Management of European corn borer with Bt corn hybrids in eastern Colorado.

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INTRODUCTION

Bt corn hybrids have been genetically modified to contain a toxin-producing gene derived from the common soil bacteria, *Bacillus thuringiensis*, that is commonly referred to as "Bt". The toxin is effective against European corn borer and southwestern corn borer, but not other corn pests such as western bean cutworm, western corn rootworm and spider mites. There are other Bt toxins that are effective against other pest insects. Bt toxin-producing genes also have been introduced into other crops such as cotton and potato. A detailed description of Bt corn hybrids and their development is available (Ostlie et al. 1997).

Bt corn hybrids became widely available for Colorado corn producers in 1998. We were interested in determining if the use of this hybrid trait is a sound decision for our production environment. To do this, we compared the agronomic performance of many of the Bt hybrids available in 1997 to non-Bt hybrids adapted to eastern Colorado. We also compared the European corn borer control efficacy of Bt corn hybrids to the current practice of properly scouted and timed insecticide applications. The results and conclusions in this report represent only a single crop year, in which European corn borer activity was greater than normal. They are intended to help decide whether to use Bt hybrids in your production system, but keep in mind that corn borer control is only one of many performance traits to consider when selecting a corn hybrid.

MATERIALS & METHODS

Bt and non-Bt corn hybrids were compared at the Irrigation Research Farm, Yuma, and the Dryden Farm, Wray. The hybrids tested are summarized in Table 1. The experiment was arranged in four replicates of a split-split plot design with insecticide treatment (treated or untreated for European corn borer) as the main plot, presence or absence of a Bt gene as the subplot, and hybrid as the sub-subplot. This experiment was planted at the Dryden Farm on 6 May 1997 and at the Irrigation Research Farm on 12 May 1997. Plot size was four rows by 26 ft. Planting was accomplished with a John Deere Maxi Merge 7000 planter equipped with Carter Manufacturing Company test plot finger units and a variable plant hydraulic drive system.

Table 1. Summary of Bt and non-Bt corn hybrids tested at Wray and Yuma, CO. 1997.

HYBRID	SEASON (DAYS)	INSERTION EVENT	PROTEIN	TRADENAME
CARGILL 5021BT	108	MON 810	CRY1Ab	YieldGard
CARGILL 6888NBT	111	---	---	---
CARGILL 6997	111	---	---	---
CARGILL 7770NBT	115	---	---	---
CARGILL 7821BT	115	MON 810	CRY1Ab	YieldGard
DEKALB 493BT	99	DBT418	CRY1Ac	Bt-Xtra
DEKALB 493NBT	99	---	---	---
DEKALB 566BT	106	DBT418	CRY1Ac	Bt-Xtra
DEKALB 566NBT	106	---	---	---
GOLDEN HARVEST 2390	102	---	---	---
GOLDEN HARVEST 2493	109	---	---	---
GOLDEN HARVEST H2390	102	MON 810	CRY1Ab	YieldGard
GOLDEN HARVEST H2493	109	MON 810	CRY1Ab	YieldGard
MIDWEST 0226	106	---	---	---
MIDWEST 7711	110	---	---	---
NOVARTIS 4306	105	---	---	---
NOVARTIS 6800BT	112	Bt11	CRY1Ab	YieldGard
NOVARTIS N4242	100	---	---	---

Table 1. (Continued)

NOVARTIS N4640	103	---	---	---
NOVARTIS N4640BT	104	Bt11	CRY1Ab	YieldGard
NOVARTIS N53-M1	107	176	CRY1Ab	KnockOut
NOVARTIS N64-Z4	110	176	CRY1Ab	KnockOut
NOVARTIS N69-C4	111	176	CRY1Ab	KnockOut
NOVARTIS N7070BT	114	Bt11	CRY1Ab	YieldGard
NOVARTIS NK4215	100	---	---	---
NOVARTIS NK6696	112	---	---	---
NOVARTIS W7070	113	---	---	---
PIONEER 3394	110	---	---	---
PIONEER 3417	108	---	---	---
PIONEER 33A14	113	MON 810	CRY1Ab	YieldGard
PIONEER 34R06	109	MON 810	CRY1Ab	YieldGard
PIONEER 35N05	105	MON 810	CRY1Ab	YieldGard
PIONEER 36K27	102	MON 810	CRY1Ab	YieldGard

The Dryden Farm experiment was located within a 138-acre, sprinkler-irrigated field planted to Pioneer 3417 on 5 May 1997. The planting date was planned to enhance the occurrence of a natural infestation of 1st generation European corn borer. The remaining fields within a 1 mile radius were planted after 7 May 1997. The Irrigated Research Farm experiment was the last corn planted at this location in order to encourage a natural infestation of 2nd generation European corn borer. Field histories for both Dryden Farm and the Irrigated Research Farm are summarized in Table 2.

Table 2. Field histories of Dryden Farm, Wray, CO and the Irrigated Research Farm, Yuma, CO.

	Irrigated Research Farm	**Dryden Farm**
Soil Type	Sandy Loam	Sandy Loam
pH	6.7	6.8
OM (%)	0.80	0.75
Starter Fertilizer	18 gal./A 8-20-5-5.5	33 gal/A 8-26-5
Nitrogen	212 lb/acre	210 lb/acre
Irrigation	16.5 inches	NA
Precipitation	9.4 inches	NA
Herbicide	Bullet 5qt/acre	Bicep II Light 2.4 qt/acre, Accent 1/3 oz/acre
Crop History	Corn in 1996	Corn for 10 years

At the Dryden Farm, chemigation applications were made with a Milton Roy Model B pump. The Lockwood sprinkler was equipped with 360° Senninger nozzles above canopy. Treatments were applied in 0.30 inches irrigation water per acre and insecticides were diluted with water to allow a 0.28 gal/acre volume of chemigated material. First generation European corn borer was treated by chemigating permethrin (Pounce 3.2E®) at 0.15 lb (AI)/acre on 11 July 1997. At this time, the infestation in the untreated, non-Bt hybrids

averaged 5% to 30% symptomatic plants and 1.2 live larvae per symptomatic plant. Second generation European corn borer was treated by chemigating lambda cyhalothrin (Warrior 1E®) at 0.03 lb (AI)/acre on 14 August 1997. On 11 August 1997 the untreated non-Bt hybrids had an accumulated egg mass count of 30%. On the day of treatment 80% of these egg masses were at the blackhead stage or hatched but no live larvae were found in the ear tips.

The Irrigated Research Farm chemigation application was made with a Milton Roy Model B pump. The Valley sprinkler was equipped with 360E Senninger nozzles on drops in canopy (six ft above ground level). The application was applied in 0.5 inch irrigation water per acre and the insecticide was diluted with water to allow a 0.5 gal/acre volume of chemigated material. Banks grass mite and 2nd generation European corn borer were controlled with chemigated bifenthrin (Capture 2E®) at 0.08 lb (AI)/acre on 18 August 1997. At this time, mites were present on the middle 1/3 of the leaves and one or two lower leaves were dying back. Also, the European corn borer infestation had an accumulated egg mass count of 28 % and 90% of the eggs were hatched or at the blackhead stage.

First generation European corn borer was evaluated on 13 & 14 August 1997 by splitting five consecutive plants in each sub-subplot and recording the total number of 5th instar larvae, pupae, and complete cavities with pupal case fragments. In addition, the percentage of symptomatic plants was determined for 25 consecutive plants per sub-subplot.

On 27 August 1997 western bean cutworm was evaluated in the untreated main plots at Dryden Farm by counting the larvae present in 50 ears per sub-subplot. Also, the instar of each larva was estimated. The treated main plots were not evaluated because the insecticide treatment for 1st generation European corn borer also controlled western bean cutworm due to the unusually late 1st generation flight (Figure 1). Western bean cutworm infested less than 1% of the ears at the Irrigated Research Farm so no evaluation was made at this location.

Second generation European corn borer, stalk rot and Banks grass mite were evaluated on 22-24 September 1997. Five consecutive plants per sub-subplot at Dryden Farm and 10 consecutive plants per plot at the Irrigated Research Farm were split from the flag leaf to the first node above ground. The shank was split and the ear tip was cut off. Larvae and pupae were recorded by their position on the plant (ear tip, ear shank, stalk above ear and stalk below ear). Stalk rot was rated by counting the number of discolored nodes (1-6). Banks grass mite infestations were evaluated at the Irrigated Research Farm in the untreated main plot by recording the number of mite-infested leaves, the number of leaves killed by mites, number of mite predators on mite-infested leaves on five consecutive plants per sub-subplot. Adults, nymphs and larvae of the following predators were observed: predatory mites (primarily *Amblyseius fallacis* (Garman)), lady beetles (primarily *Stethorus spp.*), insidious flower bug, *Orius insidiosus* (Say), and lacewings, *Chrysopa spp..*

Yields were determined at the Dryden Farm and the Irrigated Research Farm on 23 October 1997 and 31 October 1997, respectively. The two center rows of each sub-subplot were harvested with a John Deere 6600 four row combine equipped with a Carter Manufacturing Company scale, moisture tester, and test weight device. Harvested row length was hand measured and pivot wheel track skips were individually measured and subtracted from the total. Plant population was determined by counting the number of plants in 1/1000th acre. Test weight and moisture was determined per plot and grain yields converted to bu/acre at 15.5% moisture.

The gross value was based on corn valued at $2.57 per bushel. The net value was determined by subtracting the average premium paid for Bt corn ($14.67 per acre) from the gross values for sub-subplot yields for Bt hybrids and subtracting the cost of the insecticide (Dryden Farm, two applications = $17.01 per

acre; Irrigated Research Farm, one application = $18.48 per acre) from the gross values for sub-subplot yields of treated Bt and non-Bt hybrids at both locations.

Risk of European corn borer was estimated by summarizing light trap and field scouting observations for nine locations in eastern Colorado. Average weekly light trap catches were graphed and grouped into one of three risk categories.

RESULTS AND DISCUSSION

Complete analyses and all means are found in tables B1 - B14 in Appendix B (Appendix B is not included the publication, because of its size, but is available at http://www.colostate.edu/Depts/AES/pubs.htm). European corn borer flights were higher than average at both locations (Figures 1 and 2). This has allowed us to get some insight into the damage caused by European corn borer and the effectiveness and potential value of Bt corn hybrids as a European corn borer management tool.

Control of 1st generation European corn borer at Wray and Yuma is summarized over events (Table 1) in Figures 3 and 4. Keep in mind that events are not equally represented (Table 1) so some averages may not provide a realistic picture of that event's effectiveness. All events and the insecticide-treated non-Bt hybrids had similar levels of control compared to untreated, non-Bt hybrids. First generation European corn borer activity at Yuma was not sufficient to justify an insecticide treatment. Levels of 1st generation European corn borer larvae per plant were similar for all events and for the non-Bt hybrids.

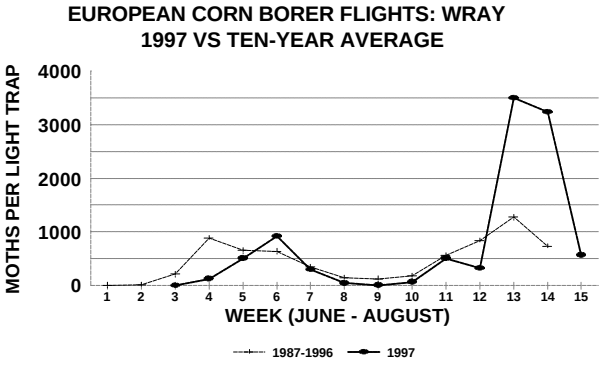

Figure 1. European corn borer light trap catches at Wray, CO in 1997 compared to the 1987-1996 average.

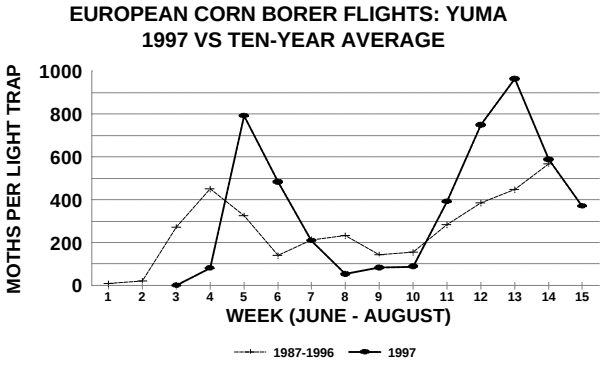

Figure 2. European corn borer light trap catches at Yuma, CO in 1997 compared to the 1987-1996 average.

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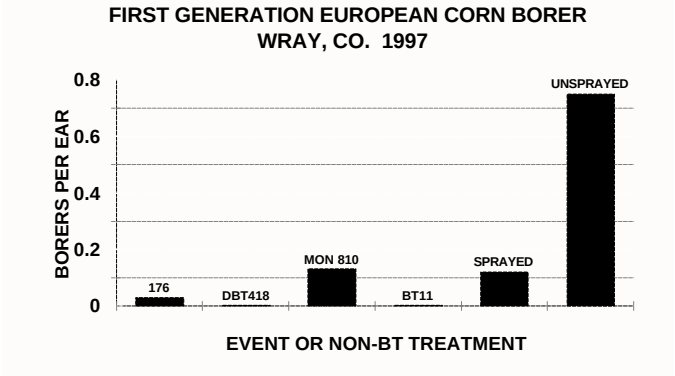

Figure 3. Control of 1st generation European corn borer, with untreated Bt corn hybrids summarized by event and compared to untreated non-Bt hybrids. Wray, CO. 1997.

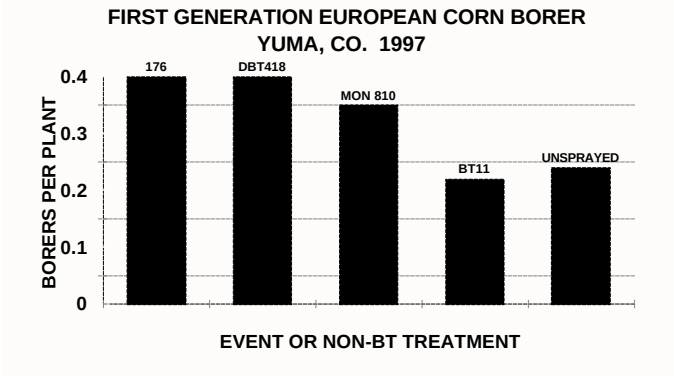

Figure 4. Control of 1st generation European corn borer, with untreated Bt corn hybrids summarized by event and compared to untreated non-Bt hybrids. Yuma, CO. 1997.

Control of 1st generation European corn borer at Wray averaged 91% over all Bt corn hybrids and 83% with the conventional chemigated insecticide treatment (0.15 lb (AI)/acre Pounce 3.2E) in the non-Bt hybrids. This compares favorably with our historical control data (Table 3).

Table 3. Control of 1st generation European corn borer in eastern Colorado: 1982 - 1997.

PRODUCT	AMOUNT PER ACRE	METHOD*	% CONTROL**
Dipel 10 G	10.00	A	66 (4)
Dipel 10 G	10.00	C	84 (2)
Dipel ES	1 qt + Oil	I	91 (4)
Lorsban 15G	1.00 (AI)	A	81 (4)
Lorsban 15G	1.00 (AI)	C	80 (6)
Pounce 3.2E	0.15 (AI)	I	88 (9)
Pounce 1.5G	0.15 (AI)	A	75 (8)
Thimet 20G	1.00 (AI)	C	77 (4)
Thimet 20 G	1.00 (AI)	A	73 (3)
Warrior 1E	0.03 (AI)	I	89 (3)

*A, aerially-applied; C, cultivator; I, insectigated (chemigated).
**Number in ( ) indicates number of tests comprising average.

Control of 2nd generation European corn borer in the ear zone was similar for both Bt corn events and for insecticide-protected non-Bt hybrids at both locations (Figures 5 and 6). Overall 2nd generation European corn borer control followed a similar pattern (Figures 7 and 8). Control of 2nd generation European corn borer at Wray also averaged 91% over all Bt corn hybrids compared with 83% for the conventional chemigated insecticide treatment (0.03 lb (AI)/acre Warrior 1E) in the non-Bt hybrids. These figures at Yuma were 89% and 67% for the Bt corn hybrids and the conventional chemigated insecticide treatment (0.08 lb (AI)/acre Capture 2E), respectively. These levels of control also compare favorably to our long-term observations (Table 4).

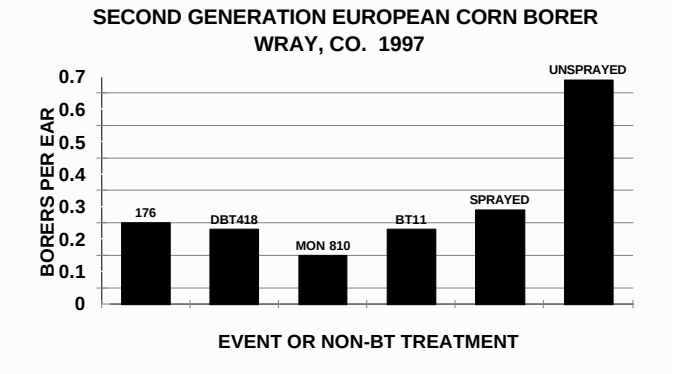

Figure 5. Control of 2nd generation European corn borer in the ear zone, with untreated Bt corn hybrids summarized by event and non-Bt hybrids summarized by insecticide treatment. Wray, CO. 1997.

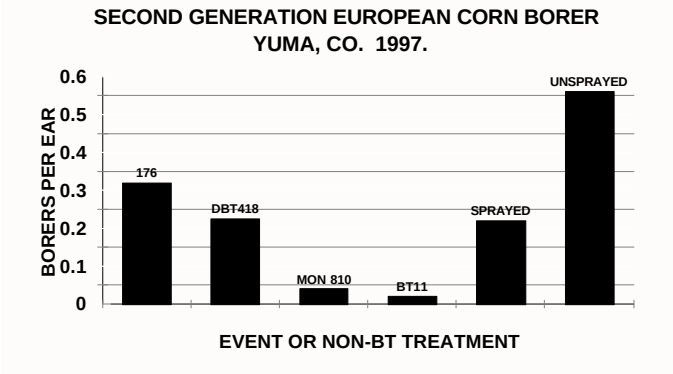

Figure 6. Control of 2nd generation European corn borer in the ear zone, with untreated Bt corn hybrids summarized by event and non-Bt hybrids summarized by insecticide treatment. Yuma, CO. 1997.

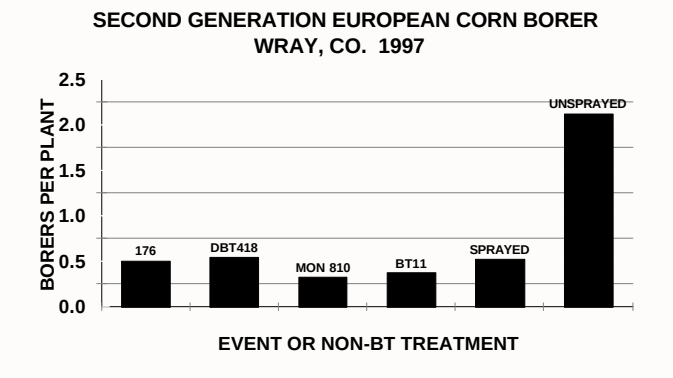

Figure 7. Control of 2nd generation European corn borer, with untreated Bt corn hybrids summarized by event and non-Bt hybrids summarized by insecticide treatment. Wray, CO. 1997.

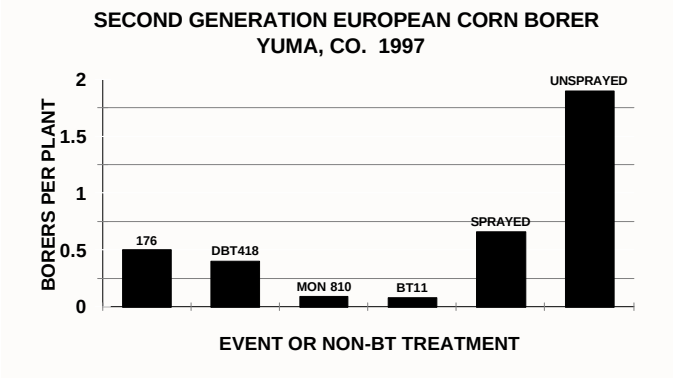

Figure 8. Control of 2nd generation European corn borer, with untreated Bt corn hybrids summarized by event and non-Bt hybrids summarized by insecticide treatment. Yuma, CO. 1997.

Table 4. Control of 2nd generation European corn borer in eastern Colorado: 1982 - 1997.

PRODUCT	AMOUNT PER ACRE	METHOD*	% CONTROL**
Dipel ES	1qt	I	50 (7)
Capture 2E**	0.08 (AI)	A	85 (8)
Capture 2E**	0.08 (AI)	I	87 (12)
Furadan 4F	1.00 (AI)	A	62 (6)
Lorsban 4E	1.00 (AI)	A	41 (6)
Lorsban 4E	1.00 (AI) + 1qt oil	I	72 (14)
Penncap M	1.00 (AI)	A	74 (7)
Penncap M	1.00 (AI)	I	74 (8)
Pounce 3.2E	0.15 (AI)	I	75 (9)
Warrior 1E	0.03 (AI)	A	80 (2)

*A, aerially-applied; C, cultivator; I, insectigated (chemigated).
**Number in ( ) indicates number of tests comprising average.

Western bean cutworm infestations were present at the Wray location and are summarized in Figure 9. This pattern is different from that observed with European corn borer in that Bt corn hybrids had no effect on

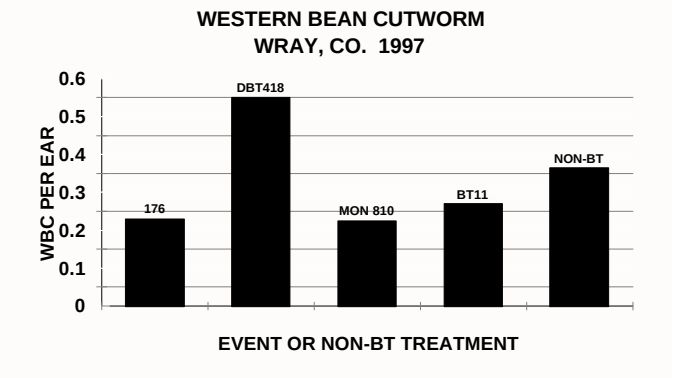

Figure 9. Western bean cutworm infestations with untreated Bt corn hybrids summarized by event and compared with all untreated non-Bt hybrids. Wray, CO. 1997.

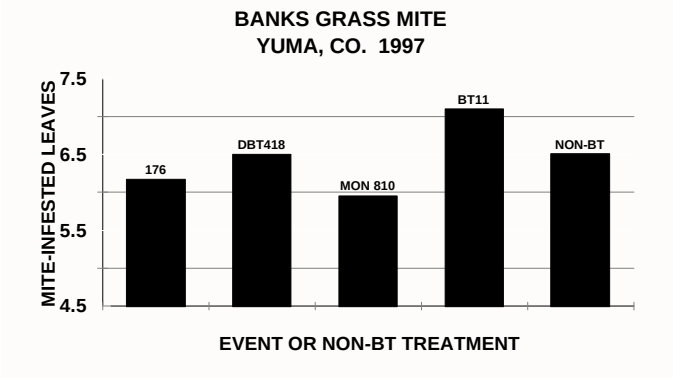

Figure 10. Banks grass mite infestations with untreated Bt corn hybrids summarized by event and compared with all non-Bt hybrids. Yuma, CO. 1997.

western bean cutworm counts. There was a small Bt-corn hybrid effect on western bean cutworm size (Table A7). Growers using Bt corn hybrids will need to scout for this pest and treat if necessary.

Banks grass mite infested the experiment at the Yuma location with a pattern similar to that shown by western bean cutworm (Figure 10). Untreated Bt corn hybrids had mite infestations levels similar to those observed in untreated non-Bt corn hybrids. Corn producers using Bt corn hybrids will need to scout for spider mites and treat for this pest if necessary.

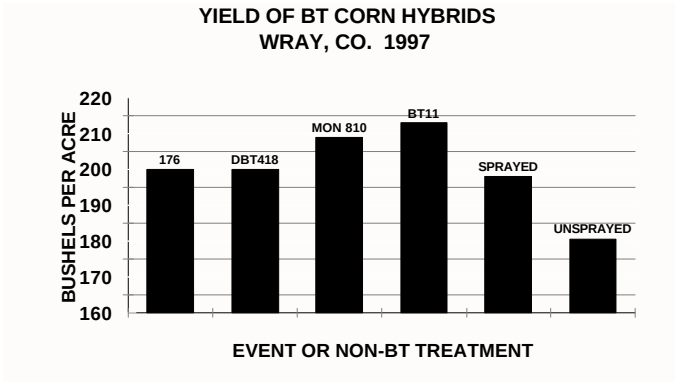

Figure 11. Yields of Bt corn hybrids, with untreated Bt corn hybrids summarized by event and non-Bt hybrids summarized by insecticide treatment. Wray, CO. 1997.

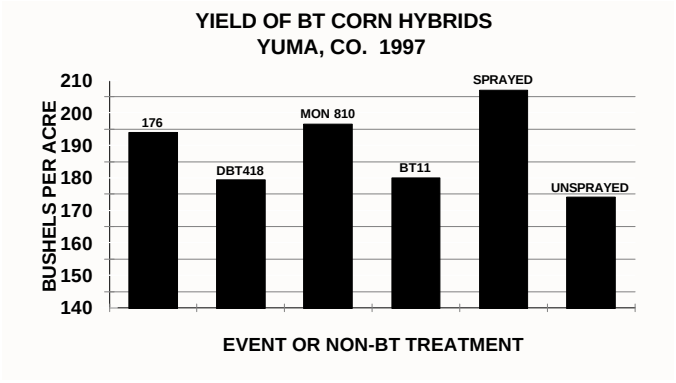

Figure 12. Yields of Bt corn hybrids, with untreated Bt corn hybrids summarized by event and non-Bt hybrids summarized by insecticide treatment. Yuma, CO. 1997.

The pattern for yields was similar to that for control of 2nd generation European corn borer at both locations (Figures 11 and 12). Untreated Bt corn hybrids had yields that were similar to those for insecticide-protected non-Bt hybrids and greater than those for unprotected non-Bt hybrids.

We also separated out 7 near isoline pairs (pairs of corn hybrids that can be distinguished genetically only by the presence of the Bt gene) to get a more accurate comparison of yields. The pairs were Dekalb 493/493Bt, DeKalb 566/566Bt, Golden Harvest 2390/H2390, Golden Harvest 2493/H2493, Novartis N4640/N4640Bt, Novartis W7070/N7070Bt, and Pioneer 3394/34R06. At Wray, the treated and untreated yield pattern for the near isoline pairs was similar to that for the overall experiment (Figure 13). Treated Bt corn hybrids had yields similar to untreated Bt hybrids and untreated non-Bt hybrids yielded less than treated non-Bt hybrids and treated or untreated Bt hybrids. Net returns at Wray (Figure 15) indicated that either untreated Bt corn and treated non-Bt corn were similarly profitable. At Yuma, however, treated Bt corn hybrids yielded more than the untreated Bt hybrids and the untreated non-Bt hybrids yielded less than any of the other three groups (Figure 14). We attribute the 13% yield difference between all treated and all untreated Bt hybrids (Table A11) to the Banks grass mite infestation. The yield differences for the untreated non-Bt hybrids compared to the other three groups is a combination of Banks grass mite and 2nd generation European corn borer losses. Because of the mite activity at Yuma, the greatest net returns were for the treated Bt and non-Bt hybrids (Figure 1 6).

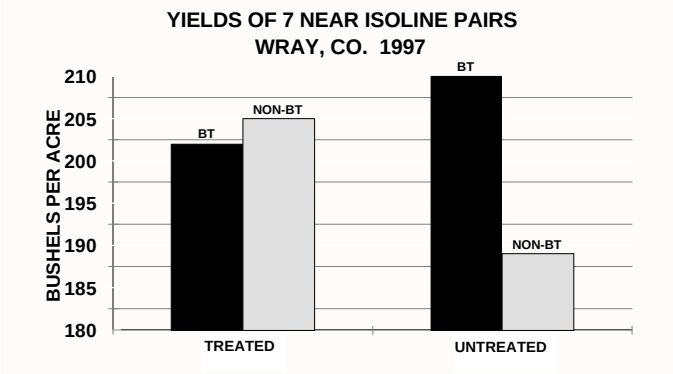

Figure 13. Treated and untreated yields for 7 near isoline pairs of Bt and non-Bt corn hybrids. Wray, CO. 1997.

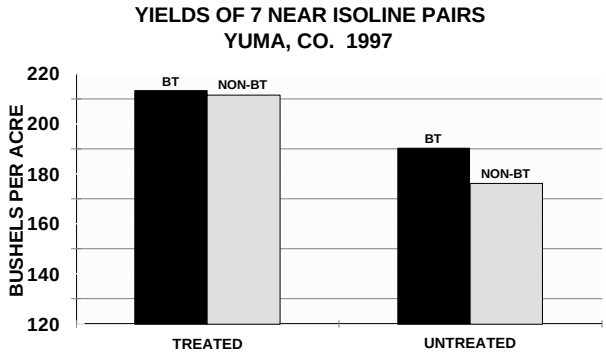

Figure 14. Treated and untreated yields for 7 near isoline pairs of Bt and non-Bt corn hybrids. Yuma, CO. 1997.

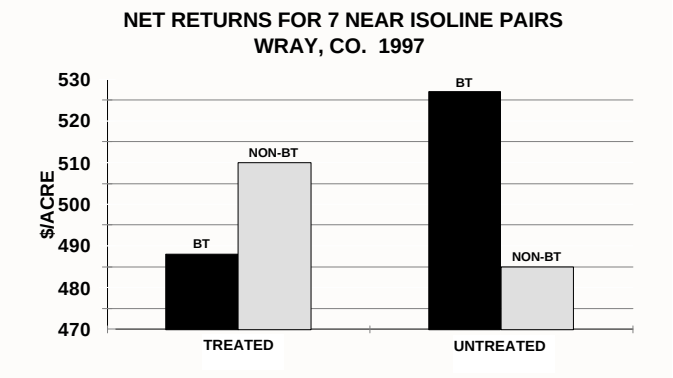

Figure 15. Net returns for 7 near isoline pairs of Bt and non-Bt corn hybrids. Wray, CO. 1997.

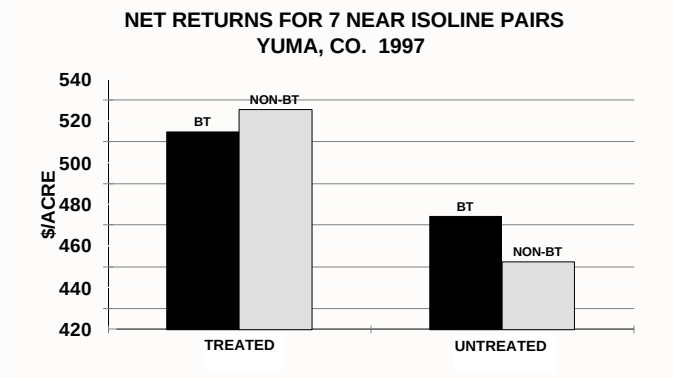

Figure 16. Net returns for 7 near isoline pairs of Bt and non-Bt corn hybrids. Yuma, CO. 1997.

Overall, yield losses to European corn borer averaged 3.0 to 3.5% per borer per plant at Wray and 3.5 to 4.0% at Yuma. Approximately 1/3 of the loss at Wray was attributable to 1st generation damage. These per borer losses are consistent with other reports for infestations at late whorl and after pollen shed (Mason et al. 1996).

Unreplicated strip tests also were conducted with Bt and non-Bt corn hybrids in 1997 and 1998. These are not discussed here, but are presented in Appendices C and D (available only at http://www.colostate.edu/Depts/AES/pubs.htm). The results of the strip tests generally agreed with those reported here.

The average yield protection provided by Bt corn hybrids was of greater value than the average per acre premium of the materials tested in this experiment. This might not be true in an average corn borer year at these locations (Figures 1 and 2) and in any year in other parts of eastern Colorado. The historic information from nine light traps and associated field scouting records for the past 11 years (Figures A1 - A9, Appendix A) help define three regional risk zones for economic infestations of 1st and 2nd generation European corn borer. Each zone has an optimum European corn borer management strategy regarding the use of Bt corn hybrids and insecticides.

Soil type has a significant effect on European corn borer risk. Heavy soil areas are more likely to have the most field-to-field differences in crop maturity due to rain-related planting delays. Relatively mature (early planted) corn crops will be preferred by 1st generation European corn borer, while relatively immature (late planted) crops will be preferred by 2nd generation European corn borer. In light soil areas planting operations are less likely to be delayed significantly by rain and planting is usually completed in a relatively short period of time. Thus, European corn borer are less likely to show much preference for one planting date over another based on relative maturity in a light soil area unless there are a lot of maturity differences among the corn hybrids being grown.

Zone 1 (Burlington, Bonny Dam, Kirk) is characterized by heavy soils and consistently low light trap catches (Figures B4, B5, B6). Areas in this zone generally are not expected to have economic European corn borer infestations, although growers in the Kirk area experience occasional problems. Growers in Zone 1 should select well-adapted non-Bt corn hybrids, scout for insect pest problems and apply appropriate insecticides if justified. The exception might be the Kirk area because it has a long (4 to 5 week) 2nd generation flight (Figure B6) in some years, increasing the probability that late planted or late maturing varieties will experience economic infestation. Bt corn hybrids might be an appropriate choice for these situations.

Zone 2 (Yuma, Clarkville, Holyoke) has a high probability of late planting or late maturing varieties due to heavy soils. These areas also have a consistent history of a prolonged second generation flight that result in economic infestations (Figures B7, B8 and B9). The Bt trait would be an appropriate choice for late planted

or late maturing hybrids in these areas. The prolonged flight makes treatment decisions very difficult. The infestations accumulated over the season are economically significant, but not enough of the infestation occurs in any two week period to justify the use of an insecticide. The first generation flight is consistent enough in these areas that Bt hybrids might also be considered for early planting situations. Although there is not a consistent need for Bt hybrids in this zone, it will be important to consider resistance management requirements when selecting hybrids and their acreage allocation.

Zone 3 (Eckley, Wray, Wauneta) is characterized by light soils, relatively uniform crop maturity, and consistently large 1st and 2nd generation European corn borer flights (Figures B1, B2, and B3). Also, 2nd generation flights typically extend over long periods of time. Economic infestations from either generation are likely and often both generations have to be treated in the same field. In addition, it frequently has been difficult to obtain adequate second generation control with a single insecticide application. The use of Bt corn hybrids are recommended for this area, regardless of planting date or maturity.

In spite of this general recommendation, it may still be necessary to plant some not-Bt hybrids in this zone because of resistance management requirements. Corn Belt recommendations (Ostlie et al. 1997) are to plant non-Bt hybrids (20 - 30% of the total acres if no spraying is expected and 40% if the crop likely will be treated) to reduce the likelihood that European corn borer will become resistant to Bt corn. Seed corn companies and the Environmental Protection Agency also are developing specific resistance management requirements for their products that are expected to be similar to the Ostlie et al. (1997) recommendation.

CONCLUSIONS

1. The use of Bt hybrids is a profitable and effective approach to European corn borer management in years of heavy corn borer activity and in areas with consistent year-to-year corn borer activity. However, the use of non-Bt hybrids managed with insect scouting and properly timed insecticide applications also was a profitable and effective approach to European corn borer management in these experiments.

2. The most likely zone in eastern Colorado for profitable use of Bt corn hybrids is the Eckley-Wray-Wuaneta area. These hybrids are also a good choice for late-planted or late maturing crops in the Yuma-Clarkville-Holyoke area.

3. Superior non-Bt hybrids combined with properly scouted and timed insecticide applications may be a more economically sound pest management approach in areas with less consistent European corn borer activity such as the Burlington-Bonny Dam-Kirk area.

4. Secondary pest management benefits, such as control of western bean cutworm and western corn rootworm adults, associated with European corn borer treatments will not be realized on untreated Bt corn hybrids. Bt hybrids will have to be scouted for these pests and treated if necessary.

5. Untreated Bt hybrids may experience fewer insecticide-associated pest problems, particularly spider mite outbreaks; however this was not observed in this year's study.

REFERENCES CITED

Mason, C., M. Rice, D. Calvin, J. Van Duyn, W. Showers, W. Hutchinson, J. Witkowski, R. Higgins, D. Onstad, and G. Dively. 1996. European corn borer ecology and management. North Central Regional Extension Publication 327. Iowa State University, Ames, IA.

Ostlie, K., W. Hutchison, and R. Hellmich. 1997. Bt corn and European corn borer. North Central Regional Extension Publication 602. University of Minnesota, St. Paul, MN.

APPENDIX A

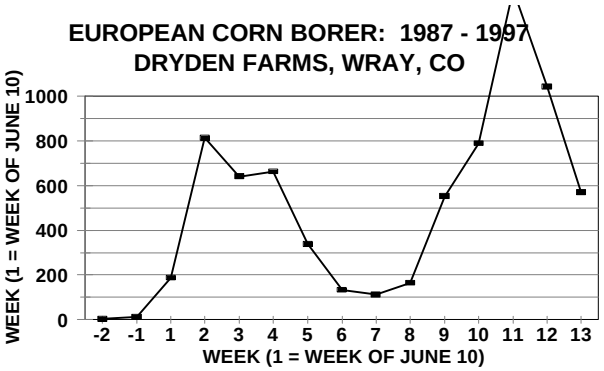

Figure A1. 11-year average flight of European corn borer (ECB) at Wray, CO, a light-soil area with consistently economic ECB infestations.

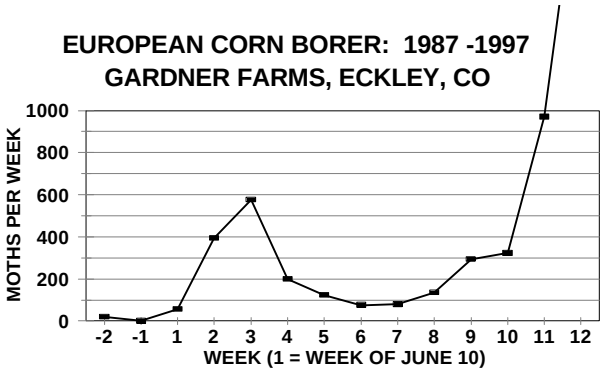

Figure A2. 11-year average flight of European corn borer (ECB) at Eckley, CO, a light-soil area with consistently economic ECB infestations.

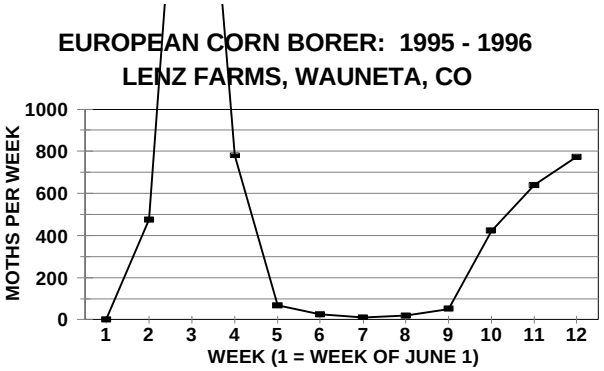

Figure A3. 1995 - 1996 average flight of European corn borer (ECB) at Wuaneta, CO, a light-soil area with consistently economic ECB infestations.

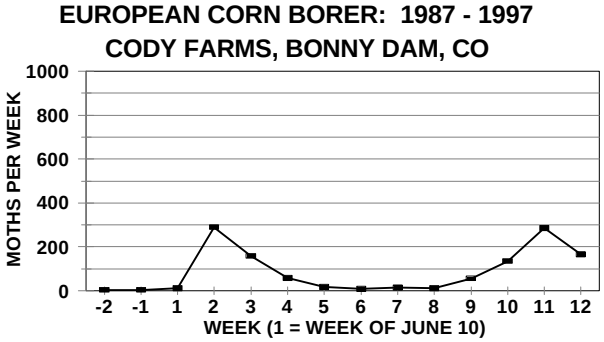

Figure A4. 11-year average flight of European corn borer (ECB) , Bonny Dam, CO, a heavy-soil area with consistently noneconomic ECB infestations.

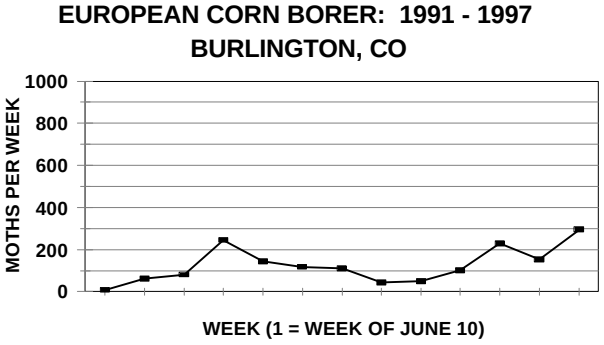

Figure A5. 11-year average flight of European corn borer (ECB) , Burlington, CO, a heavy-soil area with consistently noneconomic ECB infestations.

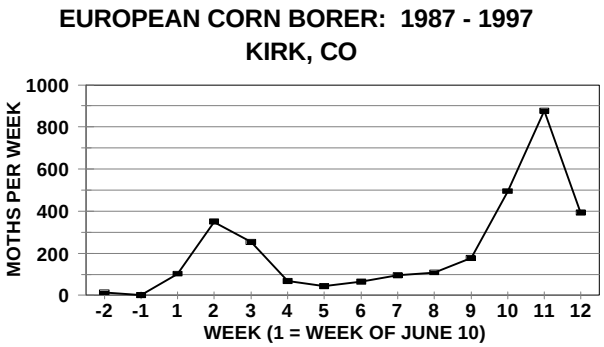

Figure A6. 11-year average flight of European corn borer (ECB) , Kirk, CO, a heavy-soil area with occasional economic ECB infestations in late-planted and late-maturing corn.

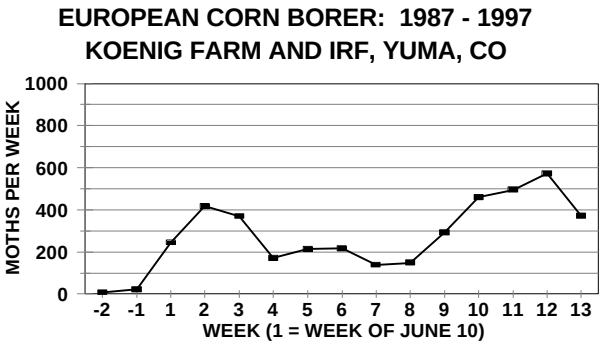

Figure A7. 11-year average flight of European corn borer (ECB) , Yuma, CO, a heavy-soil area with consistently economic ECB infestations in late-planted and late-maturing corn.

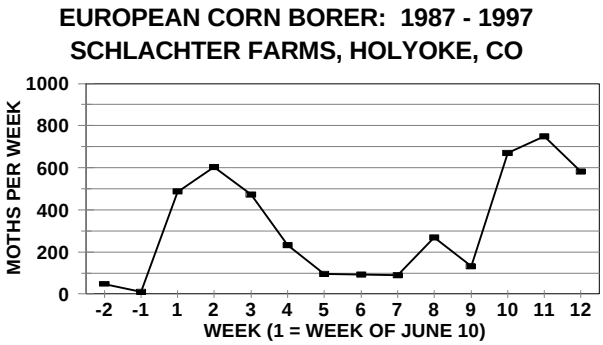

Figure A8. 11-year average flight of European corn borer (ECB) , Holyoke, CO, a heavy-soil area with consistently economic ECB infestations in late-planted and late-maturing corn.

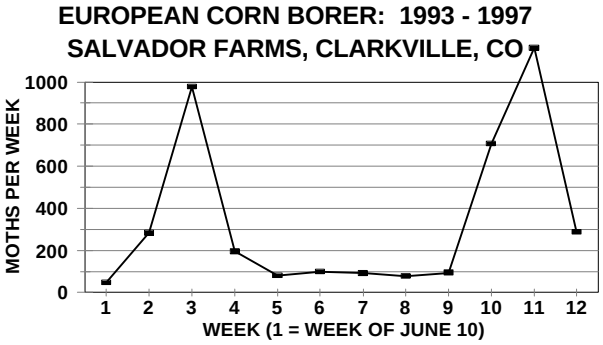

Figure A9. 5-year average flight of European corn borer (ECB) , Clarkville, CO, a heavy-soil area with consistently economic ECB infestations in late-planted and late-maturing corn.

TABLES AND STATISTICAL ANALYSES

Table B1. Control of first generation European corn borer with Bt hybrids and insecticides at Wray, CO. 1997.

	TOTAL 1ST		% SYMPTOMATIC	
	TREATED	UNTREATED	TREATED	UNTREATED
HYBRID		**BT HYBRIDS**		
CARGILL 5021BT	0.00	0.14	0.0	9.0
CARGILL 7821BT	0.00	0.17	0.0	9.3
DEKALB 493BT	0.00	0.27	0.0	14.3
DEKALB 566BT	0.00	0.00	3.0	3.0
GOLDEN HARVEST H2390	0.00	0.00	1.0	7.0
GOLDEN HARVEST H2493	0.00	0.00	1.0	3.0
NOVARTIS 6800BT	0.00	0.00	3.0	0.0
NOVARTIS N4640BT	0.10	0.00	6.0	4.0
NOVARTIS N53-M1	0.00	0.00	0.0	9.3
NOVARTIS N64-Z4	0.00	0.00	1.0	3.0
NOVARTIS N69-C4	0.00	0.10	1.0	2.0
NOVARTIS N7070BT	0.05	0.00	8.0	2.0
PIONEER 33A14	0.00	0.22	1.0	4.0
PIONEER 34R06	0.00	0.10	7.0	3.0
PIONEER 35N05	0.05	0.00	2.0	0.0
PIONEER 36K27	0.00	0.00	4.0	8.0
		NON-BT HYBRIDS		
CARGILL 6888	0.05	0.00	29.8	1.0
CARGILL 7770	0.05	0.85	21.0	51.5
DEKALB 493	0.00	0.59	14.0	43.0
DEKALB 566	0.23	0.67	15.0	28.5
GOLDEN HARVEST 2390	0.09	0.56	36.3	24.5
GOLDEN HARVEST 2493	0.27	1.33	22.8	34.2
MIDWEST 0226	0.18	0.95	24.5	58.0
MIDWEST 7711	0.05	0.37	25.5	42.8
NOVARTIS 4306	0.10	1.18	17.2	44.3
NOVARTIS N4242	0.26	0.86	25.3	25.7
NOVARTIS 4640	0.10	0.56	20.3	30.0
NOVARTIS NK4215	0.18	0.85	29.2	36.3
NOVARTIS NK6696	0.00	0.05	0.0	0.0
NOVARTIS W7070	0.05	0.76	38.2	38.3
PIONEER 3394	0.00	1.03	22.3	52.5

Table B1. (Continued)

	TOTAL 1ST	% SYMPTOMATIC
CV (%)	18.5	73.8
F value	1.47	2.26
p value	0.1196	0.0061
LSD0.05 (Any hybrid to any hybrid)	NS	73.1
	AVERAGES	
Treated	0.06	12.5
Untreated	0.38	19.4
F value	33.84	24.89
p value	0.0101	0.0155
LSD0.05	0.41	44.5
All Bt hybrids	0.04	3.7
All non-Bt hybrids	0.41	28.2
F value	86.82	590.94
p value	0.0001	<0.0001
LSD0.05	0.2	29.2
All treated Bt hybrids	0.02	2.4
All treated non-Bt hybrids	0.11	22.6
All untreated Bt hybrids	0.06	5.0
All untreated non-Bt hybrids	0.66	33.8
F value	41.62	17.88
p value	0.0007	0.0055
LSD0.05	0.25	34.8

Table B2. Control of first generation European corn borer with Bt hybrids at Yuma, CO. 1997.

	TOTAL 1ST	% SYMPTOMATIC
	BT HYBRIDS	
CARGILL 7821BT	0.00	0.0
DEKALB 493BT	0.40	18.0
DEKALB 566BT	0.80	12.0
GOLDEN HARVEST H2390	0.15	14.0
GOLDEN HARVEST H2493	0.00	14.0
NOVARTIS 6800BT	0.10	11.0
NOVARTIS N4640BT	0.05	7.0
NOVARTIS N53-M1	1.00	14.5
NOVARTIS N64-Z4	0.20	12.5
NOVARTIS N69-C4	0.40	11.5
NOVARTIS N7070BT	0.30	6.0
PIONEER 33A14	0.60	7.0
PIONEER 34R06	0.75	14.0
PIONEER 35N05	0.45	9.0
PIONEER 36K27	0.45	9.0
	NON-BT HYBRIDS	
CARGILL 7770	0.60	13.5
DEKALB 493	0.10	15.5
DEKALB 566	0.65	5.0
GOLDEN HARVEST 2390	0.30	13.5
GOLDEN HARVEST 2493	0.20	9.5
MIDWEST 0226	0.20	16.5
MIDWEST 7711	0.05	3.5
NOVARTIS 4306	0.15	11.5
NOVARTIS N4242	0.10	14.5
NOVARTIS 4640	0.15	11.0
NOVARTIS NK4215	0.10	14.0
NOVARTIS NK6696	0.45	6.5
NOVARTIS W7070	0.05	15.5
PIONEER 3394	0.10	10.0
CV (%)	159.0	91.3
F value	0.90	1.07
p value	>0.5	0.3872
LSD0.05 (Any hybrid to any hybrid)	NS	NS
	AVERAGES	
All Bt hybrids	0.38	10.6
All non-Bt hybrids	0.22	11.4
F value	0.28	0.02
p value	>0.5	>0.5
LSD0.05	NS	NS

Table B3. Control of second generation European corn borer, by position on plant, with Bt hybrids and insecticides at Wray, CO. 1997.

	EAR TIP		EAR SHANK		ABOVE EAR		BELOW EAR	
	TREATED	UNTREATED	TREATED	UNTREATED	TREATED	UNTREATED	TREATED	UNTREATED
HYBRID				**BT HYBRIDS**				
CARGILL 5021BT	0.05	0.37	0.00	0.10	0.10	0.23	0.05	0.57
CARGILL 7821BT	0.00	0.05	0.05	0.00	0.00	0.00	0.17	0.05
DEKALB 493BT	0.05	0.29	0.10	0.13	0.05	0.10	0.22	0.29
DEKALB 566BT	0.10	0.00	0.00	0.00	0.05	0.24	0.05	0.10
GOLDEN HARVEST H2390	0.00	0.00	0.00	0.00	0.10	0.00	0.05	0.00
GOLDEN HARVEST H2493	0.00	0.05	0.13	0.00	0.10	0.00	0.13	0.05
NOVARTIS 6800BT	0.00	0.05	0.05	0.10	0.05	0.05	0.10	0.05
NOVARTIS N4640BT	0.10	0.17	0.00	0.14	0.05	0.10	0.29	0.13
NOVARTIS N53-M1	0.30	0.14	0.00	0.05	0.05	0.09	0.00	0.14
NOVARTIS N64-Z4	0.00	0.05	0.05	0.05	0.00	0.05	0.10	0.00
NOVARTIS N69-C4	0.24	0.35	0.14	0.09	0.00	0.09	0.14	0.33
NOVARTIS N7070BT	0.00	0.17	0.05	0.00	0.00	0.05	0.05	0.00
PIONEER 33A14	0.05	0.05	0.05	0.00	0.09	0.00	0.13	0.05
PIONEER 34R06	0.00	0.13	0.05	0.00	0.14	0.00	0.09	0.00
PIONEER 35N05	0.05	0.23	0.05	0.00	0.05	0.00	0.10	0.10
PIONEER 36K27	0.00	0.09	0.05	0.00	0.20	0.09	0.18	0.05
				NON-BT HYBRIDS				
CARGILL 6888	0.10	0.10	0.10	0.05	0.15	0.00	0.18	0.00
CARGILL 7770	0.05	0.35	0.10	0.05	0.05	0.05	0.30	0.10
DEKALB 493	0.36	0.30	0.09	0.35	0.05	0.62	0.34	0.05
DEKALB 566	0.34	0.14	0.10	0.25	0.10	0.49	0.13	0.00
GOLDEN HARVEST 2390	0.17	0.67	0.10	0.19	0.00	0.73	0.00	0.62
GOLDEN HARVEST 2493	0.00	0.20	0.30	0.20	0.05	0.31	0.21	0.95
MIDWEST 0226	0.00	0.43	0.14	0.05	0.00	0.69	0.09	0.59
MIDWEST 7711	0.10	0.43	0.14	0.30	0.00	0.29	0.14	1.12
NOVARTIS 4306	0.44	0.70	0.20	0.64	0.10	2.07	0.22	1.12
NOVARTIS N4242	0.10	0.20	0.10	0.38	0.10	0.27	0.35	1.04
NOVARTIS 4640	0.09	0.38	0.14	0.44	0.00	0.68	0.25	0.91
NOVARTIS NK4215	0.05	0.28	0.05	0.35	0.00	0.05	0.10	0.45
NOVARTIS NK6696	0.05	0.05	0.05	0.05	0.00	0.13	0.05	0.47
NOVARTIS W7070	0.44	0.68	0.14	0.27	0.09	0.20	0.14	1.24
PIONEER 3394	0.24	0.96	0.00	0.14	0.00	0.58	0.05	0.56

Table B3. (Continued)

	EAR TIP	EAR SHANK	ABOVE EAR	BELOW EAR
CV (%)	16.7	10.5	18.8	19.7
F value	1.16	2.10	2.40	2.72
p value	0.3026	0.0116	0.0035	0.0009
LSD0.05 (Any hybrid to any hybrid)	NS	0.37	0.68	0.79
		AVERAGES		
Treated	0.11	0.08	0.06	0.14
Untreated	0.25	0.14	0.27	0.36
F value	35.50	28.90	104.16	63.05
p value	0.0095	0.0126	0.0020	0.0042
LSD0.05	0.21	0.11	0.17	0.28
All Bt hybrids	0.10	0.05	0.07	0.11
All non-Bt hybrids	0.26	0.18	0.26	0.39
F value	18.99	21.79	62.41	70.14
p value	0.0048	0.0134	0.0002	0.0002
LSD0.05	0.20	0.15	0.11	0.19
All treated Bt hybrids	0.06	0.05	0.07	0.12
All treated non-Bt hybrids	0.16	0.11	0.04	0.17
All untreated Bt hybrids	0.13	0.04	0.07	0.11
All untreated non-Bt hybrids	0.37	0.25	0.44	0.78
F value	2.64	5.90	80.17	47.09
p value	0.1553	0.0512	0.0001	0.0005
LSD0.05	NS	NS	0.15	0.27

Table B4. Control of second generation European corn borer, by position on plant, with Bt hybrids and insecticides at Yuma, CO. 1997.

	EAR TIP		EAR SHANK		ABOVE EAR		BELOW EAR	
	TREATED	UNTREATED	TREATED	UNTREATED	TREATED	UNTREATED	TREATED	UNTREATED
HYBRID				**BT HYBRIDS**				
CARGILL 7821BT	0.00	0.05	0.00	0.00	0.00	0.00	0.00	0.00
DEKALB 493BT	0.20	0.15	0.05	0.05	0.00	0.05	0.00	0.25
DEKALB 566BT	0.05	0.15	0.00	0.10	0.00	0.00	0.00	0.05
GOLDEN HARVEST H2390	0.15	0.00	0.00	0.00	0.00	0.00	0.15	0.00
GOLDEN HARVEST H2493	0.00	0.05	0.00	0.00	0.00	0.05	0.05	0.05
NOVARTIS 6800BT	0.05	0.00	0.05	0.00	0.00	0.00	0.00	0.00
NOVARTIS N4640BT	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15
NOVARTIS N53-M1	0.15	0.00	0.00	0.05	0.05	0.05	0.05	0.05
NOVARTIS N64-Z4	0.35	0.35	0.00	0.10	0.00	0.15	0.00	0.10
NOVARTIS N69-C4	0.10	0.15	0.00	0.30	0.00	0.10	0.00	0.10
NOVARTIS N7070BT	0.00	0.05	0.00	0.00	0.00	0.00	0.05	0.05
PIONEER 33A14	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.10
PIONEER 34R06	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.10
PIONEER 35N05	0.05	0.05	0.00	0.00	0.00	0.00	0.00	0.10
PIONEER 36K27	0.00	0.00	0.00	0.10	0.00	0.00	0.15	0.00
				NON-BT HYBRIDS				
CARGILL 7770	0.05	0.35	0.00	0.30	0.00	0.40	0.50	1.05
DEKALB 493	0.25	0.20	0.00	0.30	0.05	0.40	0.85	1.45
DEKALB 566	0.25	0.05	0.10	0.25	0.05	0.10	0.20	0.70
GOLDEN HARVEST 2390	0.15	0.55	0.25	0.60	0.00	0.25	0.35	1.15
GOLDEN HARVEST 2493	0.05	0.25	0.00	0.10	0.00	0.25	0.35	1.25
MIDWEST 0226	0.35	0.15	0.00	0.15	0.05	0.45	0.25	1.05
MIDWEST 7711	0.15	0.30	0.00	0.15	0.00	0.20	0.10	0.75
NOVARTIS 4306	0.15	0.40	0.05	0.50	0.00	0.55	0.50	1.80
NOVARTIS N4242	0.20	0.20	0.05	0.45	0.00	0.25	0.65	1.15
NOVARTIS 4640	0.23	0.28	0.00	0.32	0.08	0.30	0.22	0.88
NOVARTIS NK4215	0.20	0.10	0.00	0.90	0.05	0.35	0.50	0.90
NOVARTIS NK6696	0.15	0.05	0.05	0.00	0.00	0.00	0.00	0.15
NOVARTIS W7070	0.15	0.15	0.00	0.10	0.00	0.10	0.40	1.30
PIONEER 3394	0.15	0.45	0.05	0.20	0.30	0.45	0.95	1.15

Table B4. (Continued)

	EAR TIP	EAR SHANK	ABOVE EAR	BELOW EAR
CV (%)	13.1	10.6	12.4	20.8
F value	1.41	2.05	0.68	0.74
p value	0.1529	0.0170	>0.5	>0.5
LSD0.05 (Any hybrid to any hybrid)	NS	0.37	NS	NS
		AVERAGES		
Treated	0.13	0.02	0.02	0.22
Untreated	0.15	0.17	0.15	0.55
F value	2.55	114.59	60.29	63.40
p value	0.2086	0.0017	0.0044	0.0041
LSD0.05	NS	0.06	0.07	0.14
All Bt hybrids	0.07	0.03	0.02	0.05
All non-Bt hybrids	0.21	0.17	0.17	0.73
F value	27.93	87.52	12.19	68.52
p value	0.0019	0.0001	0.0130	0.0002
LSD0.05	0.07	0.04	0.10	0.16
All treated Bt hybrids	0.08	0.01	0.00	0.03
All treated non-Bt hybrids	0.18	0.04	0.04	0.42
All untreated Bt hybrids	0.07	0.05	0.03	0.07
All untreated non-Bt hybrids	0.25	0.31	0.29	1.05
F value	1.81	52.54	6.66	11.95
p value	0.2277	0.0004	0.0418	0.0130
LSD0.05	NS	0.05	0.14	0.23

Table B5. Control of second generation European corn borer and stalk rot, with Bt hybrids and insecticides at Wray, CO. 1997.

	TOTAL 2ND		STALK ROT	
	TREATED	UNTREATED	TREATED	UNTREATED
HYBRID	**BT HYBRIDS**			
CARGILL 5021BT	0.20	1.24	0.37	0.05
CARGILL 7821BT	0.20	0.10	0.00	0.17
DEKALB 493BT	0.38	0.78	0.10	0.00
DEKALB 566BT	0.19	0.33	0.17	0.27
GOLDEN HARVEST H2390	0.15	0.00	0.18	0.05
GOLDEN HARVEST H2493	0.33	0.10	0.19	0.47
NOVARTIS 6800BT	0.18	0.23	0.09	0.10
NOVARTIS N4640BT	0.46	0.49	0.47	0.09
NOVARTIS N53-M1	0.35	0.42	0.14	0.13
NOVARTIS N64-Z4	0.14	0.14	0.14	0.36
NOVARTIS N69-C4	0.50	0.83	0.14	0.38
NOVARTIS N7070BT	0.09	0.22	0.19	0.00
PIONEER 33A14	0.27	0.10	0.24	0.05
PIONEER 34R06	0.26	0.13	0.39	0.09
PIONEER 35N05	0.23	0.33	0.14	0.14
PIONEER 36K27	0.42	0.24	0.23	0.05
	NON-BT HYBRIDS			
CARGILL 6888	0.54	0.14	0.05	0.00
CARGILL 7770	0.46	1.01	0.33	0.00
DEKALB 493	0.82	2.21	0.40	0.54
DEKALB 566	0.65	1.46	0.15	0.05
GOLDEN HARVEST 2390	0.28	2.79	0.20	0.88
GOLDEN HARVEST 2493	0.55	1.80	0.25	0.90
MIDWEST 0226	0.22	2.22	0.20	0.38
MIDWEST 7711	0.37	1.68	0.09	0.31
NOVARTIS 4306	0.99	4.90	0.10	0.29
NOVARTIS N4242	0.56	1.34	0.57	0.23
NOVARTIS N4640	0.48	2.41	0.32	0.27
NOVARTIS NK4215	0.18	1.22	0.09	0.17
NOVARTIS NK6696	0.14	0.64	0.00	0.05
NOVARTIS W7070	0.80	2.29	0.18	0.13
PIONEER 3394	0.30	3.37	0.00	0.30

Table B5. (Continued)

	TOTAL 2ND	STALK ROT
CV (%)	23.2	23.0
F value	3.52	1.50
p value	<0.0001	0.1083
LSD0.05 (Any hybrid to any hybrid)	1.14	NS
	AVERAGES	
Treated	0.37	0.20
Untreated	1.11	0.21
F value	174.86	0.05
p value	0.0009	>0.5
LSD0.05	0.32	NS
All Bt hybrids	0.30	0.17
All non-Bt hybrids	1.23	0.24
F value	51.45	4.21
p value	0.0004	0.0861
LSD0.05	0.43	NS
All treated Bt hybrids	0.27	0.20
All treated non-Bt hybrids	0.47	0.20
All untreated Bt hybrids	0.33	0.14
All untreated non-Bt hybrids	1.86	0.28
F value	25.08	4.21
p value	0.0024	0.0861
LSD0.05	0.61	NS

Table B6. Control of 2nd generation European corn borer and stalk rot, with Bt hybrids and insecticides at Yuma, CO. 1997.

	TOTAL 2ND		STALK ROT	
	TREATED	UNTREATED	TREATED	UNTREATED
HYBRID	**BT HYBRIDS**			
CARGILL 7821BT	0.00	0.05	0.15	0.07
DEKALB 493BT	0.25	0.50	0.21	0.18
DEKALB 566BT	0.05	0.30	0.33	0.39
GOLDEN HARVEST H2390	0.30	0.00	1.50	0.21
GOLDEN HARVEST H2493	0.05	0.15	0.80	0.59
NOVARTIS 6800BT	0.10	0.00	0.07	0.12
NOVARTIS N4640BT	0.00	0.15	0.27	0.47
NOVARTIS N53-M1	0.25	0.15	0.35	0.50
NOVARTIS N64-Z4	0.35	0.70	0.07	0.03
NOVARTIS N69-C4	0.10	0.65	0.16	0.17
NOVARTIS N7070BT	0.05	0.10	0.16	0.44
PIONEER 33A14	0.05	0.10	0.03	0.05
PIONEER 34R06	0.00	0.10	1.10	0.27
PIONEER 35N05	0.05	0.15	0.29	0.23
PIONEER 36K27	0.15			
CARGILL 7770	0.55	2.10	0.30	0.16
DEKALB 493	1.15	2.35	0.50	0.53
DEKALB 566	0.60	1.10	0.25	0.14
GOLDEN HARVEST 2390	0.75	2.55	0.90	1.06
GOLDEN HARVEST 2493	0.40	1.85	0.79	1.06
MIDWEST 0226	0.65	1.80	0.36	0.96
MIDWEST 7711	0.25	1.40	0.46	0.47
NOVARTIS 4306	0.70	3.25	0.51	0.90
NOVARTIS N4242	0.90	2.05	0.38	0.60
NOVARTIS 4640	0.53	1.78	1.24	1.15
NOVARTIS NK4215	0.75	2.25	0.94	1.39
NOVARTIS NK6696	0.20	0.20	0.03	0.09
NOVARTIS W7070	0.55	1.65	0.66	0.71
PIONEER 3394	1.45	2.25	0.50	0.23

Table B6. (Continued)

	TOTAL 2ND	STALK ROT
CV (%)	23.0	23.1
F value	1.12	0.91
p value	0.3409	>0.5
LSD0.05 (Any hybrid to any hybrid)	NS	NS
	AVERAGES	
Treated	0.39	0.47
Untreated	1.03	0.46
F value	74.29	0.19
p value	0.0033	>0.5
LSD0.05	0.21	NS
All Bt hybrids	0.17	0.33
All non-Bt hybrids	1.29	0.62
F value	71.87	29.42
p value	0.0001	0.0016
LSD0.05	0.23	0.23
All treated Bt hybrids	0.12	0.35
All treated non-Bt hybrids	0.67	0.52
All untreated Bt hybrids	0.21	0.27
All untreated non-Bt hybrids	1.90	0.67
F value	13.80	4.76
p value	0.0099	0.0718
LSD0.05	0.32	NS

Table B7. Western bean cutworm infestations in Bt and non-Bt hybrids at Wray, CO. 1997.

	WBC PER EAR	WBC INSTAR
	BT HYBRIDS	
CARGILL 5021BT	0.26	3.7
CARGILL 7821BT	0.26	4.0
DEKALB 493BT	0.30	3.9
DEKALB 566BT	0.82	4.5
GOLDEN HARVEST H2390	0.06	1.8
GOLDEN HARVEST H2493	0.19	3.9
NOVARTIS 6800BT	0.23	4.3
NOVARTIS N4640BT	0.25	4.4
NOVARTIS N53-M1	0.07	3.8
NOVARTIS N64-Z4	0.14	3.2
NOVARTIS N69-C4	0.42	3.3
NOVARTIS N7070BT	0.28	4.5
PIONEER 33A14	0.40	4.2
PIONEER 34R06	0.23	4.7
PIONEER 35N05	0.24	4.2
PIONEER 36K27	0.14	3.3
	NON-BT HYBRIDS	
CARGILL 6888	1.88	4.3
CARGILL 7770	0.58	4.2
DEKALB 493	0.18	4.9
DEKALB 566	0.37	4.4
GOLDEN HARVEST 2390	0.19	4.3
GOLDEN HARVEST 2493	0.40	4.4
MIDWEST 0226	0.54	4.4
MIDWEST 7711	0.47	3.9
NOVARTIS 4306	0.62	4.4
NOVARTIS N4242	0.11	3.6
NOVARTIS N4640	0.37	4.2
NOVARTIS NK4215	0.30	4.8
NOVARTIS NK6696	0.17	4.4
NOVARTIS W7070	0.29	3.4
PIONEER 3394	0.51	4.4
CV (%)	21.2	26.4
F value	2.02	1.02
p value	0.0170	0.4413
LSD0.05 (Any hybrid to any hybrid)	0.88	NS
	AVERAGES	
All Bt hybrids	0.26	3.9
All non-Bt hybrids	0.43	4.3
F value	2.09	17.34
p value	0.0174	0.0252
LSD0.05	0.34	1.4

Table B8. Banks grass mite infestations in Bt and non-Bt hybrids at Yuma, CO. 1997.

HYBRID	MITE-INFESTED LEAVES	MITE-KILLED LEAVES	MITE PREDATORS PER LEAF
		BT HYBRIDS	
CARGILL 7821BT	6.5	4.1	1.3
DEKALB 493BT	5.7	2.9	3.8
DEKALB 566BT	6.4	3.3	4.3
GOLDEN HARVEST H2390	6.1	2.5	4.8
GOLDEN HARVEST H2493	6.8	3.4	2.3
NOVARTIS 6800BT	7.4	4.4	11.0
NOVARTIS N4640BT	6.4	2.4	4.3
NOVARTIS N53-M1	6.3	3.5	3.0
NOVARTIS N64-Z4	5.8	3.1	0.8
NOVARTIS N69-C4	6.5	3.5	8.7
NOVARTIS N7070BT	7.6	4.1	7.3
PIONEER 33A14	6.0	3.2	5.0
PIONEER 34R06	5.9	3.2	3.0
PIONEER 35N05	4.8	2.2	4.8
PIONEER 36K27	5.6	3.0	3.3
		NON-BT HYBRIDS	
CARGILL 7770	8.0	4.1	5.8
DEKALB 493	7.6	5.1	2.3
DEKALB 566	6.5	3.6	5.8
GOLDEN HARVEST 2390	6.5	4.5	3.5
GOLDEN HARVEST 2493	6.0	2.8	3.0
MIDWEST 0226	6.9	3.8	3.5
MIDWEST 7711	6.4	3.4	3.0
NOVARTIS 4306	7.0	3.6	5.3
NOVARTIS N4242	4.9	3.1	3.8
NOVARTIS 4640	6.6	3.9	4.6
NOVARTIS NK4215	6.1	3.9	5.0
NOVARTIS NK6696	6.1	3.5	3.8
NOVARTIS W7070	6.1	3.9	2.8
PIONEER 3394	6.7	2.8	2.0
CV (%)	20.5	39.1	42.1
F value	0.98	0.91	1.00
p value	>0.5	>0.5	>0.5
LSD0.05 (Any hybrid to any hybrid)	NS	NS	NS
		AVERAGES	
All Bt hybrids	6.2	3.2	4.5
All non-Bt hybrids	6.5	3.7	3.9
F value	11.55	38.19	0.35
p value	0.0425	0.0085	>0.5
LSD0.05	0.8	0.8	NS

Table B9. Lodging, harvest moisture and test weight for Bt and non-Bt hybrids at Wray, CO. 1997.

	LODGING		% MOISTURE		TEST WEIGHT	
	TREATED	UNTREATED	TREATED	UNTREATED	TREATED	UNTREATED
HYBRID			**BT HYBRIDS**			
CARGILL5021BT	0.3	1.0	13.7	15.0	58.5	59.0
CARGILL 7821BT	0.0	0.5	15.5	17.8	58.9	59.0
DEKALB 493BT	0.0	0.8	11.1	10.6	59.1	58.0
DEKALB 566BT	0.0	0.8	11.5	11.4	57.6	59.3
GOLDEN HARVEST H2390	0.3	0.8	12.2	12.0	58.5	58.0
GOLDEN HARVEST H2493	0.5	0.3	14.2	12.8	58.1	59.1
NOVARTIS 6800BT	0.0	0.0	11.6	11.3	59.3	59.7
NOVARTIS N4640BT	0.3	0.0	11.6	12.0	59.8	58.8
NOVARTIS N53-M1	0.2	0.8	11.2	12.5	58.7	58.0
NOVARTIS N64-Z4	0.0	0.0	13.5	14.3	58.7	58.0
NOVARTIS N69-C4	0.3	0.3	12.5	11.1	59.5	59.3
NOVARTIS N7070BT	0.0	0.8	13.2	13.2	58.8	58.0
PIONEER 33A14	0.0	1.2	14.6	15.2	58.5	58.0
PIONEER 34R06	0.0	0.0	11.4	12.8	58.6	59.4
PIONEER 35N05	0.8	1.0	13.1	13.6	60.0	58.0
PIONEER 36K27	0.0	1.0	12.3	13.5	58.1	58.0
			NON-BT HYBRIDS			
CARGILL 7770	0.3	1.0	16.0	15.9	59.5	59.6
CARGILL 6888	0.0	0.5	13.6	14.4	58.2	58.7
DEKALB 493	0.0	2.0	10.6	10.7	58.5	59.6
DEKALB 566	0.5	1.3	11.9	11.8	58.4	58.0
GOLDEN HARVEST 2390	0.5	3.0	11.2	10.9	58.4	58.7
GOLDEN HARVEST 2493	0.5	1.0	12.3	12.1	58.4	58.6
MIDWEST 0226	1.5	1.5	12.9	13.6	59.0	59.0
MIDWEST 7711	0.8	1.8	14.2	13.5	58.9	59.3
NOVARTIS 4306	0.0	1.5	9.900	12.1	57.8	58.5
NOVARTIS N4242	0.3	0.5	10.5	10.9	57.9	58.8
NOVARTIS 4640	0.2	2.3	10.5	10.5	58.9	58.1
NOVARTIS NK4215	0.3	2.3	11.0	10.3	59.0	58.9
NOVARTIS NK6696	0.5	1.0	12.5	13.8	58.8	59.3
NOVARTIS W7070	0.3	1.5	12.8	12.0	59.1	58.4

Table B9. (Continued)

PIONEER 3394	0.0	1.8	11.7	12.3	58.6	59.4
	LODGING		**% MOISTURE**		**TEST WEIGHT**	
CV (%)	124.7		10.6		1.4	
F value	0.8		0.62		1.79	
p value	>0.5		>0.5		0.0392	
LSD0.05 (Any hybrid to any hybrid)	NS		NS		1.6	
			AVERAGES			
Treated	0.3		12.3		58.7	
Untreated	1.1		12.6		58.7	
F value	49.46		0.92		0.00	
p value	0.0059		>0.5		>0.5	
LSD0.05	1.3		NS		NS	
All Bt hybrids	0.4		12.9		58.7	
All non-Bt hybrids	1.0		12.1		58.7	
F value	24.07		13.93		0.15	
p value	0.0027		0.0097		>0.5	
LSD0.05	1.0		1.3		NS	
All treated Bt hybrids	0.2		12.7		58.8	
All treated non-Bt hybrids	0.3		12.0		58.6	
All untreated Bt hybrids	0.6		13.1		58.6	
All untreated non-Bt hybrids	1.6		12.2		58.8	
F value	11.27		0.15		6.16	
p value	0.0153		>0.5		0.0476	
LSD0.05	1.2		NS		0.9	

Table B10. Lodging, harvest moisture and test weight for Bt and non-Bt hybrids at Yuma, CO. 1997.

	LODGING		MOISTURE		TEST WEIGHT	
	TREATED	UNTREATED	TREATED	UNTREATED	TREATED	UNTREATED
HYBRID			**BT HYBRIDS**			
CARGILL 7821BT	0.3	0.3	21.0	18.3	58.3	58.0
DEKALB 493BT	0.5	1.3	12.3	11.3	57.5	56.7
DEKALB 566BT	1.0	0.8	11.6	12.2	57.7	57.1
GOLDEN HARVEST H2390	0.3	0.5	13.1	12.1	57.9	58.5
GOLDEN HARVEST H2493	2.3	2.5	12.4	15.0	57.8	57.1
NOVARTIS 6800BT	0.3	0.5	13.3	12.0	57.7	57.4
NOVARTIS N4640BT	0.0	1.5	14.1	13.2	58.4	54.1
NOVARTIS N53-M1	0.3	1.3	12.2	14.8	58.3	57.4
NOVARTIS N64-Z4	0.0	1.0	11.4	15.3	58.0	57.8
NOVARTIS N69-C4	0.3	0.5	16.2	15.6	58.4	58.3
NOVARTIS N7070BT	0.3	1.0	15.0	13.4	57.8	57.5
PIONEER 33A14	0.0	0.8	14.6	17.5	58.3	58.4
PIONEER 34R06	0.3	2.3	14.2	15.0	57.6	57.6
PIONEER 35N05	0.0	1.8	15.0	12.2	57.9	57.5
PIONEER 36K27	1.0	1.5	12.5	12.2	57.9	57.6
			NON-BT HYBRIDS			
CARGILL 7770	0.0	1.5	19.0	17.6	58.6	56.2
DEKALB 493	0.5	0.8	12.7	11.6	57.2	57.0
DEKALB 566	0.0	1.0	13.5	12.8	58.0	57.0
GOLDEN HARVEST 2390	0.0	1.5	11.0	12.7	56.8	57.4
GOLDEN HARVEST 2493	0.8	1.3	13.5	13.6	57.0	57.2
MIDWEST 0226	0.3	1.3	13.3	14.8	57.6	57.8
MIDWEST 7711	0.8	3.0	15.0	16.3	57.9	57.5
NOVARTIS 4306	0.8	1.5	13.8	11.3	58.3	57.7
NOVARTIS N4242	1.0	0.8	12.0	11.2	57.3	57.5
NOVARTIS 4640	0.8	1.0	12.6	11.1	57.8	57.1
NOVARTIS NK4215	1.0	2.0	12.3	11.5	57.9	56.5
NOVARTIS NK6696	1.0	1.8	15.9	13.5	59.0	58.7
NOVARTIS W7070	0.5	1.0	15.2	13.5	56.9	57.5

Table B10. (Continued)

PIONEER 3394	1.0	1.0	14.9	13.9	58.2	58.1
	LODGING		**MOISTURE**		**TEST WEIGHT**	
CV (%)	118.3		12.8		2.0	
F value	1.27		1.48		1.38	
p value	0.2301		0.1228		0.1695	
LSD0.05 (Any hybrid to any hybrid)	NS		NS		NS	
				AVERAGES		
Treated	0.5		13.9		57.9	
Untreated	1.3		13.5		57.4	
F value	83.22		6.62		7.98	
p value	0.0028		0.0823		0.0665	
LSD0.05	1.1		NS		NS	
All Bt hybrids	0.8		14.0		57.7	
All non-Bt hybrids	1.0		13.4		57.5	
F value	1.16		10.74		1.48	
p value	0.3218		0.0169		0.2688	
LSD0.05	NS		1.17		NS	
All treated Bt hybrids	0.4		14.0		58.0	
All treated non-Bt hybrids	0.6		13.8		57.7	
All untreated Bt hybrids	1.2		14.0		57.4	
All untreated non-Bt hybrids	1.4		13.1		57.4	
F value	0.04		4.71		0.68	
p value	>0.5		0.0729		>0.5	
LSD0.05	NS		NS		NS	

Table B11. Stand, grain yield, and crop values for Bt and non-Bt hybrids at Wray, CO. 1997.

	STAND		YIELD		GROSS VALUE ($)		NET VALUE ($)	
	TREATED	UNTREATED	TREATED	UNTREATED	TREATED	UNTREATED	TREATED	UNTREATED
				BT HYBRIDS				
CARGILL5021BT	31000	27250	180.5	178.1	463.83	457.72	432.15	443.05
CARGILL 7821BT	26750	27000	216.4	205.1	556.06	527.00	524.38	512.33
DEKALB 493BT	27750	27000	179.2	180.0	460.48	462.72	428.80	448.05
DEKALB 566BT	29000	27500	217.4	220.9	558.78	567.59	527.10	552.92
GOLDEN HARVEST H2390	27750	28250	199.2	203.7	511.82	523.50	480.14	508.83
GOLDEN HARVEST H2493	29000	26250	213.8	224.1	549.45	576.03	517.77	561.36
NOVARTIS 6800BT	28000	28000	227.5	205.6	584.61	528.46	552.93	513.79
NOVARTIS N4640BT	25750	32500	190.3	205.7	488.99	528.59	457.31	513.92
NOVARTIS N53-M1	26500	26500	202.6	190.7	520.79	490.18	489.11	475.51
NOVARTIS N64-Z4	27000	35000	230.3	235.6	591.96	605.38	560.28	590.71
NOVARTIS N69-C4	27000	28000	163.1	172.4	419.24	443.01	387.56	428.34
NOVARTIS N7070BT	28250	28000	218.4	226.9	561.26	583.17	529.58	568.50
PIONEER 33A14	28250	26250	236.2	234.5	607.03	602.60	575.35	587.93
PIONEER 34R06	25750	26000	197.2	213.6	506.84	548.89	475.16	534.22
PIONEER 35N05	27000	37000	230.1	188.6	591.36	484.58	559.68	469.91
PIONEER 36K27	26000	33000	227.8	227.1	585.40	583.53	553.72	568.86
				NON-BT HYBRIDS				
CARGILL 7770	28750	28000	200.0	174.1	513.97	447.38	496.96	447.38
CARGILL 6888	28000	29500	216.1	181.4	555.43	466.17	538.42	466.17
DEKALB 493	26750	27000	186.0	156.6	478.11	402.56	461.10	402.56
DEKALB 566	28000	29250	212.9	195.8	547.12	503.20	530.11	503.20
GOLDEN HARVEST 2390	26000	26500	201.0	185.6	516.48	477.04	499.47	477.04
GOLDEN HARVEST 2493	29000	27750	217.7	208.2	559.39	535.15	542.38	535.15
MIDWEST 0226	21250	26750	198.6	178.1	510.39	457.72	493.38	457.72
MIDWEST 7711	26250	26750	202.5	185.1	520.39	475.69	503.38	475.69
NOVARTIS 4306	24750	25250	157.1	149.2	403.65	383.41	386.64	383.41
NOVARTIS N4242	28000	25500	170.4	157.4	435.88	419.80	418.87	419.80
NOVARTIS 4640	27625	27750	167.6	170.4	430.67	437.97	413.66	437.97
NOVARTIS NK4215	29000	27500	177.7	174.8	456.80	449.25	439.79	449.25
NOVARTIS NK6696	27500	29000	213.4	190.2	548.52	488.90	531.51	488.90
NOVARTIS W7070	28500	27500	224.4	217.4	576.59	558.62	559.58	558.62

Table B11. (Continued)

PIONEER 3394	27000	25750	225.0	185.0	578.30	475.35	561.29	475.35
	STAND		**YIELD**		**GROSS VALUE**		**NET VALUE**	
CV (%)	8.0		12.7		12.7		13.1	
F value	5.15		0.65		0.65		0.64	
p value	<0.0001		>0.5		>0.5		>0.5	
LSD0.05 (Any hybrid to any hybrid)	100.4		NS		NS		NS	
				AVERAGES				
Treated	27336		203.2		522.31		497.73	
Untreated	28156		194.2		499.22		491.65	
F value	2.65		3.38		3.38		0.14	
p value	0.2014		0.1634		0.1634		>0.5	
LSD0.05	NS		NS		NS		NS	
All Bt hybrids	28258		207.6		533.46		510.29	
All non-Bt hybrids	27234		189.3		486.56		478.05	
F value	19.19		11.96		11.96		5.84	
p value	0.0047		0.0135		0.0135		0.0521	
LSD0.05	44.5		6.7		10.74		NS	
All treated Bt hybrids	27547		208.1		534.87		503.19	
All treated non-Bt hybrids	27125		198.0		508.92		491.91	
All untreated Bt hybrids	28969		207.0		532.06		517.39	
All untreated non-Bt hybrids	27344		180.6		464.20		464.20	
F value	6.63		1.17		1.17		1.10	
p value	0.0421		0.3215		0.3215		0.3357	
LSD0.05	52.9		NS		NS		NS	

Table B12. Stand, grain yield, and crop values for Bt and non-Bt hybrids at Yuma, CO. 1997.

	STAND		YIELD		GROSS VALUE ($)		NET VALUE ($)	
	TREATED	UNTREATED	TREATED	UNTREATED	TREATED	UNTREATED	TREATED	UNTREATED
HYBRID				**BT HYBRIDS**				
CARGILL 7821BT	25500	26500	235.1	186.5	604.05	479.28	570.90	464.63
DEKALB 493BT	30500	29000	188.0	163.9	483.13	421.10	449.93	406.45
DEKALB 566BT	27500	30000	235.7	194.8	605.83	500.55	572.68	485.85
GOLDEN HARVEST H2390	28250	29000	190.3	200.4	489.15	514.98	456.00	500.28
GOLDEN HARVEST H2493	28750	30000	212.6	208.1	546.40	534.70	513.25	520.03
NOVARTIS 6800BT	29750	29000	223.7	177.8	575.50	457.00	542.38	442.30
NOVARTIS N4640BT	29000	30250	193.2	159.3	496.48	409.38	463.28	394.68
NOVARTIS N53-M1	28500	27500	221.5	176.3	569.13	452.95	536.00	438.28
NOVARTIS N64-Z4	28750	28000	230.4	215.5	592.83	553.90	559.70	539.25
NOVARTIS N69-C4	27750	29250	219.2	190.1	563.45	488.48	530.30	473.80
NOVARTIS N7070BT	25250	26250	242.1	203.0	622.50	521.85	589.38	507.15
PIONEER 33A14	26250	26250	239.6	204.8	615.78	526.20	582.63	511.50
PIONEER 34R06	25750	25750	230.5	202.0	592.43	519.13	559.28	504.45
PIONEER 35N05	27000	28500	210.3	192.4	540.53	494.43	507.40	479.78
PIONEER 36K27	26750	27250	241.2	182.4	619.85	468.80	586.70	454.10
				NON-BT HYBRIDS				
CARGILL 7770	30500	27500	222.0	152.7	570.50	392.53	552.03	392.53
DEKALB 493	28750	30250	190.7	163.0	490.15	418.78	471.70	418.78
DEKALB 566	27750	28750	221.0	150.6	568.03	387.05	549.53	387.05
GOLDEN HARVEST 2390	27000	28000	206.7	176.1	531.13	452.68	512.63	452.68
GOLDEN HARVEST 2493	28000	28000	217.8	193.8	559.63	498.13	541.15	498.13
MIDWEST 0226	27000	27250	223.6	170.3	574.68	437.65	556.18	437.65
MIDWEST 7711	27750	28500	234.3	201.4	602.10	517.45	583.63	517.45
NOVARTIS 4306	27000	29500	188.8	184.9	485.25	475.20	466.75	475.20
NOVARTIS N4242	28750	28750	171.5	142.7	440.78	366.88	422.35	366.88
NOVARTIS 4640	29000	29250	183.8	153.4	472.28	394.09	453.79	394.09
NOVARTIS NK4215	28750	30000	186.0	171.7	478.03	441.35	459.53	441.35
NOVARTIS NK6696	27750	26750	220.7	197.2	567.18	506.85	548.70	506.85
NOVARTIS W7070	28000	28250	226.5	179.8	582.15	461.95	563.65	461.95
PIONEER 3394	27750	28000	234.7	199.0	603.25	511.33	584.78	511.33

Table B12 (continued).

	STAND	YIELD	GROSS VALUE	NET VALUE
CV (%)	9.0	13.7	13.7	14.2
F value	0.57	0.59	0.63	0.59
p value	>0.5	>0.5	>0.5	>0.5
LSD0.05 (Any hybrid to any hybrid)	NS	NS	NS	NS
		AVERAGES		
Treated	27933	214.2	550.48	524.66
Untreated	28350	182.1	468.06	460.73
F value	1.39	81.87	81.80	48.85
p value	0.3240	0.0029	0.0029	0.0060
LSD0.05	NS	7.1	11.35	11.35
All Bt hybrids	27925	205.7	528.66	504.75
All non-Bt hybrids	28358	190.6	489.89	480.65
F value	1.36	17.18	17.34	6.48
p value	0.2870	0.0060	0.0059	0.0438
LSD0.05	NS	5.5	8.76	8.75
All treated Bt hybrids	27683	220.9	567.80	534.65
All treated non-Bt hybrids	28183	207.5	533.16	514.68
All untreated Bt hybrids	28167	190.5	489.51	474.83
All untreated non-Bt hybrids	28533	173.8	446.62	446.62
F value	0.03	0.80	0.42	0.42
p value	>0.5	>0.5	>0.5	>0.5
LSD0.05	NS	NS	NS	NS

CHEMIGATED INSECTICIDES AND BT CORN HYBRIDS FOR CONTROL OF EUROPEAN CORN BORER, DRYDEN FARM, WRAY CO, 1997

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Insecticide applications for first generation European corn borer were made on the East Dryden farm on 11 July 1997 and the West Dryden farm on 9 July 1997. A treatment for second generation European corn borer at the East Dryden farm was applied 14 August 1997. Treatments were applied with a Milton Roy Model B chemigation pump through sprinkler systems equipped with 360^{o} nozzles with 0.5 inch (0.3 inch for second generation) irrigation water per acre. All insecticides for the second generation treatments were diluted with water to a uniform volume of 0.28 gal/ per acre prior to application.

Chemical control of European corn borer on the non-Bt corn hybrid was compared to the European corn borer control provided by one or two Bt corn hybrids planted in untreated, four-row strips through each of the fields. On the Dryden East farm chemical control on Pioneer '3417' was compared to control by Golden Harvest 'H2493'. On the Dryden West farm chemical control on Pioneer '3489' was compared to control by Golden Harvest 'H2493' and Pioneer '34R06'

The first generation European corn borer infestation level at the time of application was 29 to 35 % symptomatic plants with an average of 2.3 live larvae per plant. Treatments for this infestation were evaluated on 4 August 1997 by splitting four groups of 5 symptomatic plants from the flag leaf to the first node above ground. Larvae, pupae and abandoned cavities were counted. The second generation European corn borer infestation level at the time of application was an accumulated egg mass count of 30%. On the day of treatment 80% of these egg masses were at the blackhead stage or hatched but no live larvae were found in the ear tips. Second generation treatments were evaluated on 22 September 1997 by splitting eight groups of 10 plants and recording the number of larvae and fresh, abandoned cavities. Second generation larvae and cavities were recorded by location on the plant (above ear insertion, below ear insertion, ear tip, and ear shank). Statistical comparisons were made between the untreated control and a given treatment, using a two-tailed t-test (assumed equal variance and % = 0.05).

Chemical control on the non-Bt corn hybrids was excellent at both locations (Table 1). No European corn borer larvae were found on any of the Bt corn hybrids. Chemical control of second generation European corn borer at the East Farm was inferior to the control provided by the Bt corn hybrid (Table 2). Control with Capture 2E and the higher rate of Warrior was similar and superior to the other insecticide treatments. Net values of treated non-Bt corn hybrids were similar to untreated Bt corn hybrids of similar yield potential.

Field history:

Pest:	European corn borer, *Ostrinia nubilalis* (Hübner)
Cultivar:	Pioneer '3417' (East Farm), Pioneer '3489' (West Farm)
Planting Date:	4 May 1997 (East Farm), 14 May 1997 (West Farm)
Irrigation:	Sprinkler
Crop History:	Corn past ten years
Herbicide:	Bicep II Light 2.4 qts/acre, Accent 1/3 oz/acre
Insecticide:	None prior to first generation treatment
Fertilization:	33 gal/acre starter 8-26-5, 210 N as 32-0
Soil type:	Sandy loam, OM 1.7%, pH 6.5 (East Farm), OM 1.4%, pH 6.8 (West Farm)
Location:	NW1/4 Sec 2, 4N 44W Yuma County, CO (East Farm)
	SE ¼ Sec 18 4N 43W Yuma County, CO (West Farm)

Table 1. Chemigated insecticides and Bt corn hybrids for control of first generation European corn borer, Dryden Farms, Wray, CO. 1997.

TREATMENT	LARVAE PER PLANT	% CONTROL
EAST DRYDEN (INSECTICIDES APPLIED ON PIONEER '3417')		
GOLDEN HARVEST 'H2493'	0.0*	100
WARRIOR 1E, 0.03	0.5*	90
POUNCE 3.2E, 0.15	0.8*	84
UNTREATED CONTROL	4.8	---
WEST DRYDEN (INSECTICIDES APPLIED ON PIONEER '3489')		
PIONEER '34R06'	0.0*	100
GOLDEN HARVEST 'H2493'	0.0*	100
POUNCE 3.2E, 0.15	0.3*	94
WARRIOR 1E, 0.03	0.6*	88
UNTREATED CONTROL	5.2	---

*Fewer than untreated control (two-tailed t-test, assumed equal variance, % = 0.05).

Table 2. Control of second generation European corn borer with insecticides and Bt-corn hybrids. East Dryden Farms, Wray, CO. 1997.

	EUROPEAN CORN BORER PER 80 PLANTS					
PRODUCT, LB (AI)/ACRE	EAR TIP	EAR SHANK	BELOW EAR	ABOVE EAR	TOTAL	% CONTROL
GOLDEN HARVEST 'H2493'	0	1	0	1	2**	97
CAPTURE 2E, 0.08	5	1	6	2	14*	82
WARRIOR 1E, 0.03	5	3	6	5	19*	76
POUNCE 3.2E, 0.20	16	6	14	7	43*	45
WARRIOR 1E, 0.025	33	19	12	6	70	10
UNTREATED CONTROL	17	15	11	35	78	---
POUNCE 3.2E, 0.15	28	18	31	12	89	0

*Fewer than untreated control (two-tailed t-test, assumed equal variance, % = 0.05).
**Fewer than untreated control and best insecticide treatments (two-tailed t-test, assumed equal variance, % = 0.05).

Table A14. Yield and net values for Bt and non-Bt corn hybrids, Dryden Farms, Wray, CO. 1997

HYBRID	YIELD (BU/ACRE)	NET VALUE
EAST DRYDEN NON-BT CORN HYBRIDS		
GOLDEN HARVEST 2493 (TREATED)	215	$534.07
GOLDEN HARVEST 2493	194	$498.58
PIONEER 3417 (TREATED)	224	$557.20
PIONEER 3417	222	$570.54
EAST DRYDEN BT CORN HYBRIDS		
GOLDEN HARVEST H2493 (TREATED)	201	$483.42
GOLDEN HARVEST H2493	201	$501.90
WEST DRYDEN NON-BT CORN HYBRIDS		
GOLDEN HARVEST 2493	154	$394.68
PIONEER 3489	174	$445.99
WEST DRYDEN BT CORN HYBRIDS		
GOLDEN HARVEST H2493	170	$423.78
PIONEER 34R O6	190	$473.40

COMPARISON OF EUROPEAN CORN BORER CONTROL WITH REPLICATED Bt AND NON-Bt HYBRIDS, DRYDEN FARM, WRAY, CO. 1998.

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Planting was accomplished on 16 May 1998 with a John Deer Maxi Merge 7000 planter equipped with Carter Manufacturing Company test plot finger units and a variable plant hydraulic drive system. Each treatment consisted of three replicates of four row by 80 ft plots arranged in a randomized complete block design. The hybrids used are summarized in Table 1. The experiment was located within a 138 acre, sprinkler irrigated field planted to the non-Bt corn hybrid, Pioneer 3417, on 14 and 15 May 1998. This was the last to be planted of a cluster of five fields in order to maximize recruitment of second generation European corn borer.

Hybrids were evaluated for second generation European corn borer damage on 24 September 1998 by splitting 10 consecutive plants in each plot and recording the number of first generation cavities and fresh second generation cavities, larvae, and pupae. Second generation larvae and cavities were recorded by location on the plant (above ear, below ear, ear shank and ear tip). Western bean cutworm was evaluated on 25 August 1998 by opening the ear tip and counting the number of larvae on 60 consecutive plants in each plot. Insect counts were subjected to analysis of variance and mean separation by the Student-Neuman-Keul method (a=0.05).

Yields were measured on 5 November 1998 by harvesting by hand17.5 ft of the center two rows of each plot. Harvested ears were shelled and moisture and test weight determined. Yields were then converted to bu/acre at 15.5% moisture. Plant population, ear height and percent lodging were determined at harvest.

All Bt hybrids at the Dryden farm location had less second generation European corn borer damage than the non-Bt hybrids, Garst 8366IT and Pioneer 3559 (Table 2). First generation damage was too low to allow meaningful comparisons of Bt and non-Bt hybrids (Table 3). The use of Bt hybrids did not control western bean cutworm (Table 3). Yield of the treatments differed significantly (Table 4). Insertion event did not have a noticeable effect on European corn borer counts (Figure 1). Western bean cutworm densities were not affected by the use of Bt corn hybrids (Figure 2).

Yields varied by with insertion event (Figure 3). At the Dryden farm, all events with the exception of Star Link, yielded more than the non-Bt hybrids.

Field History

Pest:	European corn borer, *Ostrinia nubilalis* (Hübner) Western bean cutworm, *Richia albicosta* (Smith)
Planting Date:	15 May 1998
Plant Population:	33,000
Irrigation:	Sprinkler/Lockwood Rotators
Crop History:	Continuous corn 5 years
Herbicide:	3.5 Ag Prowl 2.0 lb. ai/ac Atrazine
Insecticide:	None
Fertilization:	250 N, 91 P, 24 K, 17 S
Soil Type:	Sandy loam, OM 1.4%, pH 6.8
Location:	Yuma County, CO, SE ¼, Sec 18 4N, 43W

Table 1. Characteristics of corn hybrids.

COMPANY	VARIETY NUMBER	SEASON (DAYS)	EVENT	PROTEIN	TRADE NAME
CARGILL	4220BT	104	MON 810	CRY 1 AB	YIELD GUARD
CARGILL	5021BY	106	MON 810	CRY 1 AB	YIELD GUARD
DEKALB	DK 493BTX	99	DBT 418	CRY 1 AB	BT EXTRA
DEKALB	DK 545BTY	104	MON 810	CRY 1 AB	YIELD GUARD
DEKALB	DK 566BTX	106	DBT 418	CRY 1 AC	BT EXTRA
DEKALB	DK 580BTY	108	MON 810	CRY 1 AB	YIELD GUARD
DEKALB	CR8671BTY	108	MON 810	CRY 1 AB	YIELD GUARD
GARST	8850BT	109	MON 810	CRY 1 AB	YIELD GUARD
GARST	8366BT/LL	113	CBH 351	CRY 9 C	STAR LINK
GARST	8366IT	113	NON Bt	---	IMI-CORN
GOLDEN HARVEST	EX 8665BT	104	MON 810	CRY 1 AB	YIELD GUARD
GOLDEN HARVEST	EX 8478BT	114	MON 810	CRY 1 AB	YIELD GUARD
PIONEER	3559	103	NON Bt	---	---
PIONEER	34 A03	107	MON 810	CRY 1 AB	YIELD GUARD
PIONEER	33 A14	113	MON 810	CRY 1 AB	YIELD GUARD
PIONEER	34 T14	110	MON 810	CRY 1 AB	YIELD GUARD
WILSON	1210BT	102	MON 810	CRY 1 AB	YIELD GUARD
WILSON	1436BT	108	MON 810	CRY 1 AB	YIELD GUARD

Table 2. Second generation European corn borer control with replicated Bt and non-Bt hybrids, Dryden farm, Wray, CO. 1998.

HYBRID	2nd GENERATION ECB PER PLANT ± SEM[1]				
	ABOVE EAR	BELOW EAR	EAR TIP	EAR SHANK	TOTAL
WILSON 1436BT	0.0 ± 0.0 C	0.0 ± 0.0 C	0.0 ± 0.0 B	0.0 ± 0.0 B	0.0 ± 0.0 B
WILSON 1210BT	0.0 ± 0.0 C	0.0 ± 0.0 C	0.0 ± 0.0 B	0.0 ± 0.0 B	0.0 ± 0.0 B
PIONEER 34A14PDF	0.0 ± 0.0 C	0.0 ± 0.0 C	0.0 ± 0.0 B	0.0 ± 0.0 B	0.0 ± 0.0 B
PIONEER 34T14PDR	0.0 ± 0.0 C	0.0 ± 0.0 C	0.0 ± 0.0 B	0.0 ± 0.0 B	0.0 ± 0.0 B
GARST 8550BT	0.0 ± 0.0 C	0.0 ± 0.0 C	0.0 ± 0.0 B	0.0 ± 0.0 B	0.0 ± 0.0 B
DEKALB CR8671BTY	0.0 ± 0.0 C	0.0 ± 0.0 C	0.0 ± 0.0 B	0.0 ± 0.0 B	0.0 ± 0.0 B
DEKALB 580BTY	0.0 ± 0.0 C	0.0 ± 0.0 C	0.0 ± 0.0 B	0.0 ± 0.0 B	0.0 ± 0.0 B
CARGILL 5021BT	0.0 ± 0.0 C	0.0 ± 0.0 C	0.0 ± 0.0 B	0.0 ± 0.0 B	0.0 ± 0.0 B
PIONEER 34A03	0.0 ± 0.0 C	0.0 ± 0.0 C	0.1 ± 0.1 B	0.0 ± 0.0 B	0.1 ± 0.1 B
CARGILL 4220BT	0.1 ± 0.1 C	0.0 ± 0.0 C	0.0 ± 0.0 B	0.0 ± 0.0 B	0.1 ± 0.1 B
GARST 8366BTLL	0.0 ± 0.0 C	0.1 ± 0.1 C	0.0 ± 0.0 B	0.0 ± 0.0 B	0.1 ± 0.1 B
GOLDEN HARVEST EX8478BT	0.0 ± 0.0 C	0.1 ± 0.1 C	0.0 ± 0.0 B	0.0 ± 0.0 B	0.1 ± 0.1 B
GOLDEN HARVEST EX8665BT	0.0 ± 0.0 C	0.1 ± 0.1 C	0.0 ± 0.0 B	0.0 ± 0.0 B	0.1 ± 0.1 B
DEKALB 545BTY	0.0 ± 0.0 C	0.0 ± 0.0 C	0.0 ± 0.0 B	0.1 ± 0.1 B	0.1 ± 0.1 B
DEKALB 493BTX	0.2 ± 0.2 C	0.0 ± 0.0 C	0.0 ± 0.0 B	0.0 ± 0.0 B	0.2 ± 0.2 B
DEKALB 566BTX	0.0 ± 0.0 C	0.3 ± 0.2 C	0.0 ± 0.0 B	0.1 ± 0.1 B	0.4 ± 0.2 B
GARST 8366IT	0.8 ± 0.3 B	0.9 ± 0.3 B	0.4 ± 0.2 A	0.7 ± 0.3 A	2.8 ± 0.9 A
PIONEER 3559	1.7 ± 0.4 A	1.3 ± 0.5 A	0.0 ± 0.0 B	0.4 ± 0.2 AB	3.4 ± 0.7 A
F Value	9.61	5.57	2.88	3.59	12.43
p > F	< 0.0001	< 0.0001	0.0003	< 0.0001	< 0.0001

[1]SEM, standard error of the mean. Means in the same column followed by the same letter(s) are not statistically different, SNK (a=0.05).

Table 3. First generation European corn borer and western bean cutworm control with replicated Bt and non-Bt hybrids, Dryden farm, Wray, CO. 1998.

HYBRID	1st GENERATION ECB ± SEM[1]	WESTERN BEAN CUTWORM ± SEM[1]
PIONEER 34A14PDF	0.0 ± 0.0	5.0 ± 0.6
GOLDEN HARVEST EX8665BT	0.0 ± 0.0	6.3 ± 1.8
DEKALB 493BTX	0.1 ± 0.1	6.3 ± 2.0
GARST 8366IT	0.1 ± 0.1	7.7 ± 2.0
WILSON 1210BT	0.0 ± 0.0	9.0 ± 2.1
DEKALB 545BTY	0.2 ± 0.2	9.7 ± 5.2
DEKALB 580BTY	0.0 ± 0.0	9.7 ± 2.0
GARST 8366BTLL	0.1 ± 0.1	11.0 ± 4.0
PIONEER 34T14PDR	0.0 ± 0.0	11.7 ± 4.3
GARST 8550BT	0.1 ± 0.1	12.0 ± 4.5
CARGILL 4220BT	0.0 ± 0.0	12.3 ± 5.5
WILSON 1436BT	0.0 ± 0.0	12.7 ± 1.8
PIONEER 34A03	0.0 ± 0.0	14.7 ± 3.0
DEKALB CR8671BTY	0.0 ± 0.0	15.3 ± 4.4
CARGILL 5021BT	0.0 ± 0.0	16.0 ± 11.1
DEKALB 566BTX	0.2 ± 0.2	17.7 ± 13.2
PIONEER 3559	0.1 ± 0.1	19.0 ± 3.8
GOLDEN HARVEST EX8478BT	0.1 ± 0.1	25.3 ± 5.2
F Value	0.97	0.94
p > F	0.4916	0.5390

[1]SEM, standard error of the mean.

Table 4. Yields of Bt and non-Bt corn hybrids, Dryden Farm, Wray, CO. 1998.

HYBRID	YIELD (BU/ACRE)
GARST 8550BT	211.9
PIONEER 34A14PDF	210.2
PIONEER 34T14PDR	207.1
DEKALB 566BTX	194.1
DEKALB 580BTY	192.9
PIONEER 34A03	190.7
GOLDEN HARVEST EX8665BT	185.5
CARGILL 4220BT	184.3
PIONEER 3559	183.7
WILSON 1210BT	183.6
DEKALB CR8671BTY	181.1
GOLDEN HARVEST EX8478BT	179.7
WILSON 1436BT	176.2
DEKALB 545BTY	173.1
DEKALB 493BTX	170.7
CARGILL 5021BT	168.0
GARST 8366BTLL	164.7
GARST 8366IT	154.4
Average Yield	184.5
Coefficient of Variation	8.00
LSD (a=0.05)	16.9

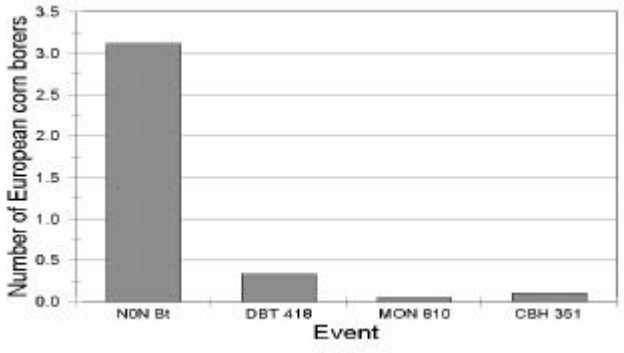

Figure 1. European corn borers per plant summarized over Bt event, Dryden Farm, Wray, CO, 1998.

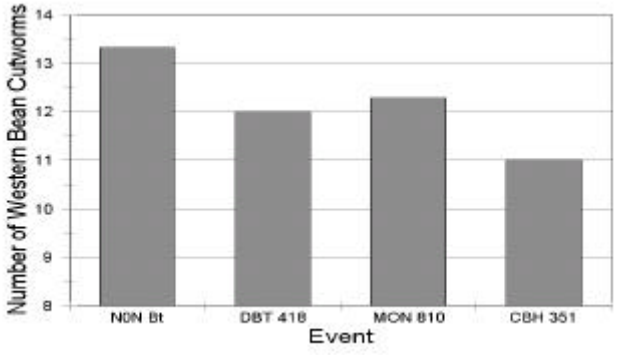

Figure 2 Western bean cutworm per 60 plants summarized over Bt event, Dryden Farm, Wray, CO, 1998.

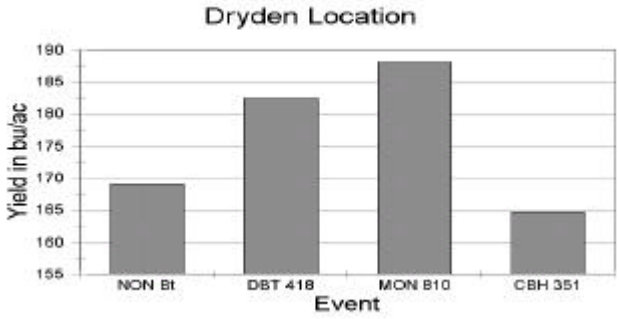

Figure 3. Corn yields summarized over Bt event, Dryden Farm, Wray, CO, 1998.