The ICAC Recorder

Pakistan is Exploring Triple Gene Transgenic Cotton, Destruction of Residual Bolls and Mill Waste and Mating Confusion Technologies

Interview with Dr Khalid Abdullah

Dr Khalid Abdullah is the Cotton Commissioner at the Ministry of National Food Security and Research, Government of Pakistan. Dr Abdullah is an eminent cotton scientist of international repute. Dr Abdullah spent 20 years of his career as active researcher, administrative and policy formulator. He authored a book, book chapter and wrote over 40 scientific papers, supervised 25 Doctoral and Post Graduate students in Entomology and Plant Protection. Dr Abdullah joined the Ministry in 2010. As Cotton Commissioner, he recommends policy guidelines and future strategies on cotton to the government. Dr. Abdullah has been actively involved in Technical Assistance Program for C-4 countries with Ministry of Commerce and Ministry of Textile Industry.

How serious is the problem of pink bollworm in Pakistan?

The pink bollworm (PBW) has been a serious pest since 2015 in Pakistan. It has been causing annual losses of 2-3 million bales in cotton production, either directly or indirectly. The graph above shows a small surge in population build-up in May-June, which is followed by a big peak of infestation and population build-up in August and September, that severely damages cotton crop. These two peaks have a different level of influence depending on the time of sowing. The recommended time of sowing in Pakistan is April May. Late sown cotton when planted in May-June becomes very vulnerable to the cotton leaf curl virus (CLCuV) leading to the crop being stunted in its early growth stages and bearing very few flowers thus resulting in poor yields. Therefore, wherever it is possible to advance sowing, especially in the absence of cotton-wheat rotation, farmers prefer early sowing or timely sowing of cotton crop to escape CLCuV. However, crops sown in March start flowering in May-June and support the first generation PBW larvae. The proportion of early sown crop is actually less. Usually less than 1.0% percent of the area is sown in first week of April 1-2% percent in second week of April and 2-3% percent in the 3rd week of April. Though less than 5-6% of the area is sown before mid-April, the early sown crop provides food for the early generation PBW and facilitates carryover of the pest into the later crop stages of the season. Most importantly, by the time, the timely sown cotton (after wheat) reaches flowering stage, the second-generation population of PBW would have sufficiently built up to damage early flowers and fruiting bodies. Farmers spray insecticides such as triazophos and its mixtures to control PBW because of which the problem gets worse, with whitefly resurgence as a consequence of insecticide applications. This triggers the beginning of an end, wherein cotton becomes unremunerative due to high cost of production, primarily through the additional cost of repeated insecticide applications, especially during the peak arrival stage of cotton. As the industrial procurement slows down and prices drop, farmers either abandon the crop or lose interest in investing more on crop management.

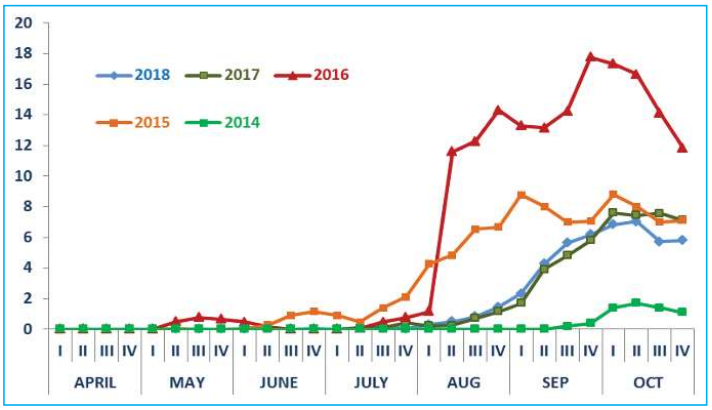

Figure 1. PBW hotspots (%) above ETL in Punjab
Source: Pest Warning and Quality Control Department, Punjab

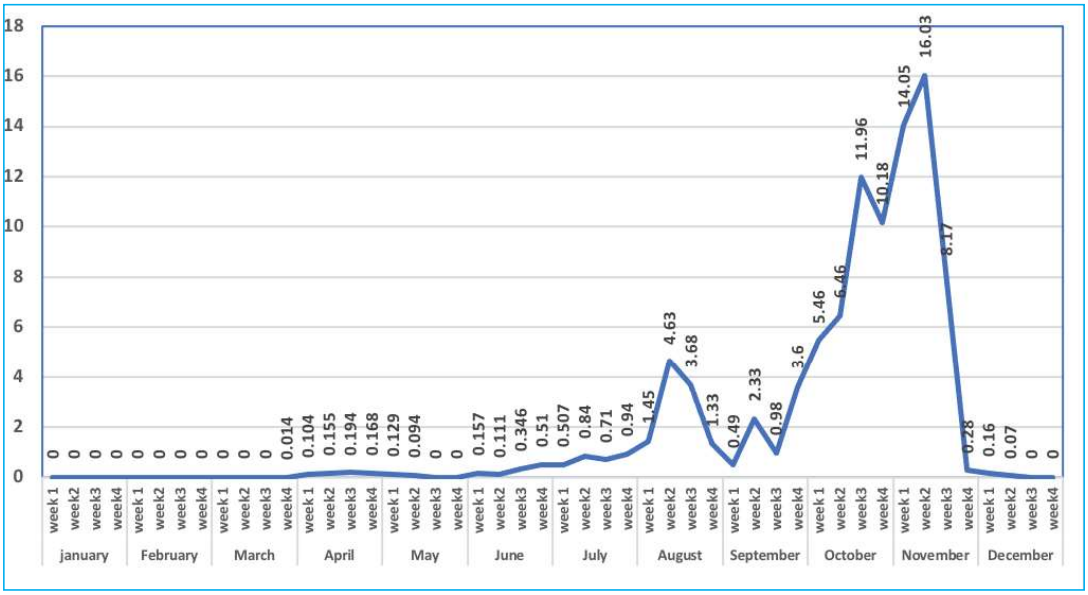

Figure 2. Month-wise PBW moth catches/trap at Multan during 2020.
Note that the trend is not very different from the previous years as shown in figure 1.

Another factor that contributes to PBW pestilence is the mill waste of ginning factories', where infested bolls are ginned and the trash along with larvae are thrown away. The mill waste becomes a strong source of infestation. Cotton stalks are usually stacked and stored near cotton fields and are commonly used as kitchen firewood in rural households. The infested immature un-picked bolls attached to cotton stalks also become a source of first-generation moths which emerge when temperatures get favourable and early sown cotton is available in fields.

What could the range of economic damage (%) be in different regions?

The direct production losses were estimated to be about 1-2 million bales in Punjab and 0.5-1 million bales in Sindh province, whereas the indirect losses could be much higher than that. Cotton production in Pakistan dropped to 9.18 million bales during 2019-20 which is expected to reduce further to less than 7.0 million bales in 2020-21. The damage due to rains is estimated be about 1.6 million in Sindh province during 2020-21. Cotton in Punjab was badly hit by PBW, whitefly and CLCV, while the crop in Sindh province suffered from a moderate PBW attack.

How serious was the pink bollworm in earlier times compared to what it is in recent years?

Pink bollworm was a serious pest in the past, during the pre-GMO period. However, the American bollworm *Helicoverpa armigera* which had developed resistance against major pesticide groups was a more serious pest than PBW. This doesn't mean that PBW was not causing damage prior to 2005. The Pakistan Central Cotton Committee (PCCC) introduced pheromone band as a male disruptive technique and found it to be very effective. PBW is no longer a serious pest in many advanced countries and hence the research backstopping has been far less than it was in yester years of the pre-GMO era.

What do you think are the factors that prompted its recent resurgence as a serious pest?

Several factors appear to have influenced PBW resurgence in Pakistan. After the patent expiry of BG-1, the local seed companies in Pakistan introduced BG-I into local varieties through 'introgression breeding'. Exotic varieties that were introduced directly were not performing well in Pakistan due to CLCV and high temperatures. The Agriculture Department was unable to effectively enforce or implement any refugeprogram or resistance management strategy. GMO technologies other than BG-1 were patented and technology providers were reluctant to come to Pakistan because the country lacked legal protection or plant breeder rights (PBR) until 2016. The multiple gene varieties developed by the local biotechnology institutes especially Centre of Excellence in Molecular Biology (CEMB) at Lahore could not be approved in Pakistan due to regulatory issues and the 18th constitutional amendment which placed agriculture in the provincial domain in 2012. These were a few of the chain events that resulted in the surge of PBW problem in Pakistan

Have there been any recent innovations for PBW management from research institutes in Pakistan?

Different groups are working on rearing PBW on an artificial diet developed by local ingredients for resistance monitoring studies. Some scientists are exploring the most effective recommendations of appropriate insecticides. Studies are underway for off season management of PBW at ginning factories and the impact of turning stored cotton-stalk stacks upside down two three time during season. Studies also showed that banning early sowing or fixing of an early crop sowing window combined with a mandatory installation of PB rope in early

sown cotton crop, were found to be very effective. But all these strategies need a commitment and effective administrative follow up and coordination with district management.

Figure 3. Ginning mill waste with PBW larvae

Is there any concerted mission programme or a campaign to control or eradicate PBW in Pakistan?

As of now there are no mission mode programmes on a very big scale, but a program to introduce PB rope for PBW management has been in place for the last three years, albeit at a very limited scale for demonstration purposes. For off season management, the district governments introduced Section 144 and mandated ginning factories to dispose of mill waste, turn cotton stalk stacks upside down at fortnightly interval and enforce a restriction on early sowing within a designated window. Recently locally developed triple gene (Cry1Ac-Cry2Ab-EPSPS) varieties, CEMB Klean, Cotton 3 and CKC-3 were approved by the Provincial Seed Council. The National Seed Council allowed a fast-track procedure to approve some more promising varieties with the new technologies developed by local institutions in public and private domain.

Figure 4. Residual boll picking machine developed by CCRI Multan

Figure 5. A field after final picking. Left: stalks with left over bolls. Right: bare stalks after picking residual bolls with the boll picking machine

The Central Cotton Research Institute has re-engineered a boll picking machine, which picks up the left-over bolls (mostly infested) when operated after final picking. It collects more than 95% of the leftover bolls in a bin. The collected bolls are spread in sunlight for opening. Pheromone traps are placed nearby to catch any emerging adults from such bolls. Un-infested bolls do open and provide about 40-60 kg lint per acre. Though the lint is of inferior quality, it gives an additional income to farmer. The cotton stalks collected from the fields subsequent to the machine-pass, can be safely stacked and stored for fuel purpose without the fear of pest carryover from residual diapausing PBW larvae. A prototype machine was tested on farmers' fields and on campus last year and proved effective. Multiple machines are being prepared through a project to be used on a rental bases in cotton growing regions.

What in your opinion are the most important management strategies?

Looking into the sustainability and economics, I feel that an integrated approach would solve the problem. Importantly, off-season management through regulatory enforcement, is imperative to halt the population build up early in the season. Effective monitoring through moth-catches in traps and boll dissection is important to arrive at reliable economic threshold levels (ETLs) so as to take pesticide application decisions. Larvae in ginning waste can be used for multiplication of natural enemies in fields using Natural Enemies Field Reservoir (NEFR) Technology, which proved its effectivness in mealy bug management as well. Seed processing technologies can also play their role in PBW management. Sole reliance on synthetic pesticides triggers multi-dimensional problems that are difficult to manage and raise the cost of production. Chemicals be used as a part of strategy but should not become the only strategy. Pest scouting must be launched as a national campaign by mobilizing support from the civil society. PBW monitoring is a technical subject and the public sector can conduct capacity building programmes and data analysis for area specific recommendations. Well-designed strategies considering local agroecological conditions and social norms would be the best strategies for PBW management.