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EVALUATION OF CORN BORER RESISTANCE AND GRAIN YIELD FOR BT AND NON-BT CORN HYBRIDS[1]

by

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SUMMARY

Fourteen corn hybrids (eight Bt and six non-Bt) were evaluated for corn borer resistance and grain yield performance. Second generation European and southwestern corn borer pressure averaged 0.29 and 0.45 larvae per plant, respectively, in the non-Bt plots. Corn borer tunneling averaged 12.8 cm per plant in the non-Bt corn hybrids. Tunneling was reduced to trace levels in hybrids containing Bt events Bt11, MON810, and CBH351; however, both hybrids with event 176 suffered noticeable tunneling. The yield loss from lodging due to corn borers averaged 13.3 bu/a for the non-Bt hybrids. Hybrids with events MON810, Bt11, and CBH351 generally had less than a bushel or two of grain on the ground at harvest time. Standing corn yields averaged 121.8 bu/a for the six non-Bt hybrids, and 108.0, 134.9, 136.7, and 132.6 for the hybrids with events 176, Bt11, MON810, and CBH351, respectively. The best non-Bt hybrid (Pioneer 32J55) had a standing yield of 161.8, and the best Bt hybrid (Pioneer 33A14) had a standing yield of 164.0.

PROCEDURES

Corn plots were machine-planted on 28 April at 34,400 seeds/a at the Southwest Research-Extension Center near Garden City, KS. Spot replanting was done as necessary. The stand was thinned to 100 plants per 60 row-ft. Atrazine (1.5 lb ai/a) was applied preplant on 29 March. At planting, 2.5 qt Topnotch and 0.5 qt of Atrazine were applied. Postemergence herbicide applications were made on 24 May and 7 June using 0.33 and 0.53 oz of Accent/a, respectively, along with 0.2 gal crop oil concentrate. No insecticides were used. The soil was a saline-Richfield silt-loam with a pH of 7.5 to 8.0. The field was furrow irrigated on 12 July, 28 July, and 14 Aug. with 8.5, 6.7, and 6.3 inches of water, respectively. Monthly rainfalls for April through Aug. were 2.2, 3.5, 4.2, 3.5, and 2.6 inches. The plots were four rows wide (10 ft) by 30 ft long. Two rows (5 ft) of Bt corn were planted between the plots as border rows, and 10-ft alleyways at the end of each plot were left bare. The border rows and alleyways were included to reduce larval migration between plots. The experimental design was a randomized block design with four replications. There were 14 hybrids with relative maturity ratings of 110 to 118 days.

Infestations by second generation corn borer were entirely native. Data for second-generation corn borers were taken from 10 plants in the two center rows of each plot (five consecutive plants in each row). The plants were dissected to record corn borers and corn borer tunneling. Kernel damage was recorded as the estimated percentage of kernels damaged per ear (mostly corn earworm damage). Stalk rot was recorded as the number of nodes at the base of the plant showing noticeable stock rot injury. Yield was determined by separately harvesting ears from standing plants and from plants lodged because of corn borer damage. The lodged corn was harvested by hand, and the standing corn was machine harvested. The two middle rows of each plot were harvested in late October. Grain yield was calculated separately for standing and fallen corn and corrected to 15.5% moisture.

The data were analyzed by an analysis of variance, and means were separated using the least significant difference test. To simplify the discussion, results are averaged across non-Bt hybrids and the hybrids with the four Bt events.

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RESULTS AND DISCUSSION

First generation corn borer pressure was light, and no data were collected. Second generation European and southwestern corn borers averaged 0.29 and 0.45 larvae per plant, respectively, in the non-Bt plots (Table 1). Corn borer tunneling averaged 12.8 cm per plant in the non-Bt corn hybrids. Tunneling was reduced to trace levels in hybrids containing Bt events Bt11, MON810, and CBH351; however, both hybrids with event 176 suffered noticeable tunneling (Table 1). In hybrids with events 176, Bt11, MON810, and CBH351 second generation ECB larvae were reduced by 52, 100, 100, and 100%, respectively (Fig. 1); second generation SWCB larvae were reduced by 61, 100, 95, and 100% (Fig. 2); and corn borer tunneling was reduced by 64, 100, 98, and 100% (Fig. 3).

Corn earworm damage to kernels in the ear was relatively light, averaging only 0.7 % in the non-Bt hybrids (Table 2). The hybrid with Bt11 had about a 60 % reduction in kernel damage compared with the non-Bt hybrids. Hybrids with Bt176, MON810, and CBH351 showed little reduction in kernel damage.

Stalk rot averaged less than one node per plant and did not differ significantly among hybrids.

A hailstorm on 1 July, when the plants were at the pretassel stage, caused 50 to 60% defoliation and bruised and broke many stalks. The 110-day hybrids had most of their leaves exposed to the hail, but the 116- to 118-day hybrids were able to extend one or two leaves after the hailstorm. Yields probably were reduced 30 to 40%, and the differences between shorter and longer maturity hybrids were exaggerated (Table 2).

Yields of standing corn averaged 121.8 bu/a for the six non-Bt hybrids and averaged 108.0, 134.9, 136.7, and 132.6 for hybrids with events 176, Bt11, MON810, and CBH351, respectively (Table 2). The best non-Bt hybrid (Pioneer 32J55) had a standing yield of 161.8, whereas the best Bt hybrid (Pioneer 33A14) had a standing yield of 164.0. These were two of the longest maturity hybrids in the trial. The yield losses from lodging caused by corn borers averaged 13.26 bu/a for the non-Bt hybrids and 7.84 bu/a for the two hybrids with event 176. Hybrids with Bt11, MON810, and CBH351 had very little yield loss (2.4 bu/a or less) (Table 2). Yield losses from corn borer lodged plants were reduced by 41, 85, 89, and 95 % for events 176, Bt11, MON810, and CBH351, respectively (Fig. 4). Total grain yields (sum of standing plus fallen) were similar for the non-Bt and the Bt hybrids, except for the two 176 hybrids. However, these two hybrids were fairly short-season and probably were damaged more heavily by the hail (Fig. 5).

Fig. 1. European corn borer larvae in Bt and non-Bt corn.

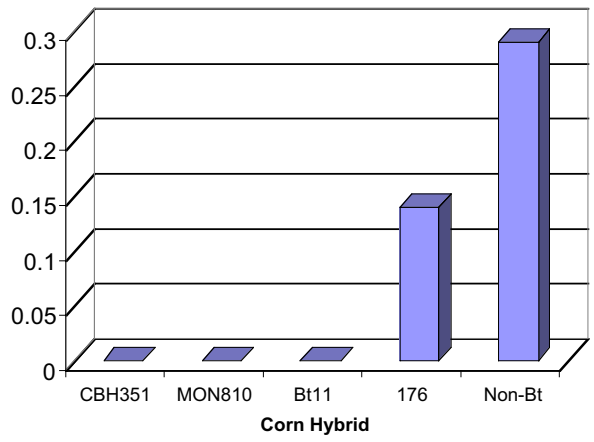

Fig. 2. Southwestern corn borer larvae in Bt and non-Bt corn.

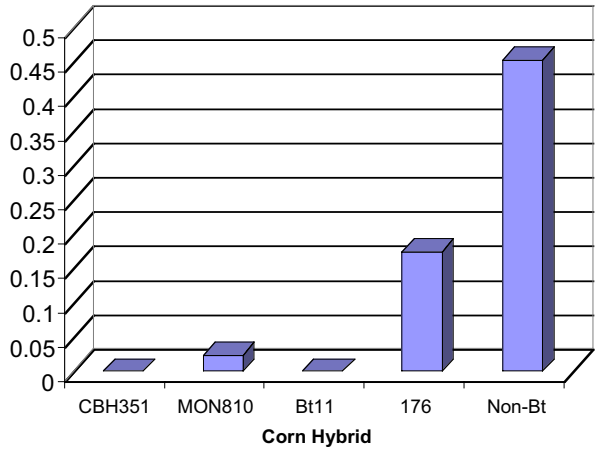

Fig. 3. Corn borer tunneling, in Bt and non-Bt corn.

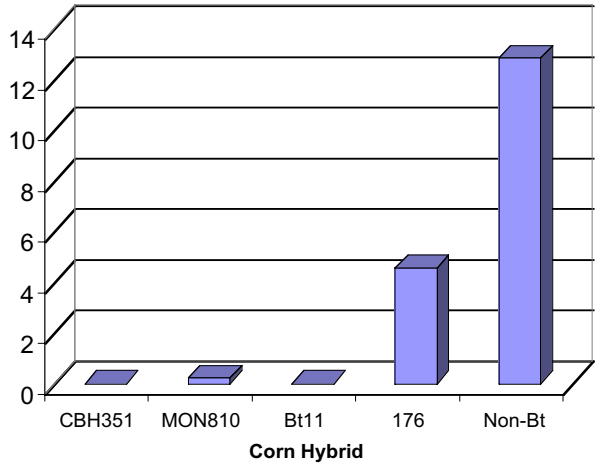

Fig. 4. Fallen grain yields of Bt and non-Bt corn.

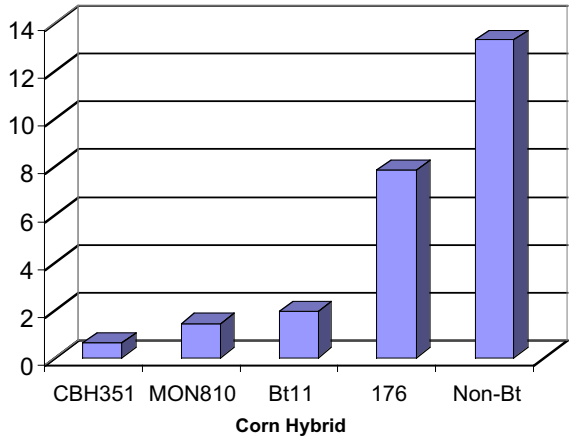

Fig. 5. Grain yields of Bt and non-Bt corn.

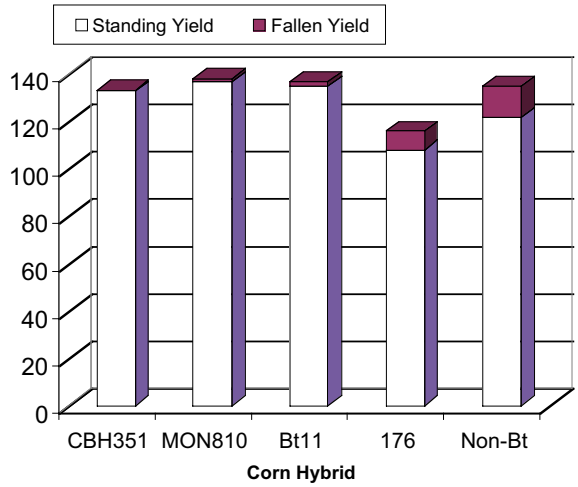

Table 1. Corn borer larvae and tunneling in Bt and non-Bt corn hybrids, Garden City, KS, 1999.

Hybrid	Bt Event	Company	Relative Maturity Rating	2nd Generation Corn Borer				
				ECB Larvae per Plant	SWCB Larvae per Plant	Number of Tunnels per Plant	Cm of Tunneling below Ear	Cm of Tunneling per Plant
4494		Novartis Seeds	110	0.18 bc	0.30 bcd	1.13 cde	7.67 bcd	9.60 bcd
MAX454	176	Novartis Seeds	111	0.23 bc	0.15 cde	0.75 def	3.13 de	4.27 de
2787	176	Mycogen	113	0.05 c	0.20 cde	0.52 efg	3.01 de	4.89 de
7590		Novartis Seeds	114	0.20 bc	0.40 abc	1.30 bcd	9.53 abc	11.28 a-d
7590Bt	Bt11	Novartis Seeds	115	0.00 c	0.00 e	0.00 g	0.00 e	0.00 e
3162IR		Pioneer	118	0.55 a	0.60 a	1.83 ab	10.70 abc	16.13 ab
32J55		Pioneer	116	0.33 ab	0.55 ab	2.13 a	12.99 ab	18.08 a
33A14	MON810	Pioneer	113	0.00 c	0.00 e	0.00 g	0.00 e	0.00 e
7821BT	MON810	Cargill	115	0.00 c	0.07 de	0.15 fg	0.40 e	0.60 e
H-2547		Golden Harvest	112	0.13 bc	0.30 bcd	0.95 cde	6.60 cd	7.47 cde
H-9230Bt	MON810	Golden Harvest	113	0.00 c	0.00 e	0.00 g	0.00 e	0.00 e
8481		Garst	112	0.33 ab	0.57 a	1.45 bc	13.38 a	14.46 abc
8481Bt/LL	CBH351	Garst	112	0.00 c	0.00 e	0.03 g	0.00 e	0.00 e
8366Bt/LL	CBH351	Garst	113	0.00 c	0.00 e	0.03 g	0.00 e	0.01 e
LSD value p=0.05				0.24	0.27	0.63	5.67	7.87
F-test Prob.				0.0002	<0.0001	<0.0001	<0.0001	<0.0001

Table 2. Corn borer and earworm damage and yield of Bt and non-Bt corn hybrids, Garden City, KS, 1999.

Hybrid	Bt Event	Company	Relative Maturity Rating	2nd Gen. Corn Borer: No. of Plants Infested per 10 Plants	2nd Gen. Corn Borer: No. of Shanks Tunneled per 10 Plants	Earworm: Percent of Kernels Damaged	Yield: Standing Plts. bu/a	Yield: Fallen Plts. bu/a	Yield: Total bu/a
4494		Novartis Seeds	110	6.50 ab	0.75 cd	0.95 a	102.5 e	15.20 ab	117.7 d
MAX454	176	Novartis Seeds	111	4.75 bc	1.25 bcd	0.97 a	107.3 de	8.75 a-d	116.0 d
2787	176	Mycogen	113	4.00 c	0.50 d	0.87 ab	108.6 cde	6.93 b-e	115.5 d
7590		Novartis Seeds	114	6.25 ab	2.25 abc	0.50 bcd	120.7 b-e	12.68 ab	133.4 cd
7590Bt	Bt11	Novartis Seeds	115	0.00 d	0.00 d	0.27 d	134.9 b	1.93 cde	136.8 cd
3162IR		Pioneer	118	8.25 a	2.75 ab	0.57 a-d	131.7 bc	16.27 a	147.9 bc
32J55		Pioneer	116	8.25 a	3.00 a	0.80 abc	161.8 a	14.13 ab	175.9 a
33A14	MON810	Pioneer	113	0.00 d	0.00 d	0.60 a-d	164.0 a	1.30 de	165.3 ab
7821BT	MON810	Cargill	115	1.00 d	0.25 d	0.82 abc	122.9 b-e	2.40 cde	125.3 cd
H-2547		Golden Harvest	112	5.75 bc	1.00 cd	0.75 abc	107.8 cde	10.30 abc	118.1 d
H-9230Bt	MON810	Golden Harvest	113	0.00 d	0.00 d	0.77 abc	123.1 b-e	0.57 de	123.7 cd
8481		Garst	112	8.25 a	3.50 a	0.65 a-d	106.1 e	10.95 ab	117.1 d
8481Bt/LL	CBH351	Garst	112	0.25 d	0.25 d	0.62 a-d	135.1 b	1.23 de	136.3 cd
8366Bt/LL	CBH351	Garst	113	0.50 d	0.25 d	0.42 cd	130.1 bcd	0.00 e	130.1 cd
	LSD value p=0.05			2.09	1.59	0.43	23.92	8.54	25.30
	F-test Prob.			<0.0001	0.0001	0.0834	<0.0001	0.0004	0.0001