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BT Technology: Allegations Imposed Vs scientific Facts

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Abstract

Introduction of Bt technology in India proved game changer as productivity from 302 kg/ha elevated to 568 kg/ha while insecticide consumption 4470 metric ton reduced to 222 metric ton. It controlled all three types of bollworms. Bacterium "Bacillus thuringenesis" produces insoluble crystal bodies in cytoplasm, which have unique feature to target lepidopteron pests.

Bt gene producing endotoxin incorporated in cotton plant by Agro bacterium Mediated Gene Transfer method (Cry 1Ac) and "Particle Bombardment method" (Cry 2Ab) in cocker 312 and subsequently in elite lines by routine back cross method. Incorporated gene, in cotton plants expressed in all plant bodies (Leaves, squares, ovules, anthers, boll rind and seeds). Produced proteins by introgressed gene(s) in plant bodies are harmless to all higher animals including human beings because of their acidic nature. It ia also harmless to all sucking pests because of same cause and hence demand insecticidal spray.

From the inception of Bt technology several allegations were imposed. All allegations were based on perception only. Scientific study proved that Bt gene does not have any impact on other economical traits of cotton. It indicates that Bt gene is effective in controlling bollworm only.

Cotton is one of the major fibre crops of global significance. In India, cotton is being cultivated on 12.8 million ha and stands first in acreage at global level.

In the year 2002-03, area under cotton was 7.7 m ha with productivity of 302 kg/ha while the year 2016-17 witnessed quantum jump in area 12.8 m ha as well as productivity touched to 568 kg/ha. Another thing interestingly, total insecticide used to control bollworm sharply declined from 4470 metric ton (2002-03) to 222 metric ton in the year 2016-17 (Anonymous 2016 AICCIP Report. ICAR, New Delhi) . Million dollar question is that which component made drastic change for increased productivity from 302 kg/ha to 568 kg/ha and reduced use of pesticide consumption for bollworm control from 4470 metric ton to 222 metric ton?

Introduction of Bt technology in the year 2002-03 in India proved game changer in cotton cultivation in India. There are many reasons of low productivity of cotton in India before 2002-03. Besides, dependency of 70% cotton area on vagaries of mansoon, diverse ecological and soil conditions, constant threat from pests particularly bollworms.

The major cotton bollworms in India are *Helicoverpa armigera* (American or green bollworm), *Pectinophora gossypiella* (Pink bollworm), *Earias vittella* (Spotted bollworm) and *Spodoptera litura* (Tobacco caterpillar). All four bollworms are lepidopteron insects which have chewing mouth system. Among all bollworms, American or green bollworm is most dominant and destructive. It causes as much as 80% losses in cotton productivity. It is highly polyphagous (more than 180 host plants). With the advent and wide spread adoption of Bt cotton since 2002-03 (in 2016-17, out of 12.8 m ha cotton grown, almost more than 95% i.e. 11.3 m ha area is under Bt cotton cultivation).Bollworms are controlled

effectively with reduction of pesticidal sprays from average 21 to 3-4 during crop season, due to Bt technique, which was a big relif to cotton growers in India. Transgenic Bt cotton, which evokes in-built resistance in the host is gaining wider adaptability as means of avoidance of losses due to bollworm because technology operates at seed level dissemination and find quick favour among the end users.

From the inception of the Bt technology several allegations were imposed on Bt technology by NGO's and certain individuals. They do not seem to respect the fact that Bt cotton has remarkable progress consistently since its introduction without experiencing any adverse effect. Most of the allegations are/ were based on perceptions without rational. There allegations seems to suggest that Bt cotton kills almost everything except bollworms for which the technology was specifically developed!! No amount of scientific data seems to satisfy them leading to unending debate.

- **It is alleged that Bt cotton contains the controversial "Terminator Technology.....**

A farmers' organization in Karnataka, Karnataka Rajya Raitha Sangha (KRRS), uprooted and burnt a few approved experimental crops in 1998 and 1999, wrongly accusing that Bt cotton contained the so-called "Terminator Technology" and the gene would escape and cause "Gene pollution" and sterility in other plants. They also alleged that Bt protein is harmful to humans, farm animals, other beneficial organisms and soil. They threatened farmers with serious consequences if they planted Bt cotton. They also held repeated public demonstrations against this technology. The crop-burning was repeated in 2002 following the official release of GM seeds. This protest had a similar outcome; some farmers received compensation from the KRRS and others sought police protection (Scoones, 2008). Apart from this media drama, the KRRS also demanded a 5-years ban on GM cotton seeds (Scoones, 2005).

Fact----The colloquial name "Terminator Technology" was coined by Rural Advancement Foundation International (RAFI), an NGO headquarter in Canada. The special feature of Terminator Technology is that the seeds derived from the parent plants will germinate in soil only if it is pre-treated with a special chemical prior to sowing. Following the allegation by the NGOs and as per the direction of the regulatory authority, the Department of Genetics, University of Delhi, carried out molecular detection tests on Bt cotton hybrids to ascertain the presence or absence of Terminator Gene.PCR results revealed that these lines were positive only for Cry 1Ac gene and did not contain Cre-recombinant gene which is an integral part component of Transgenic Technology.(T. M. Manjunath, 2011)

Another Common sense test was carried out by a progressive farmer in Haveri district and also by University of Agricultural Sciences, Dharwad, Karnataka. They sowed the Bt cotton seeds of F_2 generation and demonstrated that these germinated like normal seeds. The seeds would not have germinated if they contained terminator gene. (T. M. Manjunath, 2011)

- Mortality in sheep flocks after grazing on Bt cotton fields at Warangal in Andhra Pradesh....

There were reports in the print media that sheep died in *Telangana* region of Andhra Pradesh after grazing on leaves and pods of harvested Bt cotton plant residue in fields. (News paper reports: Deccan Herald, February 7, 2007; The Hindu, March 2, 2007; GM Watch, March 4, 2007; Hindustan Times, June 17, 2007; GM Watch, June 18, 2007; Hindustan Times, June 18, 2007.)

Fact---Anil kumar, B. *et al*. studied "Sero-Biochemical Studies in Sheep Fed with Bt Cotton Plants." the results enunciated that feeding of genetically modified (Bt) cotton plants to sheep was without detrimental effects in the biological system of sheep.

Ramdas, S. R.(2010)presented a paper entitled **"**Bt cotton and Livestock: Health Impacts, Bio-safety concerns and the Legitimacy of Public Scientific Research Institutions". In his paper he mentioned that, The Department of Veterinary Pharmacology and Toxicology, carried out a study on 32 sheep from August 2007 for a period of 8 months and was titled "Studies on the toxicity of Bt cotton plants incorporated in the feed of small ruminants". In October 2008, the department submitted their results to the university where they concluded that in the present study the feeding of transgenic cotton plants did not exert any fatalities and there was no adverse toxicity in the biological system of sheep.

The allegation is malicious without any concrete proof. After reviewing the case and available data (chemical analysis of stubble and pathological analysis of dead sheep), it was the opinion of GEAC that the report was highly exaggerated and was based more on hearsay than on scientific facts. They asserted that prior to approval for commercial cultivation, has undergone animal feeding studied and no toxic effect was found in any of the test animals even when they were fed with high doses of Bt protein through Bt cotton seed meal. Moreover, Bt proteins produced in Bt cotton are insecticidal specific to lepidopteron insects like bollworms. This protein required alkaline gut with pH 9.5 and above for their activation and specific receptors in the mid gut for protein binding to cause mortality. But the gut of sheep or other higher animals including humans is acidic and possesses proteolytic enzyme pepsin (and not Trypsin) which completely degrades Bt protein. So the sheep mortality must have been due to factors other than Bt. (T. M. Manjunath, 2011).

- Bt cotton is responsible for lower yield and there by farmers suicides in India...

The charge that "Bt cotton has failed" originates from a loose coalition of non-governmental organisations. Their narrative explicitly claims that Bttechnology lowers rather than raises on-farm yields and Bt adoption drives farmers in to debt because of high seed prices and agronomic failure, often resulting in catastrophe: sale of body parts and suicide (Herring 2006; Shiva 2006)

The studies conducted by NGO's (Gene Campaign, Deccan Development Society) supported the Bt failure narrative: lower yield, higher debt and sometimes serious externalities (Sahai (2003), Sahai and Rahman (2003); Shiva and Jafri (2004) and Qayum and Sakkhari (2005).

FACT---Studies about the agronomic and economic impacts of Bt cotton cultivation demonstrated that the adopting farmers benefit from income increase through reduced pest control costs and higher effective yields (Morse *et al*., (2004); Qaim and Zilberman 2003, Qaim and Traxler, 2005).

Naik, G. (2001) compared the performance of Bt cotton and non Bt cotton. The result of his study showed that due to use of Bt cotton, yield of cotton increased by 38%, number of spray reduced from 4 to 1. Profit increased by 77% and average increase in profit per hectare increased from Rs. 3240 to Rs. 10620.

Chavan and Wadikar (2017) attempted to know the impact of transgenic gene (Cry 1Ac and Cry 1Ac + Cry 2Ab) on the economic traits of seed cotton yield and average boll weight. Results revealed that, out of 15 hybrids, 13 hybrids of BG-I and BG-II showed same trend of heterosis as observed in NBt for seed cotton yield and Ave. Boll wt.

Scientific study: --An attempt was made by Chavan and Wadikar (2019) to put the facts about Bt on scientific basis, using various statistical modules and genetical parameters. We took the care to have hybrids of BG-I, BG-II and NBt from the parents which are isogenic but differ for only one and two genes. Trait performance of BG-I and BG-II compared with values obtained from NBt set. The differences in three sets are only of one and two genes (BG-I and BG-II) while absence of transgenic gene in NBt. We consider that if the trend in expression of trait in BG-I and BG-II is quite reverse to NBt, safely, it could be attributed to impact of inserted genes and if no significant deviation/ alteration noticed, it gives answers to NGO's that inserted transgenic gene does not influence/ relate directly to genes governing other traits like productivity potential, boll wt, maturity period, fibre length, strength and fineness etc. In present investigation, more weightage has been given to statistical parameters rather than describing trait or hybrid performance since lot of literature on such aspects like heterosis, combining ability and genetics are available.

In summarizing results, it could be concluded that, pooled analysis (Table-I) strongly supported that genes of bollworm control never influence genes governing other traits. This totally reject hypothesis of NGO who are claiming for influence of inserted genes on genes of other traits (Table-I), as well as rejects earlier established hypothesis that bollworm resistance make genotype vulnerable to jassids and vice versa.

Table-I: ANOVA Statement indicating mean sum of squares due to treatments and Sets for traits under study

Source	DF	M S S											
		Seed cotton yield	Lint Yield	Boll wt	Boll number	Ginning out turn	Seed Index	Lint index	2.5 % Span length	Bundle strength	Micronaire	Jassid grade at 75 DAS	% shoot infestation
Treatment	20	64.12	89377	0.80	72.77	10.33	1.3	0.79	3.17	6.7	0.21	-19.00	7.1
Sets	2	29.35	41228	0.05	30.68	2.30	3.8	0.64	0.94	4.5	1.50	0.01	2870.2
Error	40	0.67	1098	0.10	1.79	1.48	1.2	0.40	0.61	3.4	1.08	9.66	12.6
Set Differences		Sig	Sig	N. S.	Sig	N. S.	N. S.	N. S.	N. S.	N.S.	N. S.	N. S.	Sig

Results clearly enlightened that transgenic genes of Cry 1Ac and Cry 1Ac + Cry 2Ab, both are independent to each other and both do not influence the genes of other traits. It also gives faith to farmer's community for its safeness and utility in improving productivity and Cost: Benefit ratio, certainly not at the cost of other traits. Results of preset investigation urge to Govt. for all round promotion of transgenic cotton, not only of BG-I and BG-II but also for its further improved versions in future to overcome the problem like pink bollworm and others if occurred in future.

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