FIELD DAY 2002

Southwest Research–Extension Center

Report of Progress
895

Kansas State University
Agricultural Experiment Station
and Cooperative Extension Service

EVALUATION OF BT AND NON-BT CORN HYBRIDS FOR CORN BORER RESISTANCE AND EFFICACY OF INSECTICIDE TREATMENTS

by
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SUMMARY

Two pairs of Bt and non-Bt corn hybrids from Golden Harvest and Garst were evaluated for corn borer resistance and grain yield performance at the Southwest Research and Extension Center in Garden City, Kansas. First generation corn borer pressure in manually infested non-Bt corn averaged 1.6 southwestern corn borers and 14.8 cm (5.8 in.) of tunneling per plant. Second generation corn borer pressure from feral moths averaged 0.5 southwestern corn borer larvae and 10.9 cm (4.3 in.) of tunneling per plant in the non-Bt corn hybrids. Hybrids containing Bt events MON810 and CBH351 had only trace amounts of corn borer and tunneling for first and second generations. The yield loss from corn borer lodging averaged 36.3 bu/a for the non-Bt hybrids, but less than 5 bu/a for the Bt hybrids. Total corn yields averaged 139.2 bu/a for the 2 non-Bt hybrids, and 154.8 bu/a for the 2 Bt hybrids.

PROCEDURES

Corn plots were machine-planted on 28 April 2000 at 36,000 seeds/a at the Southwest Research-Extension Center near Garden City, KS. The two Garst hybrids were 8366 and 8366Bt (Bt event CBH351). The two Golden Harvest hybrids were 2547 and 8366Bt (Bt event CBH351) and Golden Harvest 9230Bt (Bt event MON810). The plots were 6 rows wide and 50 ft long with 10-ft alleyways at the end of each plot to reduce larval migration between plots. Pairs of Bt and non-Bt plots were planted in strips across a 15-acre field. The strips were separated by 24 rows (60 ft) of Bt corn to allow the plots to be sprayed aerially (65 ft swath). A total of 4 insecticide/miticide treatments were planned, but since spider mite populations did not develop, only a single treatment was applied for corn borers. One set of strips was treated 29 July with Capture at 5.12 oz/a. The experimental design included three factors: 1) insecticide treatment (check and treated), 2) corn borer resistance (standard susceptible and Bt-corn), and 3) seed company (with different Bt events). The plots were arranged as a split/split plot design with 4 replications.

Atrazine was applied before planting on 7 April at 1.5 lb/a. The following herbicides were applied after planting on 28 April: Roundup at 1.7 pt/a, TopNotch at 2.5 qt/a, Balance at 0.7 oz/a, atrazine at 0.5 qt/a, and 2,4-D at 1 qt/a. The field was irrigated 4.5 inches on 28 June, 3.5 inches on 11 June, 5.2 inches on 5 August and 3.6 inches on 17 August.

Spider mite numbers were estimated by collecting half the leaves from 10 plants in each plot. These leaves were placed in large Berlese funnels to extract spider mites and predators in alcohol. A pretreatment sample was taken on 27 June. Spider mite populations did not develop and additional spider mite samples were not taken.

First generation corn borer infestations were light so 10 plants in each plot were manually infested with 15 SWCB neonates per plant on 30 June (2 reps). To collect data on first generation corn borer infestations, five infested plants in each plot were dissected on 1 Aug. Second generation corn borer infestations resulted from feral moth flights. To collect data for second-generation corn borer infestations, 10 plants were dissected from one of the center rows in each plot on 16 Sept. Kernel damage (mostly due to corn earworms) was also recorded for these plants as the number of kernels damaged per ear.

The two middle rows of each plot were harvested in late October to determine grain yield and the row length was adjusted for plants removed for dissections. The ears from corn borer lodged corn were hand harvested and shelled. The ears from standing corn were machine harvested. Grain yield was calculated separately for standing and fallen corn and corrected to 15.5% moisture. Data were analyzed by 3-factor analysis of variance with a split/split plot design. Interaction means are presented graphically.

RESULTS AND DISCUSSION

In the pretreatment sample, spider mite and predator mite numbers averaged 3.0 to 8.5 spider mites and 0.0 to 0.13 predator mites per 10 half plants.

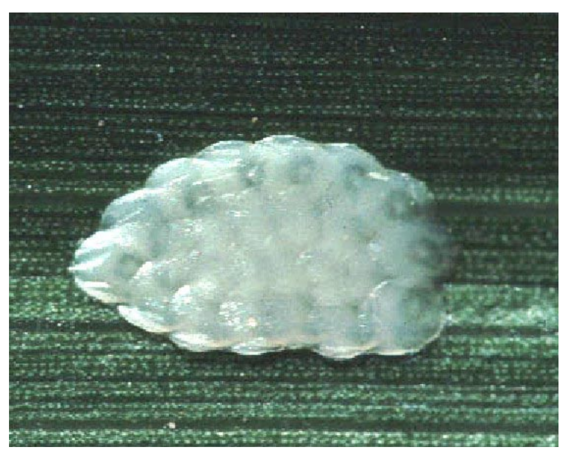
First generation corn borer pressure on the infested non-Bt plants averaged 1.6 southwestern corn borer larvae and 14.8 cm (8.3 in.) tunneling per plant (Table 1). The Bt plants were completely protected from the SWCB. The insecticide treatment had not yet been applied so the effects of insecticide were not significant and the interactions were not significant.

Second generation corn borer pressure averaged 0.5 SWCB larvae per plant and tunneling averaged 10.9 cm (4.3 in.) per plant in the non-Bt corn hybrids (Table 2). There were significant reductions in corn borers of 83% for insecticide treatment, 96% for Bt resistance and a difference of 34% for seed company. There were also significant reductions (or differences) in corn borer tunneling of 86% for insecticide treatment, 96% for Bt resistance and 31% for seed company. The significant interaction between insecticide treatment and corn borer resistance was due to the low corn borer pressure in the Bt corn treatment that did not allow for as much response to insecticide as was observed in the non-Bt treatments (Fig. 1). The significant interaction between corn borer resistance and seed company was due to the difference in the susceptibility of the two non-Bt hybrids (Fig. 2). Tunneling was reduced to trace levels in hybrids containing either MON810 or CBH351 events (Table 1 and Figs. 2 and 3). Data on European corn borer is not presented since only four second generation ECB larvae were found in 320 dissected plants.

Corn earworm damage to kernels averaged 53.0 and 39.5 kernels per ear in the non-Bt and Bt hybrids, respectively (Table 3). There were significant reductions (or differences) in corn earworm damage associated with each factor in the experiment: insecticide, resistance and company. The significant two-way interaction between insecticide treatment and corn borer resistance was due to higher damage in unsprayed non-Bt hybrid (Fig. 3). The significant two-way interaction between seed company and corn borer resistance was due to lower damage in GH non-Bt hybrid (Fig. 3). It is interesting that the insecticide treatment did not reduce kernel damage for the Bt treatments. This suggests much of the kernel damage in Bt treatments may have occurred after the insecticide residue had declined (by dusky sap beetles).

Grain yield lost to corn borer lodging was reduced 85 and 75 % by the insecticide treatment and 94 and 96 % by corn borer resistance for Garst and Golden Harvest hybrids, respectively. The significant interactions were due to higher damage recorded in the non-Bt hybrids that were reduced more by the insecticide treatment (Fig. 4a). The insecticide treatments caused greater reductions in lost yield in the Garst hybrids than in the Golden Harvest hybrids (Fig. 4b). Total grain yields (sum of standing plus fallen) were highest for insecticide treated Bt corn treatments, but the differences were not statistically significant (Table 2). The three-way interactions were due to the low yield of the GH non-Bt hybrid relative to the Bt hybrid, particularly in the sprayed treatment (Fig. 5). The GH Bt hybrid responded more to the Capture treatment than did the Garst Bt hybrid.

SWCB egg mass.



ECB egg mass.

Table 1. F-test probability values for the ANOVA tests and main effect means for 1st generation and 2nd generation SWCB observations.							
	First Generation SWCB			Second Generation SWCB			
	SWCB Larvae	Tunnel Number	Tunneling—cm	SWCB Larvae	Stalk Tunnel Number	Shank Tunnel Number	Total Tunneling--cm
Treatment Means							
A. Insecticide							
1. Check	0.9	1.4	7.8	**0.44 a**	**0.69 a**	0.11	**9.9 a**
2. Capture	0.7	1.3	7.1	**0.08 b**	**0.11 b**	0.04	**1.4 b**
B. CB Resistance							
1. Non-Bt	**1.6 a**	**2.7 a**	**14.8 a**	**0.50 a**	**0.76 a**	**0.13 a**	**10.9 a**
2. Bt	**0.0 b**	**0.0 b**	**0.0 b**	**0.02 b**	**0.04 b**	**0.03 b**	**0.4 b**
C. Seed Co.							
1. Garst	1.0	1.5	8.4	**0.31 a**	**0.46 a**	0.11	**6.7 a**
2. G H	0.6	1.2	6.5	**0.21 b**	**0.34 b**	0.05	**4.6 b**
ANOVA F-test Probability							
A. Insecticide	NS	NS	NS	**0.0179**	**0.0249**	NS	**0.0350**
B. CB Resistance	**0.0217**	**0.0130**	**0.02515**	**0.0016**	**0.0058**	**0.0400**	**0.0046**
C. Seed Co.	NS	NS	NS	**0.0193**	**0.0044**	NS	**0.0022**
A x B. Interaction	NS	NS	NS	**0.0094**	**0.026**	NS	**0.0183**
A x C. Interaction	NS	NS	NS	NS	NS	NS	NS
B x C. Interaction	NS	NS	NS	**0.0107**	**0.0084**	NS	**0.0022**
A x B x C Interaction	NS	NS	NS	NS	NS	NS	NS

Table 2. F-test probability values for the ANOVA tests and main effect means for late season observations on CEW and yield.				
	CEW Kernals damaged	Standing Yield Bu / Acre	Fallen Yield Bu / Acre	Total Yield Bu / Acre
Treatment Means				
A. Insecticide				
1. Check	**49.4 a**	106.5	**32.2 a**	138.8
2. Capture	**43.1 b**	146.4	**8.9 b**	155.2
B. CB Resistance				
1. Non-Bt	**53.0 a**	**102.9 b**	**36.3 a**	139.2
2. Bt	**39.5 b**	**150.0 a**	**4.9 b**	154.8
C. Seed Co.				
1. Garst	**57.4 a**	123.5	21.5	145.0
2. G H	**35.1 b**	129.4	19.6	149.0
ANOVA F-test Probability				
A. Insecticide	**0.0460**	NS	**0.0124**	NS
B. CB Resistance	**0.0067**	**0.0012**	**0.0002**	0.0836
C. Seed Co.	**0.0001**	NS	NS	NS
A x B. Interaction	**0.0501**	0.0563	**0.0005**	NS
A x C. Interaction	NS	NS	**0.0142**	NS
B x C. Interaction	**>0.0001**	**0.0002**	0.0748	**0.0001**
A x B x C Interaction	NS	**0.0005**	NS	**0.0022**

Fig. 1. Two-way interactions between insecticide treatment and corn borer resistance on 2nd generation SWCB.

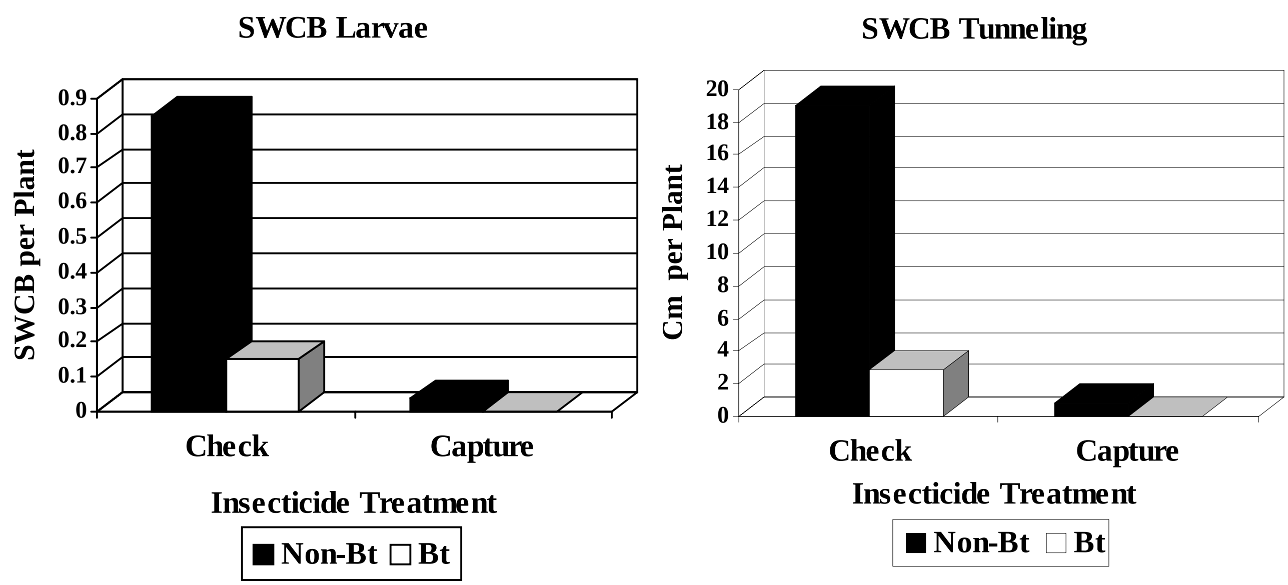


Fig. 2. Two-way interactions between seed company and corn borer resistance on 2nd generation SWCB.

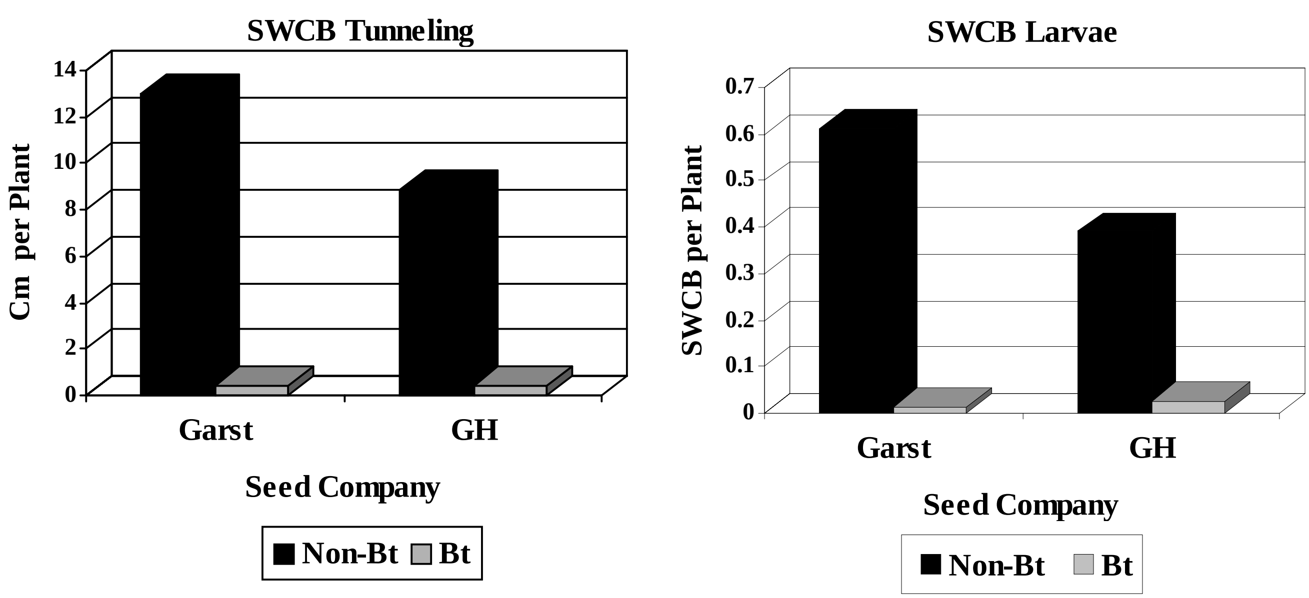
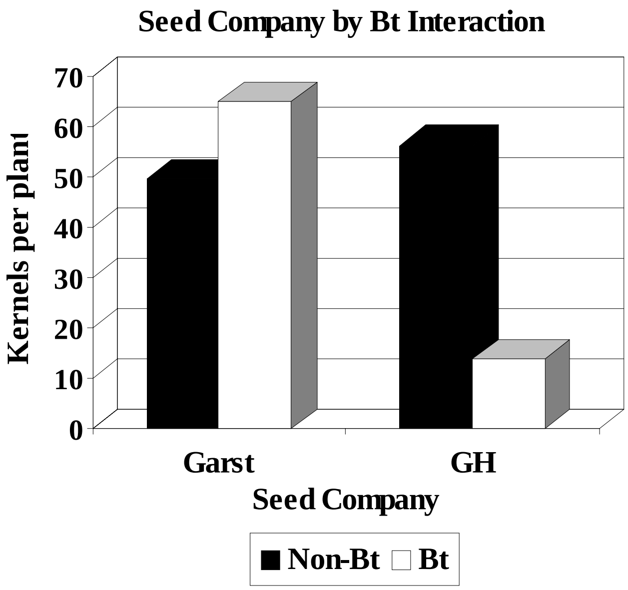


Fig. 3. Two-way Interactions between insecticide treatment and corn borer resistance or seed company and corn borer resistance on CEW kernel damage.



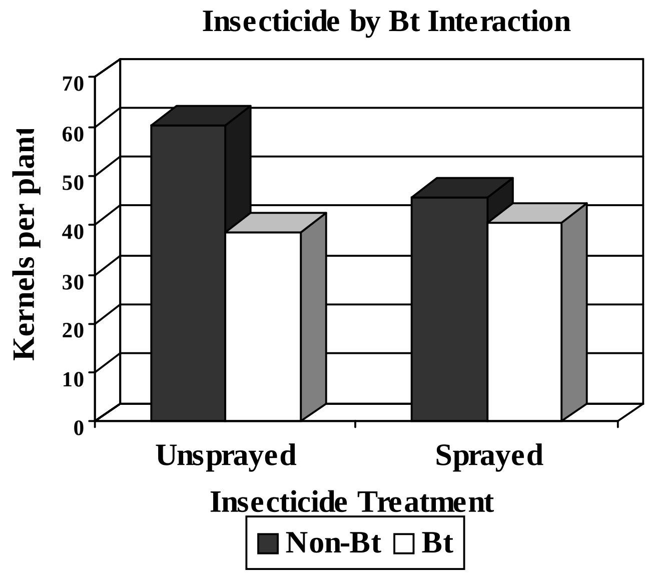
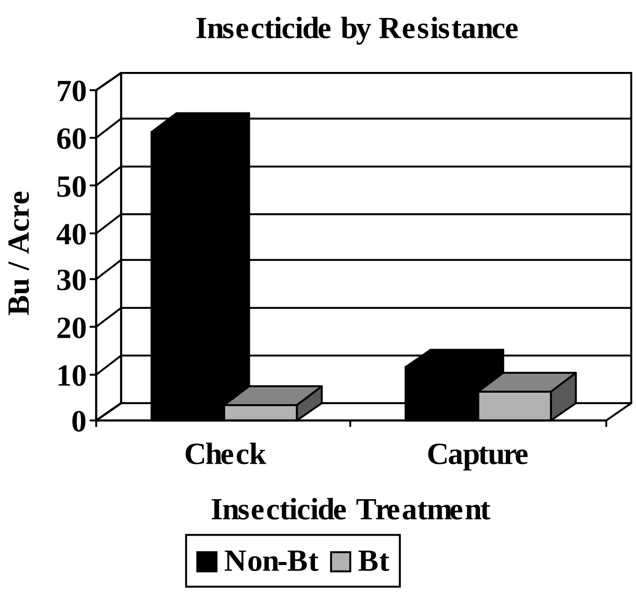


Fig. 4. Two two-way interactions between insecticide treatment and corn borer resistance or insecticide treatment and seed company on fallen grain yield.



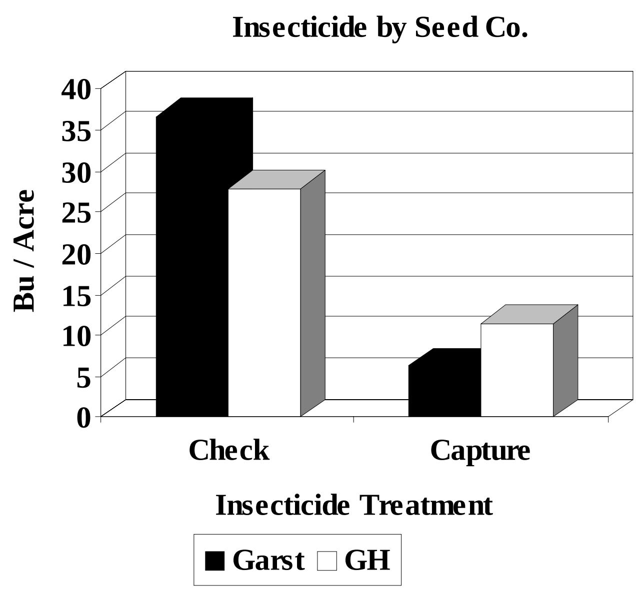
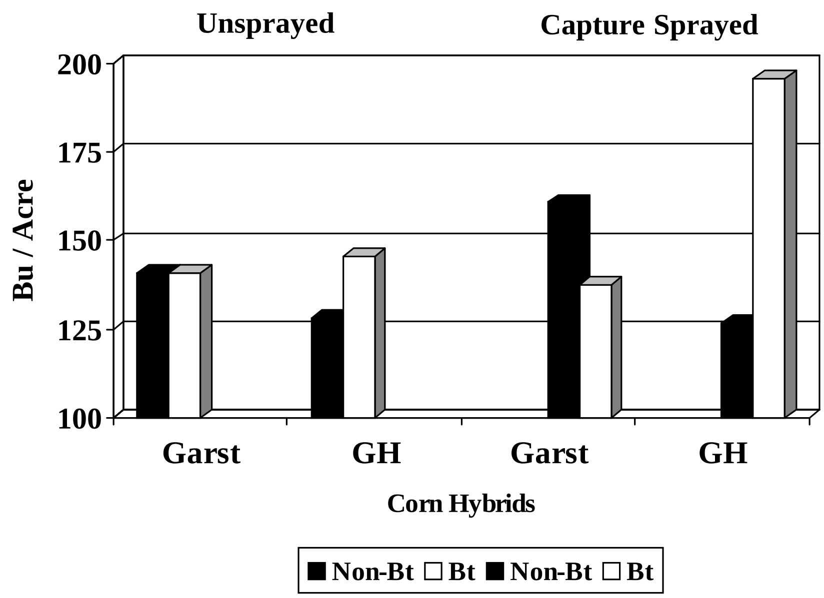


Fig. 5. Three-way interactions between insecticide treatment, corn borer resistance, and seed company on total grain yield.



Machine harvesting corn plots.

SWCB lodged corn.

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SRP 895 June 2002