11)	7.50 (6 - 9)

Agricultural landholdings where both Bt. and non-Bt. cotton, were cultivated have been divided into low yielding, medium yielding and high yielding based on the type and quality of soil, topography, availability of water for irrigation and resource capacity of farmers.

As seen in Table 3, average yield per acre in low yielding field type is 3.25 quintals and 2.75 quintals in the case of non-Bt. and Bt. cotton respectively. In the case of medium yielding field type, the yields are 5.50 quintals per acre and 4.75 quintals per acre for non-Bt. and Bt. cotton respectively. Similarly, in high yielding field type, the yield per acre is 9.0 quintals and 7.5 quintals for non-Bt. and Bt. cotton respectively. Thus, in all categories of landholdings, Bt cotton has performed worse than its non-Bt counterpart.

Cotton traders confirmed that demand for Bt cotton was low and prices ranged from Rs. 2000 to 2100/qt. Whereas non Bt cotton was selling at Rs. 2200 to2350/qt.

Economics of Bt cotton cultivation

The economics of cultivating Bt cotton is clearly not in favour of farmers. The seed is about four times more expensive than the good local hybrids. The difference in the price of seed is 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.

As Table 4 shows, the investment per acre is much higher for Bt cotton than for non-Bt cotton varieties. The Bt cotton farmer had to invest on average, Rs. 983 more per acre than his non-Bt counterpart.

Table 4: Comparative Investment in Bt. and non-Bt. cotton in Rs./acre

Input	Non-Bt. Cotton	Bt. Cotton
Seed	400	1,600
Fertiliser	2,800 (1500 - 4000)	2,800 (1500 - 4000)
Pesticide	1,533 (600 - 2500)	1,316 (500 - 2200)
Total	4,733	5,716

Yield /acre of Bt cotton was lower than non-Bt cotton and the cotton was of poorer quality thus fetching a lower price per quintal. Added to this was the higher investment in Bt cotton fields. The net result was significantly poor results from Bt cotton which are reflected in the data on comparative incomes, in Table 5.

Table 5: Comparative income from Bt. and non-Bt. Cotton

Farm Type	Non-Bt. Cotton			Bt. Cotton		
	Farmers (%)	Income/acre (Rs.)	Net Profit /acre (Rs.)	Farmers (%)	Income/acre (Rs.)	Net Profit /acre (Rs.)
Low Yielding	35	7394	**2661**	60	5637	**-79***
Medium Yielding	58	12512	**7779**	35	9737	**4021**
High Yielding	7	20475	**15742**	5	15375	**9659**

Net profit from Bt cotton was lower per acre compared to non-Bt cotton in all types of fields (low to high yielding). In fact, 60 % of the farmers cultivating Bt cotton were not even able to recover their investment and incurred losses averaging Rs. 79 per acre. The performance of Bt cotton in the areas studied in Maharshtra and Andhra Pradesh, has been decidedly poor and the farmers have had to suffer losses. Not surprisingly, an overwhelming majority of the farming families surveyed (98%) said they were not interested in growing Bt cotton again.

No Training for Farmers

The study examined if any pre cultivation training was given to the farmers by any of the government agencies or Mahyco-Monsanto. It was found that neither state nor central government agencies had provided any training. The seed company had made available pamphlets showing that spraying had to be done on Bt cotton if number of pests exceeded a certain level. The major efforts of the company were directed towards broadcasting taped messages extolling the virtues of Bt cotton rather than any tips on cultivation.

No technical assistance was provided to the farmers during cultivation either by any governmental agency or by Mahyco-Monsanto. In the absence of any extension help, farmers had no one to assist them when they faced problems during the cultivation and pest attacks.

No Regulatory Structures set up

One of the most shocking revelations of this investigation was the fact that neither State Level nor District Level Committees had been set up in either Maharashtra or Andhra Pradesh where Bt cotton was being commercially grown. This is a breach of law and a direct violation of the prescribed rules for the manufacture, use, import, export and storage of hazardous micro-organisms and genetically engineered organisms and cells, under the Environment Protection Act, 1989.

Enquiries made during the survey also revealed that no one had come to that area to collect field data for monitoring the insect attacks and crop performance so at least in this area, no baseline data are being collected to evaluate the impact of Bt cotton on the environment, on beneficial insects , on other cotton crops and on the ecosystem. This amounts to gross negligence.

Why the Mahyco-Monsanto cotton failed

A number of factors have probably contributed to the failure of Mahyco-Monsanto's Bt cotton. The first is the poor quality of the variety itself. It is well known that Mahyco-Monsanto's cotton varieties, MECH 162 and MECH 184, which were transformed to Bt 162 and Bt 184, are poor to modest performers, giving modest yields. A better performing cotton would give a better Bt cotton so the GEAC must answer why it approved this Bt cotton when better quality Bt cotton hybrids belonging to Indian companies are in the pipeline.

With the substantially higher cost of seeds, the economics of the Bt crop is not favourable for the farmer. In addition to the high cost of the seed is the modest saving in pesticide, which does not make up for the large expense incurred on seed. 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.

A further problem appears to be the vulnerability of Bt cotton to pink bollworm, which is a significant cotton pest in India. If this is indeed the case as the study demonstrates, then the Bt strategy for cotton is likely to fail because if the Bt endotoxin protects only against the green bollworm and not against the pink bollworm, then farmers will have to continue pesticide sprays. Another factor, which needs to be investigated with some rigor, is the period of gene _expression of the Bt gene in each of the varieties in which it is being incorporated. If the period of endotoxin _expression does not coincide with the period of pest attack, then no protection will be available against the bollworm.

The GEAC has to be held accountable for the failure of Bt cotton as much as the company providing the seed. Why did it keep the field trial data of Bt cotton secret when there were so many demands to examine this data ? We need to know from the GEAC how approval for commercial cultivation in Andhra Pradesh and Maharashtra was granted when no State and District level committee was set up. The GEAC must also fix responsibility for the failed cotton crop and make Mahyco-Monsanto compensate those farmers who have suffered losses. This is required under the Indian law, the Protection of Plant Variety and Farmers Rights Act 2001. Section 39.2, of the law states clearly that:

'Where any propagating material of a variety registered under this Act has been sold to a farmer or a group of farmers or any organization of farmers, the breeder of such variety shall disclose to the farmer or the group of farmers or the organization of farmers, as the case may be, the expected performance under given conditions, and if such propagating material fails to provide such performance under such given conditions, the farmer or the group of farmers or the organization of farmers, as the case may be, may claim compensation…"

References:

Morin, Shai et al. 2003, Three cadherin alleles associated with resistance to Bacillus thurengensis in pink bollworm, PNAS, 100 : 5004-5009.

Liu, Yong-Biao, Bruce E. Tabashnik, Timothy J.Dennehy, Amanda L. Patin, and Alan C. Bartlett, 1999, Development time and resistance to Bt crops, Nature, 400: 519.