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Introduction

This issue of *THE ICAC RECORDER* has a technical article, authored by Keshav R. Kranthi. It deals with immediate and impending threats of boll weevil, bollworms, whitefly and leaf curl virus to cotton production systems in major cotton growing countries. In addition to the technical article, a brief note from Dr Michel Fok, Chair of the International Cotton Researchers Association (ICRA) provides an update on recent ICRA happenings. *THE ICAC RECORDER* is pleased to present a brief biographical sketch of Dr David Stelly, ICAC Researcher of the Year 2017.

Recent research publications indicate that there are at least five biotic-threats in the five major cotton growing countries, India, China, USA, Pakistan and Brazil which need to be taken seriously to prevent yield losses and to arrest a possible decline in global cotton production. The five major problems are represented in the newly discovered cotton bollworm *Helicoverpa armigera* (Hübner) species in South America; the pervasive presence of the notorious boll weevil in Brazil; the *Bt*-resistant pink bollworm, the highly invasive insecticide-resistant whiteflies and the intractable cotton leaf curl virus disease (CLCuD) in India and Pakistan; and the impending problem of *Bt*-resistant *Helicoverpa* species in USA, China, India and Pakistan. The increasing level of pesticide usage in these countries over the recent past is a pointer towards the rising levels of pest infestation. These pests pose serious threats to cotton production and cannot be ignored. Except the newly found *H. armigera* in Brazil, the other insect pest and disease problems are not new to these countries. All five problems are recalcitrant and the countries are aware of this.

Until about a few years ago, whiteflies and CLCuD were kept under control in India and Pakistan, with a combination of new insecticides and tolerant cultivars developed by public sector institutions, whereas bollworms were effectively controlled by biotech *Bt*-cotton. But the overconfidence of rapid deployment of biotech cotton in a multitude of new cultivars, while ignoring the basic tenets of integrated pest management (IPM), allowed the worms to return with vengeance. Mostly

in India and partly in Pakistan, whiteflies and leaf curl virus proliferated in ecosystems saturated with the newly approved susceptible *Bt*-cotton hybrids/varieties. Whiteflies developed resistance to almost all recommended insecticides due to repeated and indiscriminate use. Outbreaks followed soon. Recently, pink bollworm infestations have been causing serious economic losses because of resistance to *Bt*-cotton in India and Pakistan. Reports of *Bt*-resistant-*Helicoverpa* spp., in USA, China, India and Pakistan are also causing concerns.

Thankfully, there are some remedies and solutions reported in scientific literature. However, many of these are not immediately around the corner. Biotech *Bt*-cotton expressing VIP3A is a possible next-gen remedy that is now available for use, but how long and how effectively it would keep *Helicoverpa* spp., at bay remains to be seen, especially in light of bollworm resistance to the Cry1 and Cry2 proteins. Recent scientific publications report a few other novel biotech cotton technologies for the control of boll weevils, whiteflies, CLCuD and bollworms. Unfortunately, these new biotech products may take a few more years to complete biosafety assessment and field evaluation before they are approved for commercial cultivation.

Pest management becomes fragile and more challenging when worms become resistant to *Bt*-proteins and insecticides. In the absence of a robust arsenal of scientifically developed tools, these pests can potentially recreate the nightmarish situation of the yester years. New insecticides are available, but the worms have a history of winning the battle hands down when confronted with chemicals. The current desperate predicament of having to deal with the monstrous boll weevils, the insecticide resistant whiteflies, the incurable leaf curl virus and the *Bt*-resistant bollworms, steers the roadmap back again towards IPM. Why IPM? Will IPM deliver now when it was considered to be unsuccessful in yester years by several researchers? The fact is that there is no alternative as of now except to look at holistic options that can lend long term sustainability to pest management. All such roads lead

to IPM. However, IPM can be a practical option only if taken seriously. There is a need now to scientifically reflect on the past performance of cotton IPM so that lessons can be learnt to reinvent and reconsolidate it with the help of new scientific findings. For sure, the worms would not have gained an upper hand, if IPM strategies were implemented right from the inception, incorporating *Bt*-cotton as one of the IPM tools. Unfortunately, *Bt*-cotton in many countries was seen as ‘the silver-bullet-panacea’ to the bollworm problem, consequently

IPM was ignored almost completely. It is never too late to wake up. Amalgamation of all available pest management strategies that work in consonance with ecosystem engineering could provide a robust roadmap towards sustainability. The article ‘Beware of the boll weevil, bollworms, whitefly and leaf curl virus’ attempts to throw some insights on potential remedies that are available in scientific literature, and a few that could be available in the future.

Beware of the Boll Weevil, Bollworms, Whitefly and Leaf Curl Virus

Keshav R. Kranthi, ICAC

In the last ten years, five countries, India, China, USA, Pakistan and Brazil together constituted 72 to 76% of the global cotton area annually and contributed to more than 75% of the global cotton production each year. In the recent past, there have been clear signals from research publications that pest problems are brewing up in these top five cotton producing countries. These insect pests are notorious. Concerted efforts are required to address the problems at the earliest before they become more serious. The boll weevil, cotton bollworm, pink bollworm, whitefly and leaf curl virus are known to cause heavy economic crop losses and are difficult to manage. Needless to state, changes in production of the five countries will impact global production proportionately.

The past ten years were characterized by global yield stagnation and trends towards increasing chemical usage. Increase in pesticide use during this period indicates the increased levels of attention drawn by insect pests and an insect-vector transmitted disease. Yields reached a plateau in India, USA, Pakistan and Brazil over the past 10-12 years, but, have been on the ascent consistently during the past several years in China. Though, everything looks deceptively normal as of now, the different undercurrents of biotic threats in the five major countries can potentially destabilize cotton yields in the near future, if unattended to. One of the major concerns is that, while insect pest infestation levels in major cotton growing countries continue to increase, new technologies to control them do not seem to be in place. This is reflected in the data of yield stagnation and increases in pesticide use that happened despite the introduction of new technologies such as improved varieties, new biotech products and new potent pesticides during the past ten years. Will the major countries be able to effectively combat the imminent biotic threats? Can the yields increase hereafter as we move towards 2020? Are there technologies at hand now, or short-listed for the near future to prevent decline in yields or to enhance yields, reduce chemical usage and bring down the cost of production? The answers to these questions will largely depend on the technological changes related to pest management and yield

enhancement that may take place, especially in the five major cotton producing countries.

The Five Major ‘Biotic-Stress’ Challenges

The five major cotton growing countries are now plagued with either new insect pests or with *Bt*-resistant bollworms or herbicide resistant weeds and increasing pesticide usage. Incidentally, in all the five countries, the major yield-limiting factors are biotic threats. These relate to insects and an insect transmitted disease.

The most serious threats are:

- The boll weevil, *Anthonomus grandis* (Boheman) and the cotton bollworm, *Helicoverpa armigera* (Hübner) in Brazil;
- The whitefly, *Bemisia tabaci* (Gennadius), the leaf curl virus and the *Bt*-resistant pink bollworm, *Pectinophora gossypiella* (Saunders) in India and Pakistan;
- *Helicoverpa zea* (Boddie) in USA and impending threat of *Bt*-resistance in *H. armigera* in India, Pakistan and China.

The problems are very serious and so is the potential threat to cotton production systems

The threats are being addressed efficiently by some countries, while others react only when the problem gets worse. While some countries are aware of the incoming risks, others may have only perceived some initial indications of the possible implications. Outstanding research and administrative efforts in USA paved the way for successful planning and implementation of effective programs on area-wide management of whiteflies, bollworms and boll weevils. These insects would have otherwise caused heavy economic losses to cotton production in the country. The problem of boll weevil in Brazil and the impending threats of bollworms in India, Brazil, Pakistan, USA and China deserve more attention in these countries. Incidentally, India, China, USA, Brazil and