

Chapter 18

Grower Acceptance and Utilization of Transgenic Corn in IPM Programs

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The development and commercial release of *Bt* corn represented a significant advance in management of the European corn borer, *Ostrinia nubilalis* (Hübner), southwestern corn borer, *Diatraea grandiosella* Dyar, and the corn rootworm complex, *Diabrotica* species, three of the most important insect pests of corn in North America. Before *Bt* corn was relatively widely planted to control corn borers, losses resulting from European corn borer damage and control costs exceed \$1 billion in North America each year. Although more limited in distribution within the United States (from Arizona to Alabama north to Kansas, southern Missouri, and Illinois), the southwestern corn borer causes an estimated annual loss of 1% of United States production of corn.

Corn rootworms, collectively, are the most important and destructive insect pests of corn in North America, costing corn producers \$1 billion annually in control costs and yield losses. The corn rootworm complex consists of the western corn rootworm, *Diabrotica virgifera virgifera* LeConte; northern corn rootworm, *D. barberi* Smith & Lawrence; Mexican corn rootworm, *D. virgifera zea* Krysan & Smith; and southern corn rootworm, *D. undecimpunctata howardi* Barber. The western and northern corn rootworms are the most widely distributed species in the complex and account for most of the economic importance.

Before the advent of *Bt* corn, the most common strategy for managing both species of corn borers was scouting for the pests and applying an insecticide if crop injury or pest density exceeded economic levels. Application of insecticides to control southwestern corn borers was a relatively common practice in the area of the pest's distribution. Because populations of European corn borers often fluctuate rather dramatically over time, application of insecticides to control European corn borers was sporadic and often

not practiced by some growers. One pesticide-use survey in the mid-1990s indicated that an average of 2.82 million acres of corn was treated annually with insecticides to control European corn borers in the United States. However, scouting for corn borers, especially second-generation borers, is arduous; and timing an insecticide application for maximum efficacy is difficult. Consequently, many corn producers in the past did nothing to manage European corn borers ("benign neglect"). Therefore, the promise of season-long control of European corn borers with *Bt* corn encouraged farmers who believed that the pest was otherwise difficult to manage.

Corn rootworm larvae are controlled primarily by the use of insecticides during planting (granule, liquid, or seed treatment insecticides) and by crop rotation. Many growers would prefer not to handle insecticides. In addition, crop rotation has failed to control a variant of western corn rootworms that has begun laying eggs in fields other than corn (e.g., soybean) in some areas of the eastern Corn Belt. In parts of the western Corn Belt, crop rotation has failed to control northern corn rootworms that exhibit extended diapause. So, the commercialization of *Bt* corn to control corn rootworm larvae provided corn producers with an excellent alternative to the use of insecticides and the potential unreliability of crop rotation.

Grower Acceptance of *Bt* Corn Technology

After the introduction of *Bt* corn in 1996, growers throughout North America adopted the technology relatively rapidly to manage European and southwestern corn borers. By 1999, about 26–30% of the corn acres in the United States were planted to *Bt* corn. (Estimates of acreage of *Bt* corn planted vary depending upon the source of information.) However, by 2000, primarily because of low numbers of European corn borers throughout much of the Midwest, the acreage of *Bt* corn declined to an estimated 19–25% of the corn acres. Some of this decline also could be attributed to farmers' concerns about the highly publicized, potential negative impact of *Bt* corn on non-target organisms [e.g., monarch caterpillar, *Danaus plexippus* (L.)] and the lack of a market for *Bt* corn in European and Asian countries. Concerns about the effects of *Bt* corn on the environment and food safety subsided after 2000, and the use of *Bt* corn increased modestly and steadily thereafter. In Canada, for example, *Bt* corn was planted on about 35% of the corn acres in 2001.

At the time this chapter was written, the registration of *Bt* corn to control corn rootworm larvae was relatively new. YieldGard® Rootworm corn (Cry3Bb1) protein) was