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Impact of Transgenic Cotton on Pink Bollworm in India

Madhu, T. N[1,2] and V. Chinnababu Naik[1,3]

[1]ICAR – Central Institute for Cotton Research, Nagpur, Maharashtra 440010

[2]ICAR – Central Plantation Crops Research Institute, Regional Station, Vittal, Karnataka 574243

[3]ICAR – Indian Institute of Rice research, Hyderabad 500030.

*Corresponding Author: madhuentomology@gmail.com

Genetically modified (GM) crops produce specific toxins by the insertion of one or more genes from the bacteria, *Bacillus thuringenesis* (Bt). These genes encoded for the production of insecticidal proteins and transformed to produce toxins as they grow. Presently, most of the cotton grown area in India uses Bt technology. Cotton researchers opined that, this technology has reduced chemical usage by 37% and increased crop yield and profit by 22 and 68% respectively. Induction of GM technology in commercial crops like cotton is a novel approach to counter the incidence of key pests such as Pink bollworm, *Pectinophora gossypiella* (Saunders), and American bollworm, *Helicoverpa armigera*. Among bollworm complex, *P. gossypiella* is considered as the most destructive pest of cotton worldwide and it was first reported in Indian subcontinent during 1842 by Saunders. *Pectionophora gossypiella* has restricted its host range and primarily adapted to feed on the genus *Gossypium* spp. The larvae cause extensive damage by feeding internally on cotton squares and bolls. However, it feeds and oviposit occasionally on other species of malvaceae crops.

In India, cotton is cultivated in an area of 13.4 million hectares in three distinct agro-climatic zones (North, Central and South zones). Approximately 38 per cent of the world's cotton area is present in India and contributes around 26 percent to the global cotton. In India, transgenic cotton producing *Cry1Ac* gene (Bollgard®) was introduced during 2002 after its success in the USA and Australia in 1996. It was primarily introduced to counter the infestation of cotton bollworms such as *Helicoverpa armigera*, *Earias insulana*, *E. vittella* and *P. gossypiella*. However, the *Bt* toxin impact was very much evident on bollworm complex resulting increase in the area (7.67 to 12.1 million hectares) and production (191 kh/ha to 520 kg/ha) of lint cotton across the country. More importantly, currently more than 90% of cotton grown are Bt cotton in India, mostly Bollgard II hybrids. However, the introduction of transgenic *Bt* cotton expressing two genes *viz.*, *Cry1Ac* and *Cry2Ab* (Bollgard II) was commercialized in 2006 specifically for *P. gossypiella*. As a result, the level of pink bollworm infestation prevailed low till 2008. Thereafter, an unusual survival of pink bollworm on transgenic crops expressing Cry1Ac was detected for the first time in the field collected populations from Amreli district of Gujarat state.

Fig.1. Pink bollworm damage on flowers and bolls

In 2017-18, widespread reports of outbreak of pink bollworm on transgenic *Bt* cotton (Bollgard II) in many cotton growing areas especially from Maharashtra and some parts of Southern states, it is possibly due to the development of resistance against cry toxins. However, in 2021-22 again a pink bollworm outbreak was reported from Punjab and Haryana and presently the resistant population of pink bollworm to Bt cotton were established in northern region of India. Despite of having narrow host range, the PBW has been frequently noticed from the middle of the crop season. Within hours after emergence, the PBW larvae enter the fruiting bodies and the pin holes of entry close down by excreta of larvae. Therefore, it is difficult to exercise any target specific control measure against the pest.

However, the survival of pink bollworm on Bt cotton is attributed to many factors including limited or non-compilation of refuge strategy with Bt cotton, cultivation of Bt cotton year after year in the same area, non-judicial application of insecticides resulting in the

biochemical and molecular changes in the pink bollworm. Hence, it could survive and breed on transgenic cotton effectively. In the present context, there are some feasible approaches are available to counter pink bollworm menace which includes cultivation of varieties – researchers opined that, growing resistant varieties can hinder the pink bollworm survival, Use of pheromones - for mass collection and mating disruption, Use of biocontrol agents such as *Trichogramma bactrae* and *Bracon sp* which parasitize the egg and larvae of pink bollworm and application of recommended insecticides at appropriate time.

Various institutes/organisations including government departments, universities, Krishi Vigyan Kendras, agribusiness companies and others have come forward to spread awareness and to train farmers in the adoption of various insect resistant management (IRM) practices in cotton. However, the standard IRM practices include:

- Crop rotation with non-host crops to break the pink bollworm cycle.
- Use branded or certified seeds (preferably verities).
- Selection of varieties with early maturity (120-130 days' duration).
- Cultivation of at least 5% non-Bt refuge crop.
- Need based application of insecticides based on ETL.
- Use of Pheromone traps for mass trapping and mating disruption (25/acre).
- Harvested along with other cotton farmers in the village (synchronized harvest).
- Destruction of green bolls at the end of the cropping season.
- Destruction of cotton stubbles to avoid carryover effect.
- Deep Summer ploughing.
- Keeping the field weed-free during off-season.

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