The ICAC Recorder

India Must Return to IPM and Explore New *Bt* Genes

Interview with Prof. Bruce Tabashnik

Prof. Tabashnik is one of the most influential scientists of our times in entomology and biological sciences. He has led the Department of Entomology at University of Arizona for 24 years. His research team studies the evolution and management of insect resistance to insecticides and transgenic plants. Current work focuses on evolution of resistance to insecticidal proteins from the bacterium *Bacillus thuringiensis* (Bt). Tabashnik is Fellow of the Royal Society of Entomology, UK. He is the recipient of several awards which include the Nan-Yao Su Award for Innovation and Creativity in Entomology, Entomological Society of America; Koffler Prize in Research, Scholarship and Creative Activity, University of Arizona. He recently won the Plant-Insect Ecosystems Lifetime Achievement Award in Entomology from the Entomological Society of America

What in your opinion are the factors that could have been responsible for the delay of PBW resistance to *Bt*-cotton in China and the USA?

I think refuges of non-*Bt* cotton delayed PBW resistance to *Bt* cotton in China and the USA. *Bt* cotton planted in China produces one *Bt* toxin, Cry1Ac. In the Yangtze River Valley of China, when the percentage of all cotton hectares planted with non-*Bt* cotton dropped to 12% in 2008 and 2009, the proportion of pink bollworm larvae resistant to Cry1Ac increased significantly from 0% in 2007 to 2.6% in 2009. However, when the percentage of cotton planted with non-*Bt* cotton increased to 25% to 27% in 2011 to 2015, the proportion of resistant pink bollworm dropped back to 0%.

In the US state of Arizona, growers planted non-*Bt* cotton on at least 26% of their cotton hectares from 1997 to 2005 (mean = 38%). During that period, PBW remained susceptible to Cry1Ac.

What could have been the main reasons for the rapid development of PBW resistance to *Bt* cotton in India?

The scarcity of refuges of non-*Bt* cotton probably contributed to the rapid evolution of PBW resistance to *Bt* cotton in India.

PBW has become a serious menace in India in recent years on *Bt*-cotton. What could have been the reasons for resurgence in pestilence?

One of the main reasons for the resurgence of PBW in India is the pest's resistance to Cry1Ac, which is produced by the first type of *Bt* cotton, and to Cry2Ab, produced in the second type of *Bt* cotton in combination with Cry1Ac.

Which technologies held the key for PBW eradication in USA?

Bt cotton and releases of billions of sterile PBW moths by airplane over cotton fields were key for PBW eradication in the USA. Other tactics included application of PBW female sex pheromones and cultural controls such as restricting the growth period for cotton and destroying crop residues after harvest.

In your opinion, will implementation of strategies such as 1. 'refuge in bag', 2. 'sterile moth release' and 3. 'pheromone mating confusion' work for resistance management or pest management in India?

Because PBW resistance to Cry1Ac and Cry2Ab produced by *Bt* cotton is common and widespread in India, refuges of non-*Bt*

cotton and other tactics are not likely to restore susceptibility to these toxins. Sterile moth releases and treatments with insecticides could be useful to reduce PBW populations.

Which strategies would you recommend for India for sustainable management or eradication of PBW?

For now, the widespread loss of the efficacy of *Bt* cotton against PBW in India means that a return to IPM emphasising other control tactics is essential. Recommended tactics for pink bollworm in India include planting of early to medium maturing cotton hybrids, termination of the crop by December, strict avoidance of ratoon cotton after harvest, removal or destruction of crop residues after harvest, deep summer ploughings, judicious use of insecticides based on scouting and thresholds, crop rotation, biological control with natural enemies, and pheromones for mass trapping and mating disruption.

I think eradication of PBW is not feasible without highly effective *Bt* cotton or another highly effective control that could be used in combination with the tactics listed above. It would be valuable to develop new *Bt* cotton that produces two or more toxins effective against PBW that are resistant to Cry1Ac and Cry2Ab. Candidates include Cry1B, Cry1C, and genetically modified Cry1A toxins.

References

Tabashnik, B. E., L. R. Liesner, P. C. Ellsworth, G. C. Unnithan, J. A. Fabrick, S. E. Naranjo, X. Li, T. J. Dennehy, L. Antilla, R. T. Staten and Y. Carrière. Transgenic cotton and sterile insect releases synergize eradication of pink bollworm a century after it invaded the United States. Proc. Nat'l. Acad. Sci. USA 118: e2019115118.

Tabashnik, B. E. and Y. Carrière. 2019. Global patterns of resistance to *Bt* crops highlighting pink bollworm in the United States, China and India. J. Econ. Entomol. 112: 2513-2523.

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