

# Resistance Update

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## Compliance with Bt Cotton Refuge Requirements in AZ

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**Bt cotton** is now beginning its ninth season of use in Arizona without any indication of resistance problems in the field. It continues to provide exceptional control of pink

cotton was developed in Arizona and cannot be used in states other than California, Arizona, or New Mexico. It consists of systematically planting at least 5% (preferably 10 to 20%) of Bt fields with non-Bt seed by having one or two hoppers on planters dispense non-Bt seed. This practice has been evaluated by producers throughout the State for many years with very favor-

able results in terms of yields and production costs. However, the terms of the Bollgard® Insecticide Resistance Management Guide specifically prohibit producers from counting non-Bt plants of in-field refuge fields as refuge for other Bt cotton fields, irrespective of the amount of non-Bt planted. For non-Bt cotton to be legitimately counted as refuge for a block of Bt cotton, it must average

effective insecticidal technology ever available for management of pink bollworm. Keeping pink bollworm from developing resistance to Bt cotton is essential for maintaining these advantages for cotton growers, workers, and the environment.

### The Problem

Analysis of refuges of non-Bt cotton in Arizona in 2003 indicated a misunderstanding on the part of some cotton growers who planted single-row or multiple-row in-field refuges. The in-field refuge approach to Bt

It is critical for Arizona producers to understand that non-Bt cotton planted within Bt fields *cannot* be counted as refuge for *other* Bt fields unless the non-Bt cotton is planted in blocks that are at least 150 feet wide.

### Definitions

#### Embedded Refuges

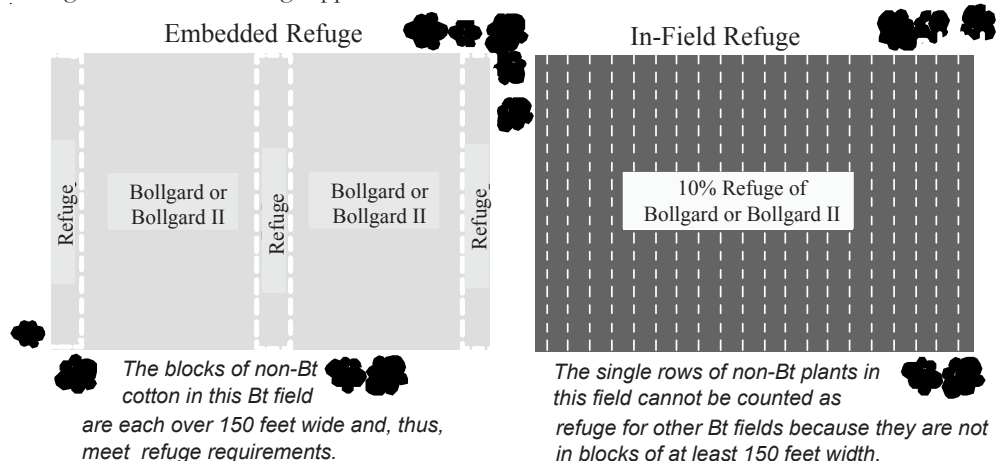
Blocks of non-Bt cotton of at least 150 feet in width that are planted within fields of Bt cotton.

#### In-Field Refuges

Single rows of non-Bt cotton, or multiple rows of less than 150 feet in width, that are planted within field of Bt cotton.

#### External Refuges

Solid blocks or fields of non-Bt cotton that are at least 150 feet in width.



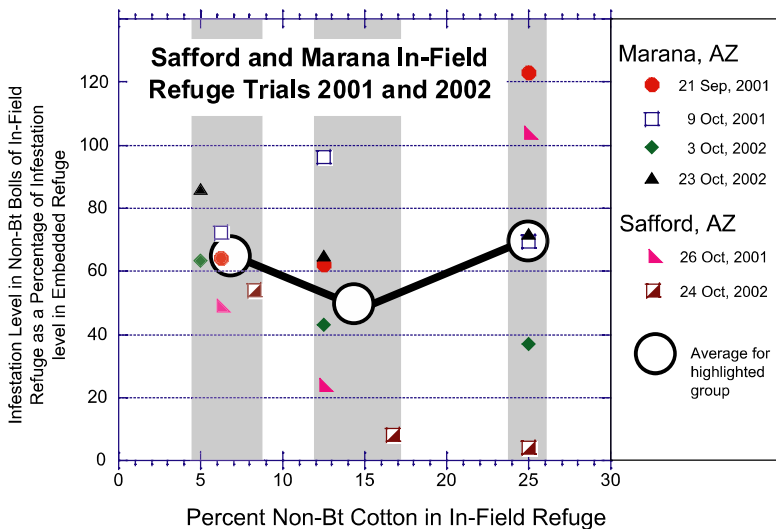


Figure 1. In-field refuges of non-Bt cotton in Marana and Safford averaged only 50-70% of the pink bollworm produced by external refuges. A value of 100% on the y-axis means that the in-field refuge produced the same number of pink bollworm as the embedded refuge.

at least 150 feet in width. There is a simple biological explanation for this restriction.

### The Explanation

The purpose of refuges of non-Bt cotton is to produce at least 500 pink bollworm moths in the refuge for every resistant pink bollworm moth that survives in the nearby Bt cotton field for which it is the refuge. Doing so makes it highly likely that rare resistant moths surviving in Bt cotton will mate with a susceptible moth from the refuge, rather than with another rare resistant moth from the Bt field. When a resistant female moth mates with a susceptible male from the refuge, the high dose of toxin in Bt cotton kills their offspring, stopping resistance genes dead in their tracks. So far, the lack of resistance to Bt cotton in the field supports the validity of this strategy for delaying resistance.

### In-Field Refuges Produce Fewer Pink Bollworm.

The reason that in-field refuges of non-Bt cotton cannot be used as the required refuge for other blocks of Bt cotton is that they yield fewer total pink bollworm per plant than do refuges of non-Bt cotton of 150 feet or greater width. The explanation for this is simple. Using a 10% in-field refuge example, one row in ten will be non-Bt and thus suitable for producing susceptible pink bollworm. However, buildup of pink bollworm in these non-Bt rows is suppressed, relative to that of solid blocks of non-Bt cotton, because 90% of the plants in the in-field refuge are Bt plants and kill pink bollworm. Pink bollworm females, unable to tell the difference between Bt and non-Bt plants, lay 90% of their eggs on Bt plants—resulting in their demise. The end result is a slower buildup of pink bollworm within in-field refuges.

More than five years of field data have shown that pink bollworm numbers in non-Bt plants of in-field refuges reach high

levels late in the season. In-field refuges intersperse non-Bt plants throughout the Bt plants, thereby insuring that susceptible moths will be distributed throughout the Bt cotton. This reduces uncertainty regarding movement of susceptible moths from external refuges to mate with resistant moths that survive in Bt fields. However, it is because *they produce fewer pink bollworm* that non-Bt plants used as in-field refuges cannot be counted toward the refuge for other Bt fields.

### Be Sure to Monitor Bt Cotton for Pink bollworm

At least once each season, you should monitor for pink bollworm in Bt cotton fields, preferably in areas adjacent to non-Bt cotton fields. This is best done once you begin to reach threshold levels of pink bollworm in your non-Bt cotton. Sample 50 bolls of Bt cotton, crack them and look for large pink larvae and exit holes. Remember that 1<sup>st</sup> and 2<sup>nd</sup> instar larvae normally survive and mine in Bt bolls. However, 3<sup>rd</sup> and 4<sup>th</sup> instar larvae, the larger pink stages, should *not* survive in bolls of Bt cotton. If you find more than 2 out of 50 bolls with large pink bollworm larvae in Bt cotton fields, this is an un-

usual event and should be reported to the Rapid Response Team.

### Arizona's Bt Cotton Rapid Response Team

To report a problem call the ARCPC at 602-438-0059. You will be asked to identify the precise location of the field where you found unusual pink bollworm survivorship. It would be helpful if problem locations were clearly marked or flagged so that follow-up collections can be made at precisely the same locations. If ACRPC field personnel confirm the unusual event, they will collect infested bolls and forward them to EARML, in Tucson, where the pink bollworm will be tested for susceptibility to Bt toxin. Additionally, bolls in which pink bollworm survive will be tested for presence of toxin to confirm that they were collected from Bt cotton.

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### SUMMARY

- ⇒ Single or multiple row in-field refuge plantings do not meet the contractual requirements as refuge for *other* Bt cotton fields. To qualify as refuge for Bt cotton, non-Bt plantings must be at least 150 feet in width.
- ⇒ Report instances of unusual survivorship of pink bollworm in Bt cotton to the ACRPC at 602-438-0059. Unusual survival is 2 or more large pink bollworm larvae in 50 bolls of Bt cotton.