

Resistance Management with Bt Corn

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Protecting against the development of corn borer resistance IS the responsibility of ALL producers using Bt corn. This responsibility must not be taken lightly. Development of resistance by corn borers to this type of corn is a real threat. This means that each producer using Bt corn must follow an approved plan. Currently, there several resistance management plans depending on the type of Bt corn being used. There is the structured refuge strategy and the refuge in the bag strategy (but this has only been approved for corn rootworms).

The Structured Refuge

This is the most common type of refuge strategy in use. For each farm using Bt corn, there are separate planting of non-Bt corn where pests are able to develop. These non-Bt refuges may take the form of strips through the Bt field, blocks within the Bt field, or separate fields. The size of these structured refuges will depend on the type of Bt corn used and for most Bt corn it will be a minimum of 20% of their corn acreage. However, with SmartStax and Intract corn, the minimum structured refuge may be as low as 5%.

The structured refuge depends on a high dose refuge strategy, non-Bt corn acreage on each farm serves as a refuge, allowing some Bt-susceptible corn borers to survive. Then if a rare resistant corn borer were able to survive on a Bt-corn plant, it would most likely mate with a susceptible corn borer. Corn borers produced from this mating would only be partially resistant, and should not be able to survive if they feed on Bt corn. What this strategy tries to prevent is one resistant corn borer mating another resistant corn borer. If this happens, then the corn borers produced would be fully resistant to the Bt corn.

When farmers use Bt corn, a portion of their corn crop must be planted with non-Bt corn on each farm using Bt corn. In Kentucky, the EPA requires that at least 20% (5% with SmartStax and Intract Bt

corn) of the total corn acreage on each farm must be planted with non-Bt hybrids. This means that the maximum amount of Bt corn on any farm would be 80% of the corn acreage planted. In cotton producing areas, the are different minimum refuge size requirements to account for Bt cotton grown in those areas.

The arrangement of Bt and non-Bt hybrids fields also is important. These plantings need to be arranged such that any moths that happen to emerge from Bt hybrids are most likely to mate with moths from the non-Bt hybrids. Refuges should be planted in adjacent fields or as a block to one side of the Bt corn in the same field. The EPA requires that the refuge be within 1/4 mile of the Bt corn if the refuge is to be treated for corn borers, otherwise if left untreated for corn borers the refuge needs to be within 1/2 mile of the Bt corn.

Bt-Rootworm Corn

The EPA has approved the use of Bt-rootworm corn. Resistance management is also an issue with rootworms and a separate resistance management plan has been developed with Bt-rootworm corn (See ENTFACT 147, *Corn Rootworm Resistance Management with Bt Corn*).

Planting Arrangement Considerations

Some producers have considered using Bt corn in some of the planter boxes and non-Bt corn in the others to plant alternating strips through fields. Planting Bt and non-Bt corn in alternating strips makes it easy to plant the refuge but difficult to manage fields. For example, if the non-Bt corn refuge reaches threshold for corn borer control, it would be impractical to treat the refuge strips with insecticides. Another consideration is harvest. One method to reduce corn borer losses in refuge corn is early harvest. In years with high corn borer numbers, Bt corn has much better standability and can be left in the field longer to dry than non-Bt corn.

Producers are not allowed to mix Bt and non-Bt seed within seed hoppers, as this will encourage the more rapid development of resistance. Because corn borers do occasionally move from plant to plant, mixing seed or planting strips may allow some partially resistant individuals to escape a lethal dose. Recommended planting arrangements for Bt corn and refuges include planting them in separate fields (they must be within 1/2 mile of each other), planting them as large blocks with a single field, planting using the outer or end rows as the refuge in a Bt corn field, or as wide strips through the field. The outer row approach allows the farmer to harvest the refuge as early as appropriate.

The refuge needs to be planted at the same time the Bt corn is planted. For example, if Bt corn is planted on three dates, each ten days apart, then refuges need to be planted on each of those planting dates as well. The refuge should be planted with hybrids that are agronomically similar to the Bt corn and planted as close to the Bt corn as possible. The refuges should receive the same fertility and irrigation inputs as the Bt corn. Reducing inputs and putting the refuge on marginal land may reduce the effectiveness of the refuge.

How Do You Know If Corn Borer Resistance Is a Problem?

Simply finding a few Bt corn plants with corn borer damage, or even a few plants with extensive damage, does not mean that the corn borers are resistant. In any unit of Bt-corn seed, there will be seeds that will produce plants that express only low levels of the Bt endotoxin or may not express the Bt-endotoxin at all (this may be as high as 2 to 5% of the seed). Determining whether or not corn

borers are resistant to Bt is very difficult, particularly in the early stages of development. Widespread economic damage throughout the field would be an indication of resistance, but resistance can only be confirmed through laboratory analysis. Producers growing Bt corn still need to monitor their fields for corn borers in order to determine that it is controlling corn borers. If corn borer resistance is suspected in Bt corn, producers should contact their local county extension service office and their seed corn representative.

Positioning Bt Corn on the Farm

What should be considered when positioning Bt hybrids on the farm? Corn borers can attack corn planted at any time, but usually first generation damage can be worse in early planted corn and late planted corn is more severely damaged by second generation European corn borer and southwestern corn borer as well as corn earworm, fall armyworm, and black cutworm. Generally in Kentucky, the best returns for Bt corn are realized when they are planted late. Later plantings are also more likely to have tip damage from corn earworm and economic infestations of fall armyworm.

Bt-Corn Rootworm/Corn Borer Stacked Hybrids

Additionally, some Bt-corn hybrids may have stacked genes for both corn borer control as well as rootworm control (e.g. YieldGard Plus, Herculex RW, Agrisure CB/RW, etc). Growers using these hybrids are required to comply with resistance management for corn borers and corn rootworms. There must be a non-Bt refuge adjacent to or within the Bt-corn field.

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