Agronomic Spotlight

Seminis grow forward

Optimizing the Use of Biotech Sweet Corn

- Sweet corn varieties with insect protection and herbicide tolerance incorporated using biotechnology are available.
- *Bt genes* can provide protection against corn earworm, European corn borer, and other insect pests.
- Monitoring of insect pests is still necessary and insecticide applications may be needed for adequate control.

Bt Based Insect Resistance

Commercial varieties of field corn containing genes for insect protection from the bacterium *Bacillus thuringiensis* (*Bt*) first became available in 1996. These varieties are protected against certain lepidopteran insects including European corn borer and corn earworm. In 2003, other *Bt* genes that conveyed protection against coleopteran insects, such as corn rootworms, became available in commercial field corn varieties. The *Cry* genes from *Bt* allow the plant to produce crystal (Cry) proteins that, once ingested, disrupt the intestinal tract of target insects, eventually killing them. Cry proteins are very specific, with toxicity to a narrow range of insects. This means that they have little or no effect on non-target organisms, including beneficial insects such as predators and bees. Another class of *Bt* insect toxic proteins, the vegetative insecticidal proteins (Vip), also convey protection against a range of insect pests through a different mechanism. These various *Bt* genes are now available in certain sweet corn varieties to provide management of important insect pests. [1,2]

Multiple Bt Toxins

Several *Cry* genes have been isolated from the *Bt* organism, and through the use of biotechnology, these genes have been transferred into sweet corn plants. Each *Cry* gene produces a version of *Bt* toxin, and the various toxins have different ranges of activity against specific groups of insects. Attribute® varieties of sweet corn, from Syngenta, contain the *Cry*1Ab gene. This gene conveys good protection against European corn borer, but it is not as effective against damage by corn earworm and fall armyworm. [3]

The Performance Series® sweet corn varieties, from Seminis, contain two *Cry* genes (*Cry*1A.105 and *Cry*2Ab2) that protect against several lepidopteran insects, including corn earworm and European corn borer. The Cry2 protein is particularly effective against fall armyworm.[3] Other stalk boring insects are also controlled by these two Cry proteins. A third *Cry* gene, *Cry*3Bb1, is present in the Performance Series® varieties and is effective against larvae of coleopteran insects, including the western, northern, and Mexican corn rootworms. These insects feed on roots, and the resulting damage can lead to plant lodging if feeding is severe. Rootworm management should also include avoiding the consecutive planting of corn and regular scouting programs for these insects, as insecticide treatments may be needed if population levels are high.

Attribute®II sweet corn varieties, from Syngenta, contain both the *Cry*1Ab gene and the *Vip*3 gene, a combination that provides protection against corn earworm, European corn borer, cutworms, and fall armyworm.[3]

One concern with using single *Bt* genes for insect protection is that this method puts selection pressure on the target insects, potentially leading to the development of biotypes of the insect that are resistant to the effects of the toxin. Using multiple *Bt* genes (pyramiding the genes) results in plants that produce multiple toxins with different modes of action (MOA), which helps prevent the development of *Bt* resistant insects. If an insect develops resistance to one toxin, it will still be killed by the other toxin that is present. Pyramiding genes, as is seen in the Performance Series® and Attribute®II varieties, helps prevent the development of *Bt* resistant insects. The application of insecticides with different MOAs also helps prevent the development of resistant insect populations.

Corn Earworm Management

Bt sweet corn hybrids have been shown to significantly outperform traditional non-*Bt* hybrids, regardless of insecticide application frequency, for the management of corn ear worm (CEW). Using *Bt* hybrids has also resulted in a marked reduction in the use of conventional insecticides for managing lepidopteran pests, such as CEW. [4]

While the insect protection traits of the *Bt* varieties may be enough to adequately manage CEW on sweet corn in some circumstances, it may not be sufficient when insect populations are high or when field corn in the area is not silking and silking sweet corn is the most attractive site for egg laying. In these cases, the *Bt* varieties will need to be

(Continued on page 2)

Optimizing the Use of Biotech Sweet Corn

(Continued from page 1)

treated with an insecticide for adequate control of CEW. [3] Sweet corn growers need to continue scouting fields as usual to detect if the target pests are present and whether an appropriate insecticide should be used according to label recommendations (Monsanto 2016 Technology Use Guide).

CEW is often the most serious insect pest for sweet corn production. Female CEW moths lay their eggs on corn silks, and when the eggs hatch, the larvae start feeding on the silk material and move down the silk channel to the ear. Once in the ear, the larvae feed on the developing kernels. Sweet corn that is silking when neighboring field corn is also silking is under less pressure from CEW because there are many egg laying sites from which the female moths can choose. Under these circumstances, *Bt* varieties may not need to be treated with an insecticide, especially if CEW populations are relatively low.[3] Sweet corn that silks early, before the neighboring field corn, or late, after field corn is done pollinating, is much more attractive to CEW for egg laying and may need to be treated with an insecticide, especially if CEW populations are high. Growers who are using a mix of *Bt* and non-*Bt* varieties may choose to plant the *Bt* varieties very early or late in the season when protection from corn ear worm feeding is needed the most.

CEW larvae need to feed on tissue containing the *Bt* toxin to be killed.[5] This can be silk tissue for cultivars with long silk channels and for eggs laid at the beginning of the silking period. As the time from pollination increases, less silk tissue is available for larvae to feed on and/or eggs are laid closer to the tip of the ear. This results in larvae reaching the ear and feeding on kernels before they consume enough toxin to be lethal. A little feeding at the tip of the ear may be acceptable, but more substantial feeding will make the ears unmarketable.

Pheromone trap monitoring programs for CEW usually have a threshold of 3-5 moths per night for the initiation of an insecticide spray program on non-*Bt* sweet corn. With *Bt* sweet corn, the first few sprays can be skipped (when long silks are present), but then a normal spray program should be followed to protect ears from later egg laying events. If field corn is silking at the same time as the *Bt* sweet corn varieties, then insecticides may not be needed. However, growers should maintain a regular scouting program and "be prepared to use insecticides on *Bt* sweet corn if it must be worm-free for their markets". [3] Scouting and pheromone trap monitoring should begin prior to first silk and continue through harvest. The *Bt* trait does reduce the need for some insecticide applications, but insecticide applications may be necessary at high infestation levels.

Regulatory Requirements

In order to reduce the chances of insects developing resistance to *Bt* toxins in large acreage crops, such as field corn and cotton, the US Environmental Protection Agency requires that certain percentages of the field be planted to non-*Bt* versions of the crops to act as a refuge for the insects. There is no such requirement for growing *Bt* sweet corn. However, there is a requirement that *Bt* sweet corn plants must be destroyed no later than 30 days, and preferably within 14 days, of harvest. Acceptable means of crop destruction include discing or plowing down of fields and rotary mowing. This helps minimize the survival of any *Bt* resistant insects that may have developed on the crop.

Benefits of Herbicide Resistance

The many of the currently available biotech sweet corn varieties are also tolerant to specific herbicides listed on their labels. These herbicide tolerance traits allow for pre- and post-emergence applications of the specific herbicides and increase the feasibility of using conservation tillage practices while maintaining adequate weed management. Herbicide tolerant sweet corn varieties can also be planted near corn and soybean crops with the same tolerance trait without the possibility of herbicide injury from unintentional spray drift.

Sweet corn yields can be reduced by early season weed pressure, and it is important to control weeds before they start competing with the corn plants, typically before the weeds are four inches tall. Using a diversity of weed management practices, including multiple herbicides with different sites of action, will help reduce the potential for the development of herbicide resistant weeds.

Sources:

[1] Hellmich, R. L. and Hellmich, K. A. 2012. Use and impact of *Bt* maize. Nature Education Knowledge 3(10):4. [2] Palma, et al. 2012. Vip3, a novel class of vegetative insecticidal proteins from *Bacillus thuringiensis*. Appl. Environ. Microbiol. Vol. 78:7163-7165. [3] Weinzierl, R. W. 2016. Preparing for corn earworm. In Illinois Fruit and Vegetable news; Vol. 22, No. 3. [4] Shelton, A. M., et al. 2013. Multi-state trials of *Bt* sweet corn varieties for control of the corn earworm (Lepidoptera: Noctuidae). Journal of Economic Entomology, 105, 2151-2159. [5] Bessin, R. *Bt*-corn: 2003. What it is and how it works. Entfact-130. University of Kentucky Cooperative Extension Service.

For additional agronomic information, please contact your local seed representative. Developed in partnership with Technology Development & Agronomy by Monsanto.

160422151116 DME070816

Roundup Ready 2 TECHNOLOGY®

Seminis