Cooperative Extension

BT Cotton In Arizona: What will Change?

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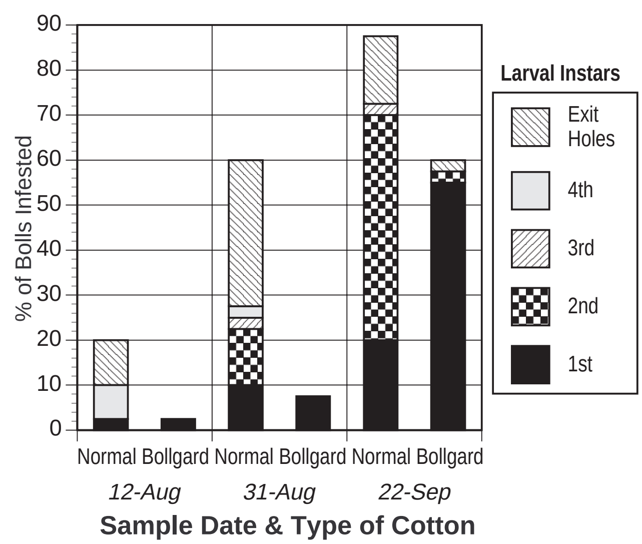
Several companies are involved with the development of transgenic cotton varieties that have been engineered to carry a gene derived from the microbe, *Bacillus thuringiensis* (Bt). For example, Monsanto calls their product Bollgard™ gene. As many of you know, Bt is a bacterium which produces substances or proteins which are toxic to insects. Bt products have been available for years in sprayable formulations for the control of insects, especially lepidopteran pests (e.g., caterpillars, loopers, worms). With the introduction of transgenic 'Bt' cotton, Bt genes and their lethal action against caterpillar pests are now available "built into" the cotton plant.

Best Management

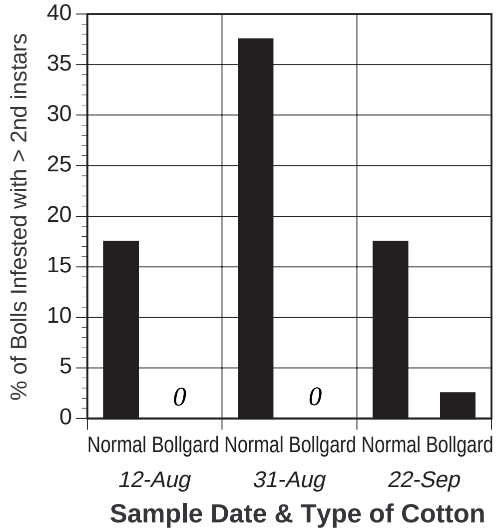
'Bt' cotton offers potential rewards to all growers in the Southwest. But, like so many modern innovations, the best managers will reap the greatest benefits from its use. One key to becoming one of these "best managers" is having a thorough understanding of how 'Bt' cotton works. Bollgard™ gene represents our first true larvicide for pink bollworm (PBW). Conventional chemical controls and pheromone technologies have historically targeted the non-damaging stage of this insect, the moth. The protein produced by the Bollgard™ gene acts directly on the larval stage of this pest. The spectrum of activity of this protein is not limited to PBW and includes other lepidopteran pests such as cotton leafperforator, tobacco budworm & cotton bollworm, cabbage looper, saltmarsh caterpillar, and beet armyworm. The protein is completely ineffective outside of lepidoptera, so *Lygus* bugs, whiteflies, thrips, and aphids will have to be managed through more conventional means. Becoming a best manager of 'Bt' cotton requires changes in thinking concerning Scouting, Insecticides, and other Cultural/Agronomic Practices.

Scouting

Because this technology is directed against PBW larvae, there should be *less reliance on adult monitoring* for tracking field level populations and triggering insecticide applications. Instead, pheromone traps should be used primarily for monitoring general, area-wide trends in moth distribution and activity to identify periods of more intensive in-field checking. There should be almost *no reliance on damage symptoms* for monitoring the progress of a PBW infestation. The reason for ignoring damage as an indicator of the need for treatment is simple, but involves a complex process. Small PBW larvae, which enter bolls usually within 24 hrs of hatching, ingest the protein along with their normal diet of cotton tissue. One feeding bout might result in "sickness" in the larva, a gut paralysis that prevents continued feeding. Additional feeding bouts might be needed to kill the larva. A larva may enter the boll, feed incidentally on boll tissues, and even molt. Therefore, the normal signs of PBW presence (e.g., warts and mines on the carpal wall, insect frass) will still be noticeable in 'Bt' cottons. In most cases, a dead, dying, or "missing" larva will be the result, making treatment unnecessary.



There will also be *less reliance on detection of small larvae* in bolls as indications of treatment (see graph above). Consultants can now scout for PBW larvae by "cracking" or cutting bolls. Their objective is to find larvae while they are young, indicating the earliest stage of PBW invasion. With 'Bt' cotton, finding first or even second instar PBW larvae will not be unusual and should not alarm the pest manager. Counts should consider only those bolls which harbor live, large larvae (3rd & 4th instars). Exact threshold levels for treatment are yet undeveloped. Research conducted in Arizona suggests that under natural infestation pressures, levels of 10% live 3rd instars or older are not reached in Bollgard™ cotton until late season, well beyond crop cut-out (see graph on next page).



So how does one determine if the Bt gene is performing adequately in the field? The best way we have found is to monitor those areas that are not protected with the gene, i.e., normal cotton. This will place *greater emphasis on scouting unprotected areas*, such as refugia maintained for resistance management or adjacent fields or area farms. Scouts should track populations in the earliest planted (non-'Bt') fields or other areas prone to PBW problems. Once scouts find high boll infestations (>10%) with large larvae (≥ 3rd instars), they can then check nearby 'Bt'-protected fields for large larvae. In order to better detect older larvae, *scouts should focus on bolls that are slightly older* than those normally cut.

Insecticides

To reap the greatest economic and environmental advantages of 'Bt' cotton, the best managers will adapt their usage of insecticides. *Pinhead square insecticide programs initiated for PBW control will not be needed*, though early season control may be warranted for non-lepidopteran pests (e.g., *Lygus*). There should be *less of a need to use lepidopteran-active insecticides for general pest control*, except where beet armyworms are very dense or where large saltmarsh caterpillars are "on the march" from some other area. Insecticide choices for other pests should be more selective with *more attention given to avoiding unnecessarily broad-spectrum materials*. This will help those best managers preserve natural enemies and enhance the natural controls of other non-lepidopteran pests. Late season insect populations in the Southwest can explode and even 'Bt' cotton could be at risk of losses to worm pests at this time. These extreme conditions may require Lepidopteran-targeted insecticides.

Cultural/Agronomic Practices

PBW management begins here, and 'Bt' cotton will be no different except for rather subtle changes in management. There will be *less of a need to "delay" planting for PBW management* (i.e., for suicidal emergence), but there will be renewed need to consider the agronomic needs of planted seed. A favorable agronomic planting window <u>must</u> be observed to *minimize the risk of re-planting*. Growers should plant only once 400 HU after Jan. 1 has been reached **and** soil temperature at planting depth (at 7–8 a.m.) is 65°F for three days running **and** there is a favorable 5-day forecast—this is typically indicated by daytime highs in the low 80's and nighttime lows greater than 48°F. If planting earlier than this, a grower should consider a variety that has exceptional seedling vigor and cold and disease tolerance. Irrigation termination, chemical termination, harvest and plowdown should be timed to *maximize the first fruit cycle set **and** minimize late season exposure to PBW and other pests*. There are two important reasons for not placing the crop in a position of compensation late in the season: 1) cultural controls are a solid basis for 'Bt' resistance management programs, and 2) there is a risk of protein breakdown or loss of expression in senescent cotton which would leave it unprotected from extreme moth pressure.

Summary

Growers should view 'Bt' transgenic technology as an opportunity to be best managers. The benefits are great: 1) lower insecticide use, 2) enhanced biological controls, 3) potential for greater yield in areas of historic losses to caterpillar pests, 4) less uncertainty about "occasional" & secondary lepidopteran pests, 5) compatibility with worker safety, and 6) increased efficiency in scouting with more attention paid to our remaining, unaffected, pest complex (e.g., whiteflies and *Lygus*). There are, however, several challenges. Scouts and growers must have patience and faith in the technology, because signs of PBW activity may still be present. The grower and pest manager relinquish some amount of control over their pest management decision-making (and budget), because investment into this technology is "up-front" in the seed bag. Therefore, each grower must carefully balance the value added cost of this seed with the potential savings to their pest control budget and to the environment. Finally, insects have only rarely been denied their "fair" share of our crops for very long. Their ability to develop resistance remains a threat even for 'Bt' cotton. Pest managers, growers, and industry must come together and implement a rational plan for the management of resistance to Bt.

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