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EFFICACY OF CRY1F CORN FOR THE CONTROL OF SOUTHWESTERN CORN BORER AND CORN EARWORM

by
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SUMMARY

This trial evaluated the efficacy of corn containing the cry1F gene for controlling southwestern corn borer, (SWCB) *Diatraea grandiosella* Dyar, and corn earworm *Helicoverpa zea* (Bobbie). Three corn hybrids were evaluated: an experimental hybrid with Bt event TC1507 expressing cry1F, a non-Bt isoline, and a commercial Bt corn hybrid with event MON810 expressing Cry1Ab. The seed was supplied by Mycogen Seeds/Dow AgroSciences. The efficacy of the Cry1F experimental hybrid against SWCB was outstanding and appeared to be equal to that of a current commercial Cry1Ab Bt corn hybrid. In addition, both transgenic hybrids appeared to suppress kernel damage at the ear tip by the corn earworm.

PROCEDURES

The plots were machine-planted on 17 May at the Southwest Research-Extension Center near Garden City, KS, using seed supplied by Mycogen Seeds/ Dow AgroSciences. Three corn hybrids were evaluated: an experimental hybrid Mycogen 2395+ with Bt event TC1507 expressing cry1F, a non-Bt isoline hybrid Mycogen 2395- and a commercial Bt corn hybrid, Pioneer 33A14 with event MON810 expressing cry1Ab. The plots were four rows wide (10 ft), 20 ft long and separated by two additional border rows of Bt corn and 10-ft wide alleys. The plot design was a randomized block design with four replicates. Four to eight rows of Bt corn were planted around the experimental plots as a border/windbreak. Emergence was recorded for plants in the two center rows on 31 May. The two south rows of each plot were infested with a total of 40 southwestern corn borer neonates on 28 and 30 June, when the plants were in the 8 to 10 leaf growth stage. First generation infestation was evaluated using modified Guthrie ratings (0-9 scale) on 10 infested plants per plot on 20 July. In addition, five infested plants were dissected to record the number of larvae and tunnels and the total tunneling per plant on 27 July. The second generation SWCB infestation came from free-flying feral moths and moths emerging from the manually infested first generation. Five ears per plot were examined on 14 August to record numbers of corn earworm, the number of damaged kernels and the percent ear tip and ear base damage. Ten plants from the two north rows were dissected on 23 September to make observations on the number of corn borer larvae per plant, plus the number and length of tunnels in the ear shanks and stalks.

RESULTS

Corn emergence was similar for the three hybrids (Table 1). The pollen shed and silking observations indicate that the M2395 hybrids (treatments 1 & 2) reached pollen shed and silking at about the same time, but that the MON810 hybrid reached that stage significantly later (Table 1).

The artificial infestation of first generation SWCB was successful, producing modified Guthrie ratings of 7.8 on a scale of 1 to 9 in the infested non-Bt hybrid plants, while only a few feeding scars were found on the two transgenic hybrids (Table 1, Fig. 1). Plant dissections revealed 100 percent infested plants and a mean of 2.7 first generation SWCB larvae per plant in the non-Bt hybrid, but no larvae were found in the Cry1F hybrid and only two infested plants were found in the Cry1Ab hybrid (Fig.2). No European corn borer larvae were recorded. There was an average of 3.2 tunnels and 7.6 inches of tunneling per plant in the infested non-Bt hybrid plants, while the transgenic hybrids with events TC1507 and MON810 reduced SWCB tunneling to almost nothing (Fig. 3).

Observations made on ears sampled 14 August recorded 90 percent of ears infested in the non-Bt hybrid (Table 2). A mean of 1.4 CEW larvae per ear with an average of 25.4 damaged kernels was recorded

Table 1. Early season observations on the efficacy of Cry1F corn on southwestern corn borer (SWCB). SWREC Garden City, Finney Co., Kansas.

Trt No	Hybrid Code	Bt-Event	Emerged 31 May	Pollen 20 July	Silking 20 July	Guthrie Rating 0-9 scale	Guthrie Rating % Plts. 3+	1st Gen. SWCB /Plant	1st Gen. Tunnels /Plant	1st Gen. Inches /Plant	1st Gen. %Plant Infested
1	M2395+	TC1507	75	50 ab	46	0.5 b	0 b	0.0 b	0.0 b	0.0 b	0
2	M2395	Non-Bt	78	90 a	55	7.8 a	100 a	2.7 a	3.2 a	7.6 a	100
3	P33A14	MON810	72	13 b	13	0.5 b	0 b	0.1 b	0.2 b	0.1 b	10
	P-value		0.6442	0.0221	0.0995	<0.0001	<0.0001	0.0027	0.0019	0.0037	—
	LSD		16.48	48.34	41	0.542	0.499	0.478	1.36	3.68	—

Table 2. Late season observations and the efficacy of Cry1F corn on corn earworm (CEW) and southwestern corn borer (SWCB). SWREC Garden City, Finney Co., Kansas.

Trt No.	Hybrid Code	Bt-Event	CEW Larvae Per ear	CEW Mean Instar	CEW Damaged Kernels/ear	% Ear Tips Infested	Bases Infested
1	M2395+	TC1507	0.9 ab	4.1	10.3 b	90	23
2	M2395	Non-Bt	1.4 a	4.3	25.4 a	97	49
3	P33A14	MON810	0.6 b	3.5	2.9 b	80	10
	P-value		0.0171	0.1566	0.0053	0.1064	0.0694
	LSD		0.472	0.878	10.547	16.42	33.23

in these ears (Fig. 4). The Bt hybrids reduced the number of CEW larvae and significantly reduced kernel damage, but the percent of ears with damage ears remained above 80. There was an average of 25.4 damaged kernels in the non-Bt hybrid ears, and the Bt hybrids significantly reduced kernel damage (Fig. 5). Reduction in damage was greatest for the MON810 hybrid, but was not significantly different from the TC1507 hybrid. Nearly all of the damage to the ear tips would have been done by the corn earworm. The transgenic hybrids also appeared to reduce kernel damage at the ear base; however, the differences were not statistically significant. The damage at the ear "base" included damage caused by early stages of the southwestern corn borer, which should have been susceptible to the toxins expressed in the Bt corn hybrids.

The second generation SWCB population averaged 1.1 larvae per plant in the non-Bt hybrid in September, but the Bt hybrids reduced the number of larvae to undetectable levels (Table 3, Fig. 6). One European corn borer larva was recorded in the 120 plants dissected, therefore, most of the stalk tunneling was done by the SWCB. There was an average of 2.6 stalk tunnels and 0.7 shank tunnels per plant with an average of 13.4 inches of total tunneling per plant in the infested non-Bt hybrids. Tunneling was undected in the Bt hybrids (Fig. 7).

The efficacy of the Cry1F experimental hybrid against SWCB was outstanding and appeared to be equal to that of a current commercial Cry 1Ab Bt corn hybrid. In addition, both transgenic hybrids appeared to suppress kernel damage at the ear tip by the corn earworm.

Fig. 1. First generation SWCB leaf-damage in three corn hybrids

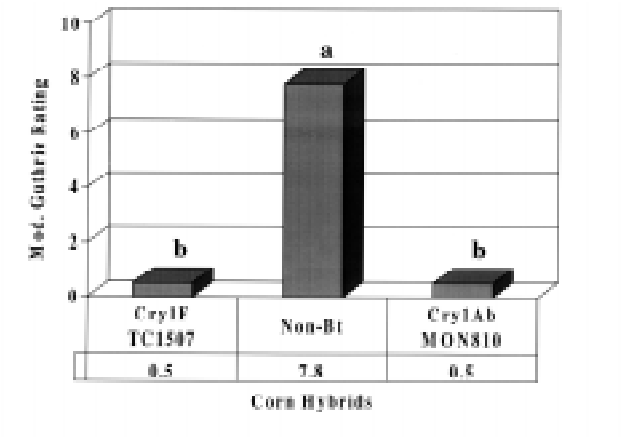


Fig.3. First generation SWCB tunneling in three corn hybrids

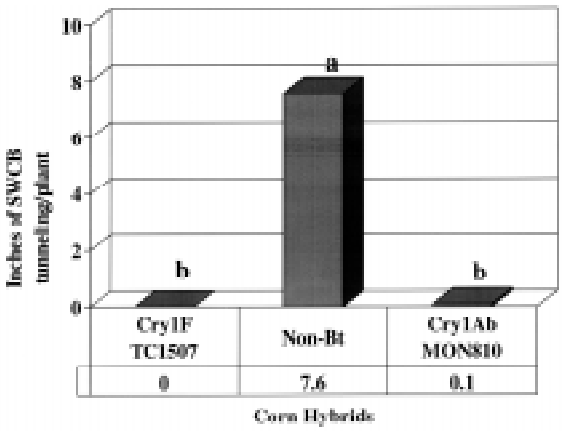


Fig. 2. First generation SWCB larvae in three corn hybrids

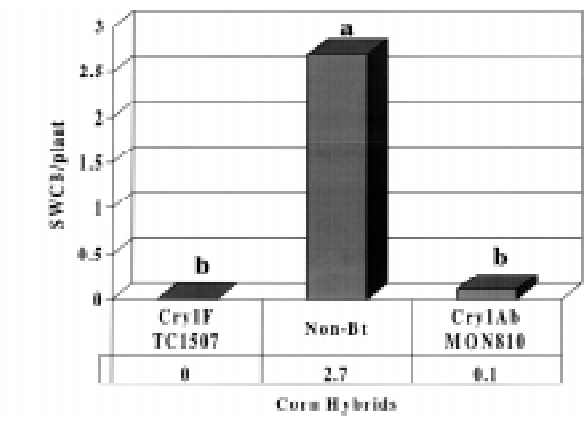


Fig. 4. Corn earworms in the ears of three corn hybrids

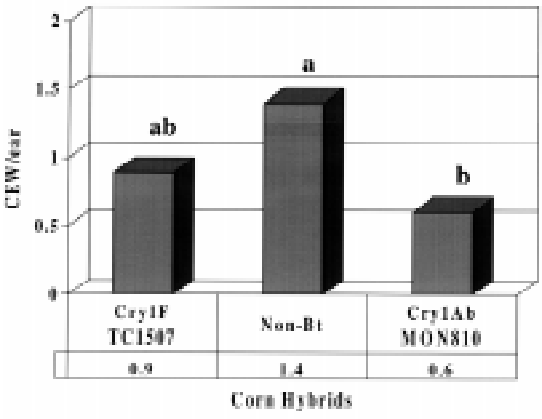


Table 3. Late season observations on the efficacy of Cry1F corn on southwestern corn borer (SWCB). SWREC Garden City, Finney Co., Kansas.

Trt No	Hybrid Code	Bt-Event	SWCB /plant	Stalk Tun No./plt	Shank Tun No./plt	Stalk Tun Inches/plt	Shank Tun Inches/plt	Total Tun Inches/plt	Plants CB Infest
1	M2395+	TC1507	0.0 b	0.0 b	0.0 b	0.0 b	0.0 b	0.0 b	0
2	M2395	Non-Bt	1.1 a	2.6 a	0.7 a	12.2 a	1.1 a	13.4 a	100
3	P33A14	MON810	0.0 b	0.0 b	0.0 b	0.0 b	0.0 b	0.0 b	0
	P-value		<0.0001	<0.0001	0.0008	<0.0001	<0.009	<0.0001	—
	LSD		0.126	0.129	0.238	2.283	0.674	2.859	—

Fig. 5. Corn earworm kernel damage in ears of three corn hybrids

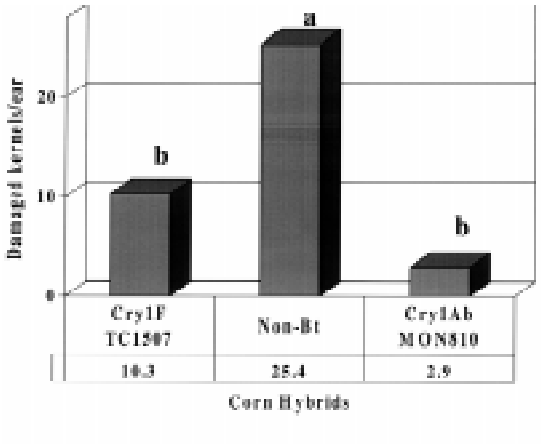


Fig. 6. Second generation SWCB larvae in three corn hybrids

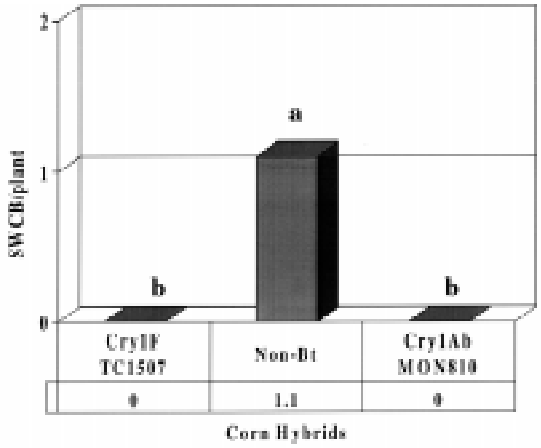
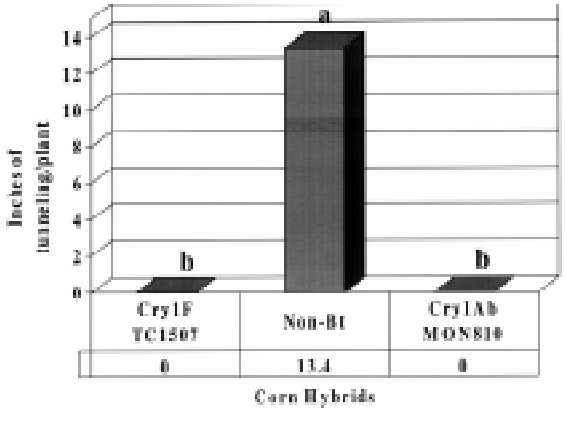


Fig. 7. Second generation SWCB Tunneling in three corn hybrids



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