

FIELD 2004A



Southwest Research-Extension Center

Report of Progress

927

*Kansas State University
Agricultural Experiment Station
and Cooperative Extension Service*

KANSAS Southwest Research-Extension Center

EFFICACY OF VIP- & CRY1AB-EVENT CORN HYBRIDS FOR THE CONTROL OF SOUTHWESTERN CORN BORER AND CORN EARWORM

by
Larry Buschman, Phil Sloderbeck, and Merle Witt

SUMMARY

This trial was conducted to evaluate the efficacy of nine corn hybrids containing three Cry1Ab events, and two Cry1Ab events stacked with a VIP event, for controlling southwestern corn borer (SWCB), *Diatraea grandiosella* Dyar, and corn earworm (CEW), *Helicoverpa zea* (Bobbie). Syngenta supplied the seed. The efficacy of the Cry1Ab experimental events against SWCB was outstanding and seemed equal to that of current commercial Bt11 hybrids. The efficacy of the VIP event stacked with Cry1Ab against the corn earworm was also outstanding.

PROCEDURES

The plots were machine-planted on 10 June at the Southwest Research-Extension Center near Garden City, Kansas, with seed supplied by Syngenta. The plots were single rows, 20 ft long, separated from each other by four border rows of Bt corn and 10-ft-wide alleys. The plot design was a randomized block design with 4 replicates. Four to 12 rows of Bt and non-Bt corn were planted around the experimental plots as a border/windbreak. Nine treatments were evaluated, including 4 experimental hybrids expressing VIP and CRY toxins, a commercial Bt corn hybrid, NK58-D1 (Bt11), the non-Bt isoline hybrid, and two insecticide treated plots. The first 10 plants in each plot were infested with southwestern corn borer (SWCB) neonates between July 9 and 13, when the plants were in the 8- to 10-leaf stage. Availability of neonates was limited, so the plants in different replicates were not equally infested. The first 5 plants received 5 to 10 neonates per plant, but the second 5 plants received only 2 to 5 neonates per plant. The insecticide-treated plots were planted to the non-Bt isoline or to the commercial Bt corn hybrid, NK58-D1. These plots were treated for second-generation SWCB with a standard insecticide, Warrior T, at 3 oz/acre per pass by using a 2-gallon hand

sprayer. The spray was directed at the plants while the nozzle was moved up and down to treat the whole plant. On August 1, the plots were treated from one side (3 oz/acre). On August 12, the plots were treated from both sides (6 oz/acre).

First-generation SWCB leaf-feeding damage was evaluated on July 28 by using a modified Guthrie scale (0-no damage, 1-some pinholes and 10-dead-heart). The modified Guthrie means can be changed to standard Guthrie means by adding one to each mean. Plants were not dissected for first-generation tunneling because there were limited plant numbers. The second-generation SWCB infestation resulted from free flying feral moths and moths emerging from the manually infested first generation. On September 18 through 24, 15 plants were dissected to make observations on second-generation SWCB and their damage. The ten plants that had been infested with first-generation neonates were included in the 15 plants, so tunneling that was produced by first-generation SWCB (before the insecticide treatment was applied) was excluded. First-generation tunneling typically had pupal case remains or very dark tissues around the tunnels. This was particularly important for treatment #7, which was susceptible during the first generation, but was treated with insecticide during the second generation. In some instances, the second-generation larvae reused the first generation tunnels, so these tunnels were counted as second-generation tunnels.

The ears from the 15 dissected plants were also examined for corn earworm (CEW) damage. Ear tip damage was measured by using the Winstrom scale, the number of cm of feeding penetration plus 1 for silk feeding. We also counted (estimated) the number of harvestable kernels removed by ear feeding CEW. Southwestern corn borer damage in the ear was also present as kernel damage at the ear base and as feeding in the husk around the shank (seldom into the shank), but this damage was minor compared with the CEW damage and was not rated separately.

RESULTS AND DISCUSSION

The artificial infestation of first-generation SWCB was successful and allowed the evaluation of the plant resistance to first-generation SWCB. Some 80 - 85% of “infested” susceptible plants had SWCB feeding damage. Infested susceptible plants had extensive SWCB feeding damage and some dead-heart (killed meristem). Modified Guthrie ratings averaged 4.1 and 5.0 (averaging across all “infested” plants) in the non-Bt isoline plants. Only a few pinhole-feeding scars were found on the transgenic hybrids, and the Guthrie ratings averaged less than 1.0 (Table 1). Only the non-transgenic plants had Guthrie ratings of higher than 4.0, and there were no significant differences among the transgenic hybrids.

By September 18 to 24, only 1 to 8.75 CEW were still present per 15 corn ears (CEW leave the ear at larval maturity). CEW damage on the ear tips was extensive, reaching 7.4 on the Widstrom scale in the untreated non-Bt hybrid (Table 2). The insecticide treatment did not significantly reduce CEW feeding damage in the ears. The three Cry1Ab event hybrids significantly reduced CEW feeding damage, compared with the non-Bt isoline. The VIP-event

hybrids further reduced CEW damage scores to levels that were usually significantly lower even than those of the Cry1Ab event hybrids. Compared with controls, the Cry1Ab event hybrids reduced damage from 72 to between 21 and 44 kernels, but the VIP-event hybrids reduced CEW feeding to between 4 and 10 kernels per ear (Table 2).

The second-generation SWCB population averaged 0.8 larvae per plant in the non-Bt hybrid. A total of 43 SWCB and one European corn borer were recorded in the 60 untreated non-Bt plants (treatment #6). Two SWCB were found in the shank; the rest were in the stalk at the base of the plant. A total of 6 untreated non-Bt plants were girdled by SWCB (treatment #6). All the Bt hybrids and the insecticide treatment significantly reduced the number of SWCB larvae to low levels (Table 3). There was an average of 1.2 tunnels and 9.1 cm of tunneling per untreated non-Bt plant (Table 3 & 4). All treatments significantly reduced the number of SWCB larvae and tunneling. One SWCB was found in a treatment-#8 plant that had significant first-generation feeding damage, suggesting that the plant was susceptible (non-expressing plant). Three infested plants were found in plots along the south border, 3 rows away from non-Bt plants in the border planting, in treatments #2, #2,

Table 1. Early-season observations for first-generation southwestern corn borers feeding on plants of different treatments, SWREC, Garden City, Kansas.

Treatment No.	Hybrid Code	Cry1Ab Event	VIP3a Event	1 st Gen. Infested / 10 Plants ^{1,2}	Modified Guthrie 0-10 scale ^{2,3}	Plants \geq 4 Guthrie ²
1	SPS1001LM	Bt11	MIR152V	3.00 c	0.28 b	0.0 b
2	SPS1002LM	3243M	MIR152V	5.75 b	0.60 b	0.0 b
3	SPS1005LM	3243M	—	4.00 bc	0.40 b	0.0 b
4	SPS1006LM	3210M	—	4.75 bc	0.40 b	0.0 b
5	SPS1007LM	Bt11	—	3.50 bc	0.35 b	0.0 b
6	SPS1008LM	—	—	8.50 a	4.10 a	6.8 a
7	SPS1008LM	—	—	8.00 a	5.00 a	6.3 a
8	N58-D1	Bt11	—	4.50 bc	0.38 b	0.0 b
9	N58-D1	Bt11	—	3.50 bc	0.35 b	0.0 b
	P-value			0.0003	>0.0001	>0.0001
	LSD			2.359	1.299	0.907

¹ Plants showing any leaf feeding.

² Means within a column that are followed by different letters are significantly different (P < 0.05)

³ Modified Guthrie Ratings taken on July 28, 2003.

#4. One of these larvae was found in a plant with so little tunneling that the larva must have migrated from another plant. Another mature SWCB larva was found in the base of a treatment-#1 plant that was on the east border, evidently 8 rows from non-Bt plants

in the border planting.

The efficacy of the experimental Cry1Ab hybrids against SWCB was outstanding and seemed equal to that of the current commercial Bt11 corn hybrid. The VIP event and a Cry1Ab event also significantly increased the efficacy of the hybrids against the CEW.

Table 2. Observations on corn earworm feeding on corn ears of different treatments, SWREC, Garden City, Kansas.

Treatment No.	Hybrid Code	Cry1Ab Event	VIP3a Event	Warrior Treatment ¹	Maturity July 28 ²	CEW			Kernels
						Larvae / 15 ears	Winstrom Ratings ³ Mean / ear	3+ / 15 ears	Damaged ³ Mean / ear
1	SPS1001LM	Bt11	MIR152V	—	2.25	1.00	1.35 c	1.25 g	4.38 d
2	SPS1002LM	3243M	MIR152V	—	1.75	2.50	1.83 c	3.50 fg	10.15 cd
3	SPS1005LM	3243M	—	—	1.25	3.00	3.28 b	7.75 de	32.15 bc
4	SPS1006LM	3210M	—	—	1.75	5.00	3.38 b	8.75 cd	44.83 b
5	SPS1007LM	Bt11	—	—	2.25	8.75	4.45 b	10.75 bc	37.58 b
6	SPS1008LM	—	—	—	2.0	7.50	7.40 a	15.00 a	72.20 a
7	SPS1008LM	—	—	Warrior	2.25	3.25	6.95 a	13.00 ab	69.10 a
8	N58-D1	Bt11	—	—	2.0	4.25	3.55 b	8.50 cd	31.90 b
9	N58-D1	Bt11	—	Warrior	1.75	2.50	2.93 bc	5.50 ef	21.83 b
P-value					0.447	0.0763	>0.0001	>0.0001	>0.0001
LSD					—	—	1.905	2.755	23.425

¹ Warrior T treatments were made August 1 and 12, during the SWCB flight.
² Plant maturity ratings, 1 = tassel, 2 = silk and 3 = brown silk taken July 28 and ear feeding damage recorded September 18 to 24, 2003
³ Means within a column that are followed by different letters are significantly different (P < 0.05)

Table 3. Observations on second-generation southwestern corn borer feeding on corn plants of different treatments, SWREC, Garden City, Kansas.

Treatment No.	Hybrid Code	Cry1Ab Event	VIP3a Event	Warrior Treatment ¹	2 nd Gen. Infested ² /15 plants	SWCB Larvae ² /15 plants	Tunnels / 15 plants ^{2,3}		
							Stalk	Shank	Total
1	SPS1001LM	Bt11	MIR152V	—	0.25 b	0.25 b	0.25 b	0.25 b	0.50 b
2	SPS1002LM	3243M	MIR152V	—	0.50 b	0.25 b	0.50 b	0.00 b	0.50 b
3	SPS1005LM	3243M	—	—	0.00 b	0.00 b	0.00 b	0.00 b	0.00 b
4	SPS1006LM	3210M	—	—	0.50 b	0.25 b	0.25 b	0.00 b	0.25 b
5	SPS1007LM	Bt11	—	—	0.00 b	0.00 b	0.00 b	0.00 b	0.00 b
6	SPS1008LM	—	—	—	12.00 a	10.75 a	15.75 a	2.00 a	17.75 a
7	SPS1008LM	—	—	Warrior	0.02 b	0.00 b	0.00 b	0.25 b	0.25 b
8	N58-D1	Bt11	—	—	0.25 b	0.25 b	0.00 b	0.25 b	0.25 b
9	N58-D1	Bt11	—	Warrior	0.00 b	0.00 b	0.00 b	0.00 b	0.00 b
P-value					0.0035	>0.0001	>0.0001	>0.0001	>0.0001
LSD					1.25	0.894	2.505	0.539	2.683

¹ Warrior T treatments were made August 1 and 12, during the SWCB flight.
² Means within a column that are followed by different letters are significantly different (P < 0.05).
³ Plants dissected September 18 to 24, 2003.

