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Cotton Gin Trash Treatment System to Destroy and Prevent Carryover of Pink Bollworm from Ginning Mills

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Introduction

Cotton is known to harbour several pests. Among them Pink bollworm (PBW) is of serious concern. The pink bollworm (*Pectinophora gossypiella*) is a dreaded pest on cotton and is distributed throughout the world's cotton-growing areas. After the introduction of *Bt*-cotton in 2002 in India, there was an excellent response as manifested by low incidence of all bollworms because the *Bt* gene provided built-in protection against them. Since 2015, frequent outbreaks of PBW have been documented in the states of Maharashtra, Andhra Pradesh, Gujrat and Telangana because of the development of resistance to PBW in *Bt*-cotton (Kranthi, 2015). The rough estimates of incidence varied from 20%-60% resulting in estimated yield losses of 10%-30% but much more in quality impairment (Mayee *et. al.* 2018). PBW adversely affects ginning percentage and spinning quality of mature bolls. Pink bollworm infestation causes significant yield losses and affects quality of cotton fibre and thus adversely affecting income of cotton farmers.

Timely termination of *Bt*-cotton crop is an important strategy to break the seasonal cycle of PBW resulting in very low carryover of PBW populations and low PBW damage in the subsequent season. Diapausing PBW larva can survive in immature unharvested cotton bolls on stalks stored by farmers (Vennila et. al. 2007). Diapausing PBW larvae survive inside cottonseeds and gin trashes stored in cotton gins. Longer the storage, higher the carryover potential. Appropriate treatment needs to be given to gin trash before its disposal to break the seasonal pest cycle.

Concern of Pink Bollworm residual infestation from Ginning Industry

Concern is raised in India that cotton ginning industries serve as sites of inoculum of PBW. In India cotton fields are small and the gins are located at considerable distances from one another, which leads to the transport of PBW over long distances. This could result in the dispersal of PBW in the neighbourhood locality where cotton is ginned. Transportation of seed cotton from infested area or the gin to the non-infested gin leads to the rapid spread of PBW. It is important to prevent the spread of PBW through ginning industry. During ginning operation there is potential for PBW to survive and pass-through pre-cleaning and ginning machinery which gets segregated into cottonseed, lint and gin trash (Hughs et. al., 1994). Ginneries are equally responsible for the spread of PBW through gin trash which has not been commonly acknowledged.

Necessity of Mechanical Treatment to Gin Trash before Disposal

Destruction of PBW larvae and pupae in gin trash and gin waste in ginning industries can effectively curb the spread of PBW from ginning mills. Unless measures are taken to control and eradicate PBW in ginning industry, its menace is likely to

continue. Mostly live PBW find its way into the gin trash from all cleaning machinery, cyclone wastes and immature and unopened bolls. Currently in ginning industry gin trash is scattered all across the industry premises, from where diapausing larvae survive and PBW moths emerge and spread to neighbouring areas causing pestilence in the subsequent seasons. Therefore, it is essential to crush all gin trash mechanically with specific devices or systems in such a way as to cause destruction of all the stages of the pest. After that has been done it is safe to dispose of the treated gin trash.

Mechanical Gin Trash Treatment System

A gin trash treatment system (Fig.1) comprising of centrifugal trash fan, cyclone and compactor was developed with a capacity of 2.5 tonnes of trash per hour with an aim to crush and treat gin trash mechanically in such a way that all PBWs are destroyed. A centrifugal trash fan was developed to treat gin trash prior to its disposal. The action of the fan kills the pink bollworms in the trash, when gin trash is passed through the impeller of a trash fan operating according to pink bollworm quarantine regulations laid down by USDA. Centrifugal trash fan was developed as per the USDA regulations for wheel diameter, inlet size, and speed of fans for treating gin trash. Cyclone (1D-3D) was developed as an air pollution abatement system on high pressure centrifugal fan discharges, to separate air and waste in cotton gins. A compactor was developed for volume reduction of gin trash after treatment. The compaction enables cost effective disposal of the treated gin trash. A gin trash treatment system has been commercialised for commercial scale production and marketing.

Figure 1: Cotton gin trash treatment system

Protocol to Destroy PBW in Gin Trash

A process protocol has been established to destroy pink bollworms from cotton gin trash by using gin trash treatment system. The trash fan wheel which crushes gin trash should have a minimum of six straight blades with minimum fan diameter of 490 mm. The trash fan should generate an air volume of 4800 m^3/h and run at a pressure of 363 mm wgp. A minimum fan tip speed of 4192 m/min i.e., about 3000 rpm should be maintained. The minimum air velocity through 254 mm ducting should be more than 17 m/s. The 1D-3D cyclone with diameter of 815 mm and height of 2445 mm needs to be employed to separate out air and trash passing through the trash fan with a pressure drop of 363 mm wgp. The screw conveyor of the compactor should have a pitch and diameter of 320 mm and should run at a speed of 72 rpm. With this protocol the developed system attains the intended objective of destroying PBW with 100% mortality rate of larvae and pupae.

Effect on Pink Bollworm Infestation of Ginning Performance

Ginning performance of PBW-infested cotton compared to un-infested cotton on DR gin showed 17%, 14%, 25% and 11% reduction in ginning percentage, fibre length, uniformity index and tenacity respectively whereas short fibre content and degree of yellowness increased by 67% and 42% respectively which is undesirable. Deterioration in colour grade of cotton of PBW infested cotton is observed to deteriorate from middling (31-1) to strict low middling (41-1) compared to un-infested cotton as per HVI colour grade chart for American upland cotton (USDA). Scanning Electron Microscope (SEM) analysis indicated poor fibre development and growth of microbes on PBW infested cotton in comparison to healthy cotton (Fig.2). The deterioration in ginning percentage and fibre quality has significant impact on the economic value of cotton thus affecting cotton producers and processors. (Fig. 2)

Suggested Measures for the Indian Ginning Industry

A gin trash treatment system along with best management practices comprising of regulatory and legislative measures are suggested to destroy and prevent dissemination of PBW through gin trash from Indian ginning industries to the

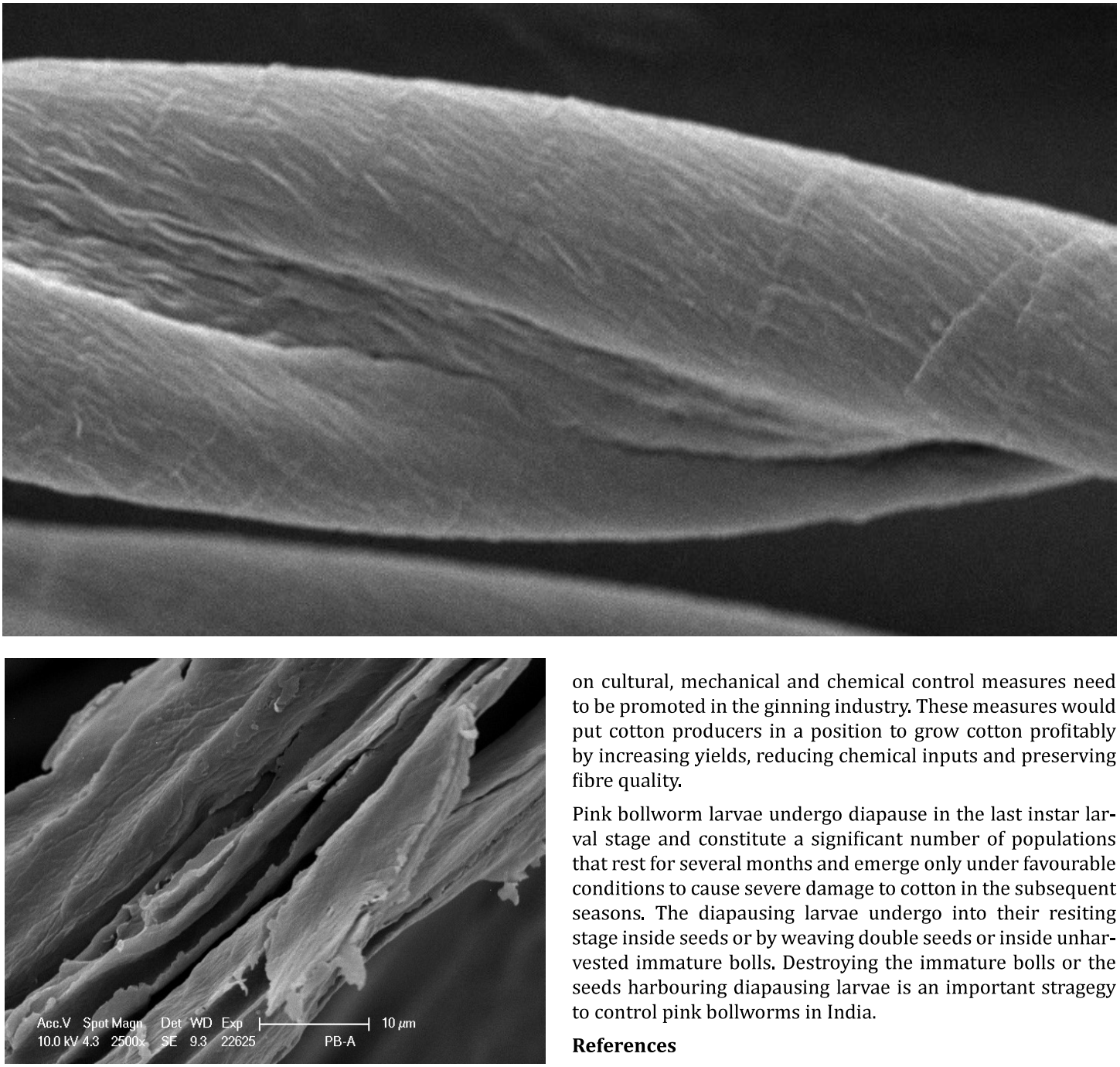

Figure 2: SEM images of healthy (above) and pink bollworm infested cotton fibre (below)

neighbourhood cotton fields. For successful elimination of PBW, the installation of a gin trash treatment system should be made mandatory in each ginning industry in India. Government regulation needs to be issued for mandatory use of this technology by the ginning industries. To encourage ginners to instal the developed system — incentives in terms of subsidy or additional cost compensation per bale ginning and pressing charges for ginners installing the system — need to be provided. Best post-harvest management practices based on cultural, mechanical and chemical control measures need to be promoted in the ginning industry. These measures would put cotton producers in a position to grow cotton profitably by increasing yields, reducing chemical inputs and preserving fibre quality.

Pink bollworm larvae undergo diapause in the last instar larval stage and constitute a significant number of populations that rest for several months and emerge only under favourable conditions to cause severe damage to cotton in the subsequent seasons. The diapausing larvae undergo into their resiting stage inside seeds or by weaving double seeds or inside unharvested immature bolls. Destroying the immature bolls or the seeds harbouring diapausing larvae is an important stragegy to control pink bollworms in India.

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