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A Field Scale Evaluation of a Genetically Engineered Corn Hybrid Resistant to European Corn Borer

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ABSTRACT

The objective of this study was to determine the effect of a genetically engineered corn hybrid with the Bacillus thuringiensis (Bt) gene and its resistance to European corn borer (ECB). This field study consisted of one field, or 130 acres of corn. The field was divided in half. One plot was planted with conventional hybrid corn, which was the control. The other plot was planted with the Bt corn hybrid, which is resistant to ECB. Both plots were examined for egg masses and live larvae throughout the growing season in 1996. Relatively high numbers of ECB and Southwestern corn borer egg masses, and live larvae were found on each visit to the field. These numbers often exceeded preferred treatment levels, which would normally warrant the use of an insecticide. Since this was a field scale study, the control plot had to be chemically treated to keep damage to a minimum. The study showed, that control of ECB in the Bt corn was comparable to that of the chemically treated corn.

INTRODUCTION

European corn borer (ECB), is considered a major pest of corn in North America. Farmers lose more than one billion dollars a year as lost yields resulting from ECB feeding. In years past the only control for European corn borer was the use of costly insecticides (Koziel, et. al, 1993). This kind of chemical control typically would be around 67 percent effective against ECB if application was during the prudent time. However, the inconvenience of scouting fields and determining treatment thresholds often narrows the application window on large corn plants, thus resulting in a much lower percent of effective control (Marney, 1996).

ECB generally has two generations annually. First generation ECB lay their eggs on the underside of corn leaves at the first of May. Hatched larvae feed on the leaf material in the whorl over a period of a week to 10 days. Third instar larvae bore into the stalk to feed, pupate, and emerge as second generation moths over a long period during the summer. These second generation moths then lay their eggs on the underside of the corn leaves close to the ear node region. Larvae will then feed on pollen accumulated in the leaf axils, and on the sheath and collar tissue. Once inside the collar, they are shielded from chemical control. Then larvae bore into the ear region of the stalk, resulting in severe yield loss from stalk lodging and/or ears dropping to the ground (Koziel, et. al, 1993).

First time available to corn growers in 1996, is the long awaited arrival of Bacillus thuringiensis (Bt) corn hybrids, also known as ECB resistant corn. Researchers have now put genes into corn to express insecticidal toxins normally found in the bacterium known as Bacillus thuringiensis. Bt toxin allows the plant to protect itself against pests such as ECB. When Bt is ingested by a susceptible insect, the protein toxin is activated by enzyme activity in the insect's stomach. The toxin destroys the cells in the insect's stomach wall (Marney, 1996). Unlike an insecticide, the Bt protein can be maintained at highly effective levels in the plant throughout the growing season (Olson, 1996). The purpose of this study was to evaluate Bt hybrid corn and it's effectiveness against ECB.

MATERIALS AND METHODS

The experimental field was located in Sedgwick Co. Kansas. (SW 1/4 7-25-3). The soil was a Vanoss silt loam (Penner, 1979). This field had been in continuous corn for the previous three years. It is irrigated by a center pivot irrigation system. Fertilizer and herbicide rates were constant across the entire field.

The field was divided into two plots. A plot on the north and a plot on the south, each contained about 65 acres. The north plot, or control plot, was planted with NG2868, a new hybrid of conventional yellow dent corn by Mycogen. The south plot was planted with NG7959, a new hybrid also by Mycogen. The NG7959 contains the Bacillus thuringiensis (Bt) gene.

The field was checked for the presence of egg masses of both the European corn borer (ECB) and the Southwestern corn borer (SWCB) on 7/21/96. The corn was in the dough stage. Four spot checks were done, two on each plot. The spot checks sites were chosen at random. Ten consecutive plants in each plot were observed, (twenty plants on each plot). Five leaves were examined on each plant starting at the ear leaf and the first two leaves above and below it. Thus fifty leaves per location were examined, (one hundred leaves per plot).

Each leaf was examined for presence of ECB and Southwestern corn borer egg masses. ECB eggs are white and laid in masses of 10 to 20 with individual eggs overlapping each other, like fish scales. Southwestern eggs are usually laid individually, with one or two overlapping each other. Counts included both hatched and unhatched egg masses. Each egg mass found was counted as a 10 percent infestation. After all plants were observed and counts recorded, the total number at each location was divided by two, to give an infestation rate for the plot.

The field was again checked for egg masses on 8/1/96. The corn was in the mid-dent stage. Egg

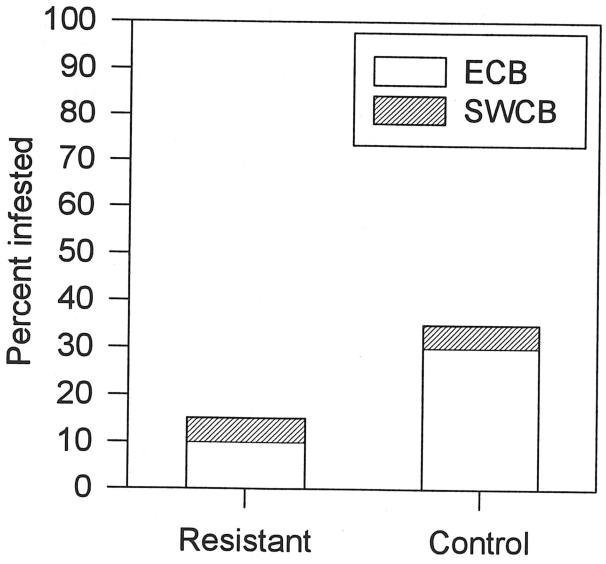

Figure 1. ECB and SWCB egg mass infestation in control and ECB resistant hybrids on 7/21/96.

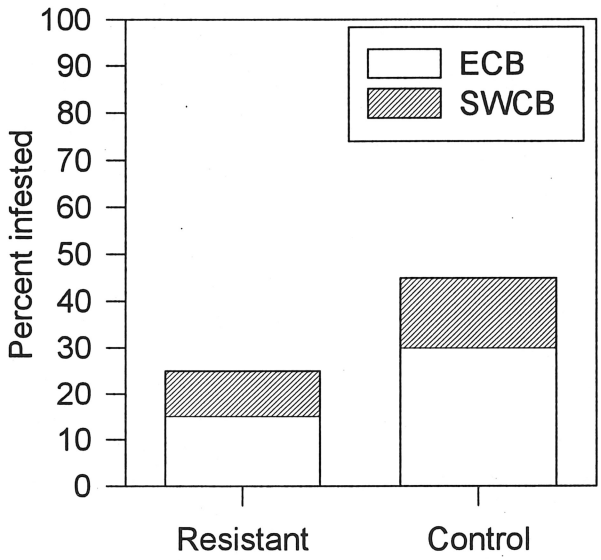

Figure 2. ECB and SWCB egg mass infestation in control and ECB resistant hybrids on 8/1/96.

masses seen on the first trip would have been hatched so plants were examined again to see if any new eggs were being laid. Spot check sites were different from those of the previous visit. Counts were recorded as before.

Due to high infestation of ECB, the control plot was sprayed with an insectide, on 7/28/96.

On 8/30/96 the field was checked for live larvae, and plants were examined for stalk feeding or tunneling. Again ten consecutive plants were examined in each of two locations. By splitting the stalk of the whole plant with a knife, tunneling could be observed as well as live larvae. Live larvae as well as shot holes in the stalk were recorded much the same way as before.

The final evaluation in the field was on 9/12/96. The corn was ready to be harvested. This time fifty consecutive plants in two different locations on each hybrid were observed for ear droppage, lodged plants, and weak stalks.

Plots were harvested on 9/19/96, and yields were recorded.

RESULTS

On 7/21/96 the egg mass infestation in the ECB resistant hybrid was. 5 percent fresh ECB, 5 percent hatched ECB, and 5 percent fresh SWCB for a total infestation of 10 percent ECB and 5 percent SWCB. On the control plot total infestations of 30 percent ECB and 5 percent SWCB were found. (Fig. 1)

On 8/1/96 egg counts were again done and numbers recorded. The resistant hybrid plot had infestations of 15 percent ECB and 10 percent SWCB. The control hybrid had a total infestations of 30 percent ECB and 15 percent SWCB. (Fig. 2)

On 8/30/96, no live ECB larvae were found in either plot. There was a 20 percent infestation of live SWCB larvae found in the resistant plot and a 10 percent infestation of live SWCB larvae in the control plot. (Fig. 3)

On 9/12/96 the last evaluation, in the ECB resistant plot, 3 percent of the plants were lodged and in the control 1 percent of the plants were lodged. (Fig. 4)

The ECB resistant hybrid yielded 180 bushels per acre, and the control hybrid yielded 190 bushels per acre. (Fig. 5)

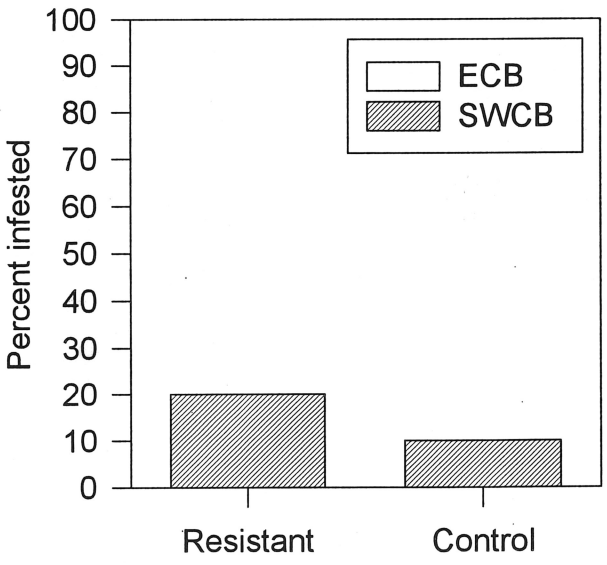

Figure 3. SWCB larva infestation in control and ECB resistant hybrids on 8/30/96.

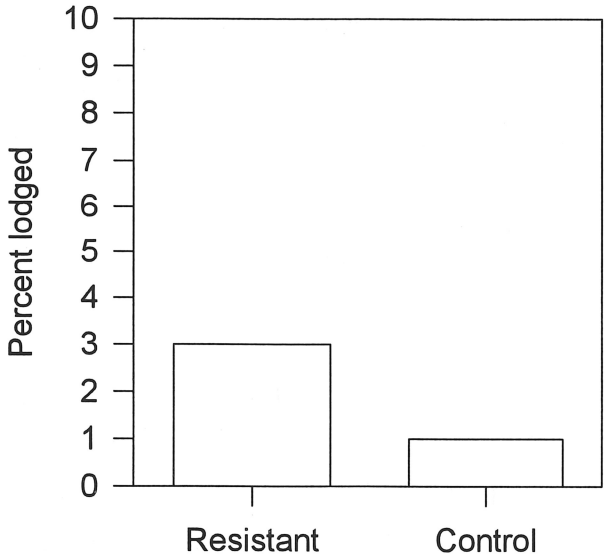

Figure 4. Percent lodged stalks of control and ECB resistant hybrids

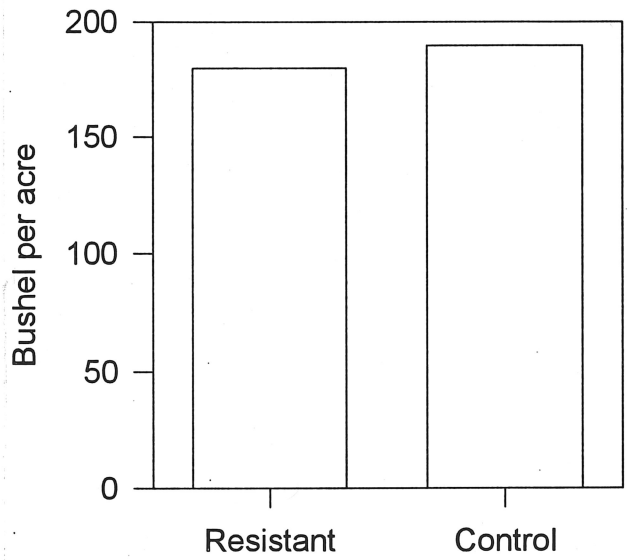

Figure 5. Yield of control and ECB resistant hybrids.

DISCUSSION

The results found in this study were encouraging. As shown in Figures 1 and 2, ample numbers of ECB egg masses were found in both the control plot and the ECB resistant plot on two different occasions. The ECB egg masses found in the control plot on 7/21/96 were quite a bit higher than the others found on that date. High numbers of ECB found in the control plot on 7/21 may have been due to sampling error. By sampling at only two locations in each plot, it is possible that the samples were not representative of the field. Kansas State University recommends scouting should be done by taking five random samples of 20 consecutive plants for every 40 to 50 acres (Calvin, et. al, 1984). On 8/1/96 the numbers of egg masses were more uniform, as would be expected. (Fig. 1)

Control in the ECB resistant corn was very good. Only 3 percent of the plants were lodged. Some of that damage may have been due to SWCB because there were live Southwestern larvae found tunneling in the stalks on 8/30/96. Although the control plot had only 1 percent lodged stalks, the results are not conclusive to which of the two species of cornborer was responsible for the damage. This data shows that Bt corn provides control of ECB that is comparable to chemicals. One thing to remember about this particular Bt hybrid is that resistance only occurs in the green tissue and in the pollen. So as the plant tissue begins to die, the resistance is less effective.

Both hybrids were new on the market for 1996. The control plot yielded 190 bushels per acre, whereas the ECB hybrid only yielded 180 bushels per acre. Having a difference of 10 bushels per acre between the two hybrids may not be completely due to the difference of 2 percent in lodging. The control plot has produced slightly higher corn yields in the past. This could be due to the topography of the field, and the fact that water stands in a portion of the field, which is a limiting factor in producing corn.

There are many things to consider when deciding between planting a Bt hybrid or using chemicals to control ECB. Economics is probably the most important one. Some corn producers will choose to plant a non-Bt hybrid, and then wait until ECB are present in the field, and then spray. This requires many hours of intensive scouting. Other producers will choose to plant a Bt hybrid corn. Chemical control (Pounce 3.2 EC, 8oz. per acre) for corn borer will cost about $15.10 per acre (Schlender, 1997). The cost of a Bt hybrid is about $120.00 a bag, compared to $100.00 a bag for a non-Bt hybrid (Hill, 1997). A bag usually covers three acres, so for about $7.00 per acre the Bt hybrid can be less expensive than chemicals.

Bacillus thuringiensis (Bt) corn could very well become a wide spread tool for control against ECB.

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