FIELD DAY 2009

Report of Progress 1014

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Efficacy of Monsanto Stacked Event Corn Hybrids for Control of Corn Earworm, Rootworm, and Southwestern and European Corn Borer, 2008

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Summary

This trial was conducted to evaluate the efficacy of corn hybrids containing several stacked events for controlling the corn rootworm (CRW), *Diabrotica virgifera virgifera*, European corn borer (ECB), *Ostrinia nubilalis*, southwestern corn borer (SWCB), *Diatraea grandiosella*, corn earworm (CEW), *Helicoverpa zea*, and western bean cutworm (WBC), *Loxagrotis albicosta*. Overall, SmartStax and YGVT3P/HXRW had outstanding efficacy against CEW and SWCB. Feral populations of CRW, ECB, and WBC were too low to test the efficacy of the hybrids. None of the hybrids escaped feeding damage by dusky sap beetle (DSB), *Carpophilus lugubris*.

Procedures

Experimental corn seed (supplied by Monsanto) was machine planted on May 16, 2008, at the Southwest Research-Extension Center (Field 28) in Garden City, KS. Plots were eight rows wide and 20 ft long. There were 10-ft-wide alleys. The study was organized as a randomized block design with four replicates. Four rows of non-Bt corn were planted around the experiment as a border and windbreak. The experiment relied on feral populations of corn pests to infest the plots. SmartStax is a stacked plant that combines YieldGard VT Triple PRO (Monsanto) with Herculex XTRA (Dow AgroSciences) technologies. These plants combine eight transgenic events in one plant, including two corn borer active events, two western corn rootworm active events, and several herbicide resistance traits. The other treatments include various combinations of these traits.

On July 30, a set of 10 corn plants were dug from rows 2 and 3 to make root injury ratings using the 0 to 3 injury rating scale proposed by Olson et al. (2005). On August 19 and 21, 20 ears from rows 4 and 5 were taken to record CEW and WBC feeding in corn ears (by location: ear tip or ear base). Feeding injury was measured by counting the number of harvestable kernels damaged by CEW or WBC and by using the Winstrum scale (centimeters of feeding penetration plus 1 for silk feeding). On October 13, another 10 plants from rows 4 and 5 were evaluated for stalk and ear pests. On October 20, all ears from rows 6 and 7 were picked and weighed to calculate grain yield.

Data were analyzed by one-way ANOVA, and means were separated by Fisher's protected LSD test ($P < 0.05$).

Results and Discussion

Feral CRW pressure, recorded on July 30, was relatively low, 0.06 to 0.07 on the 0 to 3 root rating scale, and there were no significant differences across corn hybrids (Table 1).

Feral CEW pressure was moderate with up to 60% of the corn ears infested and 0.6 CEW larvae per plant on August 19 (Figures 1 and 2, respectively). Compared with the check plots (Treatment 4), significantly fewer infested ears, CEW larvae, and damaged kernels were recorded in the two hybrids that had "VT3P" (Treatments 1 and 2; Table 1, Figures 1, 2, and 3). Feeding injury at the tip of the corn ear (mostly CEW) was significantly lower in the VT3P (Table 1). The Winstrum ratings show the same trends (Table 1). By the second week of October, the rate of ear infestation had increased from 60% in August to 87.5% in check plots (Table 2). The number of kernels damaged increased from 8.6 in August to 25.5 in October as well (Tables 1 and 2, Figures 3 and 5). However, this increase did not change the early season pattern observed across hybrids for kernel damage or Winstrum ratings (Table 2). Only hybrids that included VT3P had significantly lower rates of infestation, kernels damaged, and Winstrum ratings compared with check plots (Figure 4). Ear tip damage had the same trends but did not differ significantly. There was a general increase in ear damage, which was probably due to DSB. None of the Bt corn hybrids appeared to have efficacy on this insect.

There was a moderate infestation of SWCB, 0.2 larvae per plant (Table 2). Although the number of SWCB larvae and the resulting corn borer tunneling were very low in the VT3P and HXX lines (first three treatments), there were few significant differences across the hybrids that were meaningful (Table 2 and Figure 6). Treatment 7 unexpectedly had the most tunneling. Ear base feeding was negligible in all plots in both samples (Tables 1 and 2).

Grain yield was variable across the plots because of stand and irrigation differences, and there were no significant differences among hybrids (Table 2 and Figure 7).

ECB were not observed in the August ear collections, but two ECB were recorded in stems of the non-Bt hybrid (Treatment 4) in the October sample. Nine WBC were observed in the August ear collections, but none were observed in October. Seven WBC were found in Treatment 5.

Overall, SmartStax and VT3P/HXRW had outstanding efficacy against CEW and SWCB. Feral populations of CRW, ECB, and WBC were too low to draw conclusions on efficacy of the corn hybrids against these pests. None of the hybrids escaped DSB feeding.

References

Oleson, J.D., Y. Park, T.M. Nowatzki, and J.J. Tollefson. 2005. Node-injury scale. Journal of Economic Entomology, 98:1-8.

Table 1. Corn rootworm (CRW) rating on July 30 taken from a set of 20 root samples and corn earworm (CEW) observations from 20 ears on Aug. 19 and 21, 2008, Garden City

Treatment		Insect events present	CRW rating	Infested ear	CEW larvae	Ear tip damage	Ear base damage	Kernels damaged	Winstrum rating
			0-3	%	no./ear	----------cm/ear----------		no./ear	
						Means			
1.	YGVT3P/HXX	SmartStax[1]	0.06	2.5c	0.0c	0.0c	0	0.1c	0.0d
2.	YGVT3P/HXRW	YieldGard VT Triple Pro/Herculex RW[2]	0.07	5.0c	0.0c	0.1c	0.0	0.9c	0.2cd
3.	HXX	Herculex XTRA[3]	0.07	28.8b	0.3b	0.4bc	0.0	2.1bc	0.6cd
4.	Isoline	–	0.08	60.0a	0.6a	1.0a	0.1	8.6a	1.6ab
5.	Isoline and	–	0.07	43.8ab	0.4ab	0.8ab	0.2	7.4a	2.2a
	Counter 20 CR	8 oz/1000 row-ft							
6.	YGVT	YGVT[4]	0.05	38.8ab	0.3b	0.8ab	0.1	6.0ab	1.0bc
7.	YGVT and	YGVT[4]	0.06	45.0ab	0.4ab	0.4ab	0.3	6.4a	1.1bc
	Counter 20 CR	8 oz/1000 row-ft							
						ANOVA			
P value <		–	0.6769	0.0001	0.0001	0.0135	0.5892	0.0008	0.0015
CV		–	–	38.57	40.18	76.49	–	59.05	64.00
LSD		–	–	18.31	0.17	0.54	–	3.94	0.92

[1] Combination of YieldGard VT Triple PRO (Events MON89034 (corn borer active) and MON88017 (rootworm active)) and Herculex XTRA (Events TC1507 (corn borer active) and DAS59122 (corn rootworm active)) technologies.
[2] Combination of YieldGard VT Triple PRO (Events MON89034 (corn borer active) and MON88017 (corn rootworm active) and Herculex RW (Event DAS59122 (corn rootworm active)) technologies.
[3] Herculex XTRA (Events TC1507 (corn borer active) and DAS59122 (corn rootworm active) technologies).
[4] YGVT YieldGard VT (Event MON89034 (corn rootworm active)).
Within columns, means followed by the same letter are not significantly different ($P < 0.05$).

Table 2. Southwestern corn borer (SWCB) damage observations on October 13 from 10 plants and grain yield recorded on Oct. 20, 2008, Garden City

Treatment		Insect events present	Infested ear	SWCB larvae	Stalk tunneling	Ear tip damage	Ear base damage	Kernels damaged	Winstrum rating	Grain yield
			%	no./plant	cm/plant	----------cm/ear----------		no./ear		bu/a
			Means							
1.	YGVT3P/HXX	SmartStax[1]	15.0b	0	0b	0.4	0.1b	3.5b	0.6b	102.5
2.	YGVT3P/HXRW	YieldGard VT Triple Pro/Herculex RW[2]	25.0b	0	0.1b	0.7	0.1b	6.6b	1.0b	129.8
3.	HXX	Herculex XTRA[3]	62.5a	0	0b	1.7	0.5b	11.5ab	2.2ab	137.0
4.	Isoline	–	87.5a	0.2	1.4b	2.7	0.6b	25.5a	4.1a	116.2
5.	Isoline and	–	77.5a	0.2	2.0b	1.4	1.1ab	17.8ab	3.1a	141.6
	Counter 20 CR	8 oz/1000 row-ft								
6.	YGVT	YGVT[4]	82.5a	0.2	1.5b	1.1	2.1a	24.9a	4.0a	113.4
7.	YGVT and	YGVT[4]	90.0a	0.2	6.1a	2.1	1.1ab	18.2ab	3.8a	128.9
	Counter 20 CR	8 oz/1000 row-ft								
			ANOVA							
P value <			0.0001	10.87	0.0171	0.2158	0.0151	0.0031	0.0031	0.2824
CV			30.36	–	144.50	–	95.41	48.13	48.13	–
LSD			28.35	–	3.04	–	1.11	1.93	1.93	–

[1] Combination of YieldGard VT Triple PRO (Events MON89034 (corn borer active) and MON88017 (rootworm active)) and Herculex XTRA (Events TC1507 (corn borer active) and DAS59122 (corn rootworm active)) technologies.
[2] Combination of YieldGard VT Triple PRO (Events MON89034 (corn borer active) and MON88017 (corn rootworm active) and Herculex RW (Event DAS59122 (corn rootworm active)) technologies.
[3] Herculex XTRA (Events TC1507 (corn borer active) and DAS59122 (corn rootworm active) technologies).
[4] YGVT YieldGard VT (Event MON89034 (corn rootworm active)).
Within columns, means followed by the same letter are not significantly different ($P < 0.05$).

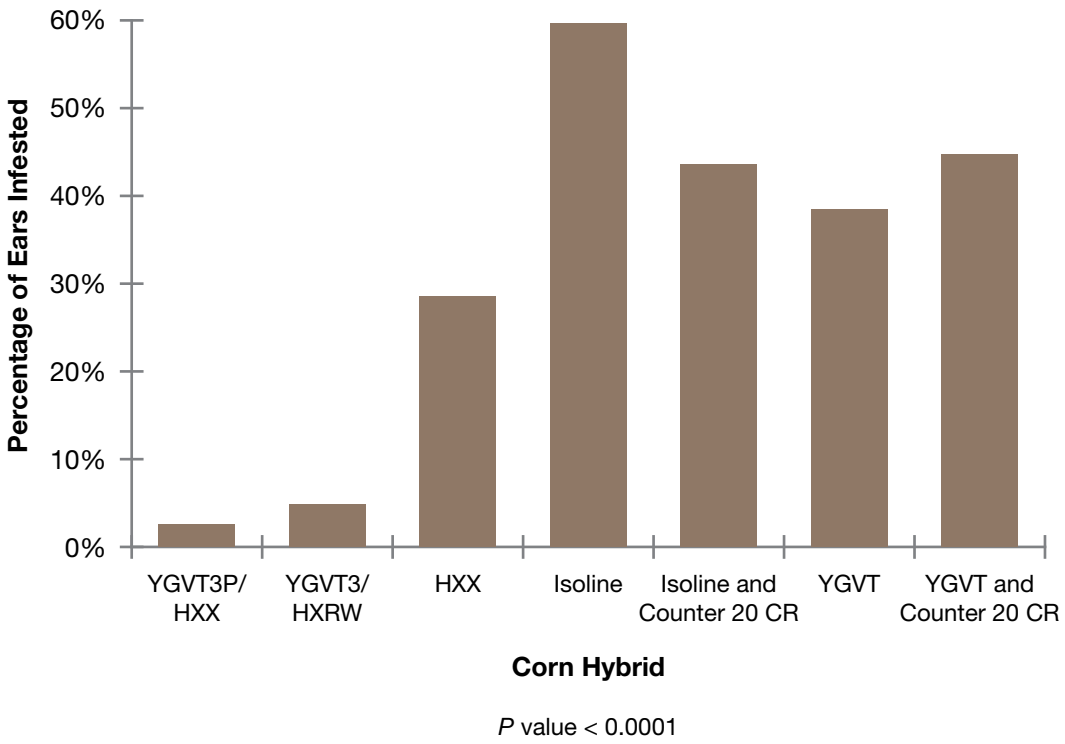

Figure 1. Infestation of corn ears, Aug. 19, 2008.

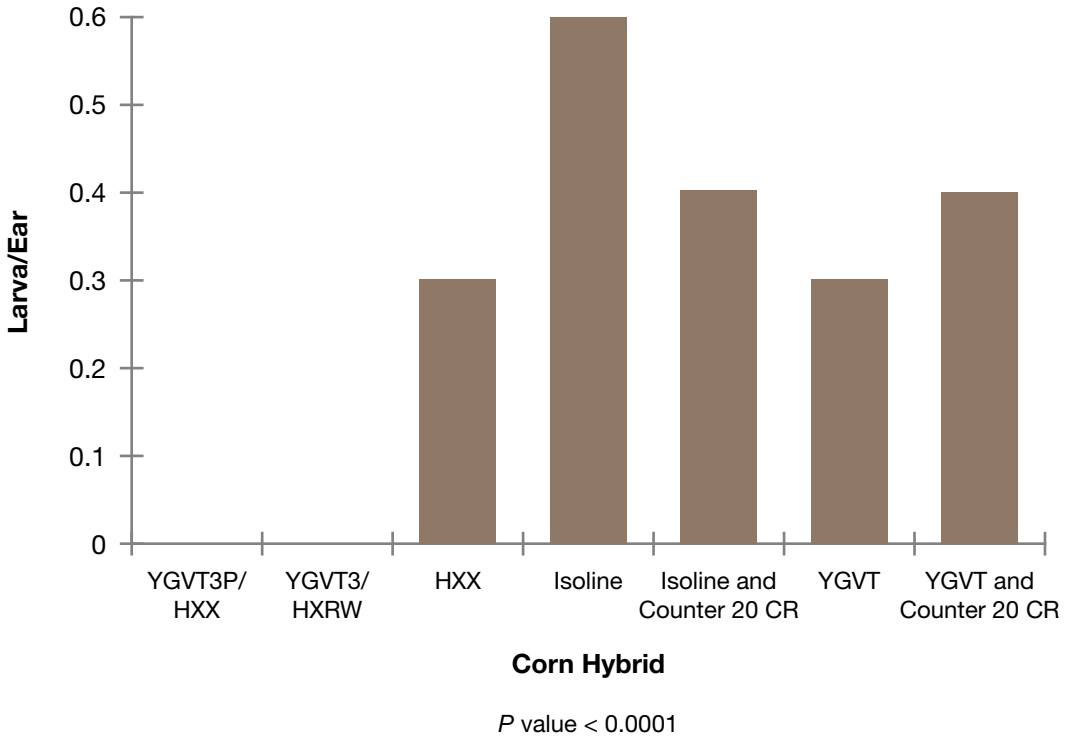

Figure 2. Corn earworm infestation, Aug. 19, 2008.

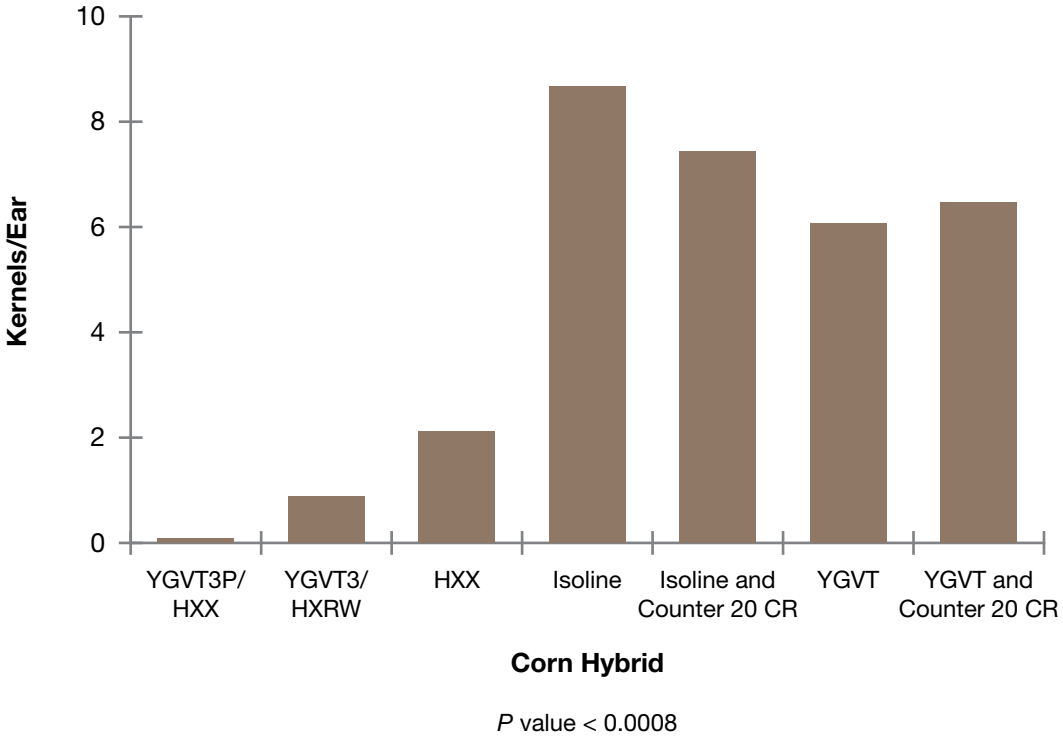

Figure 3. Kernels damaged by corn earworm, Aug. 19, 2008.

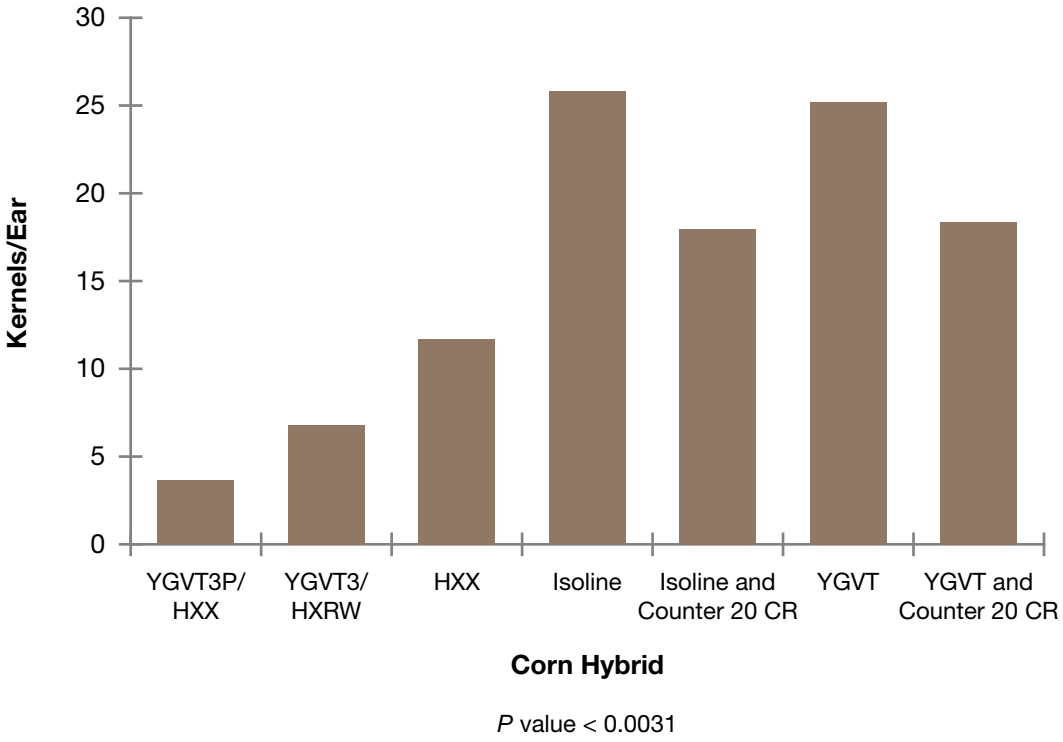

Figure 4. Kernels damaged by corn earworm, Oct. 13, 1008.

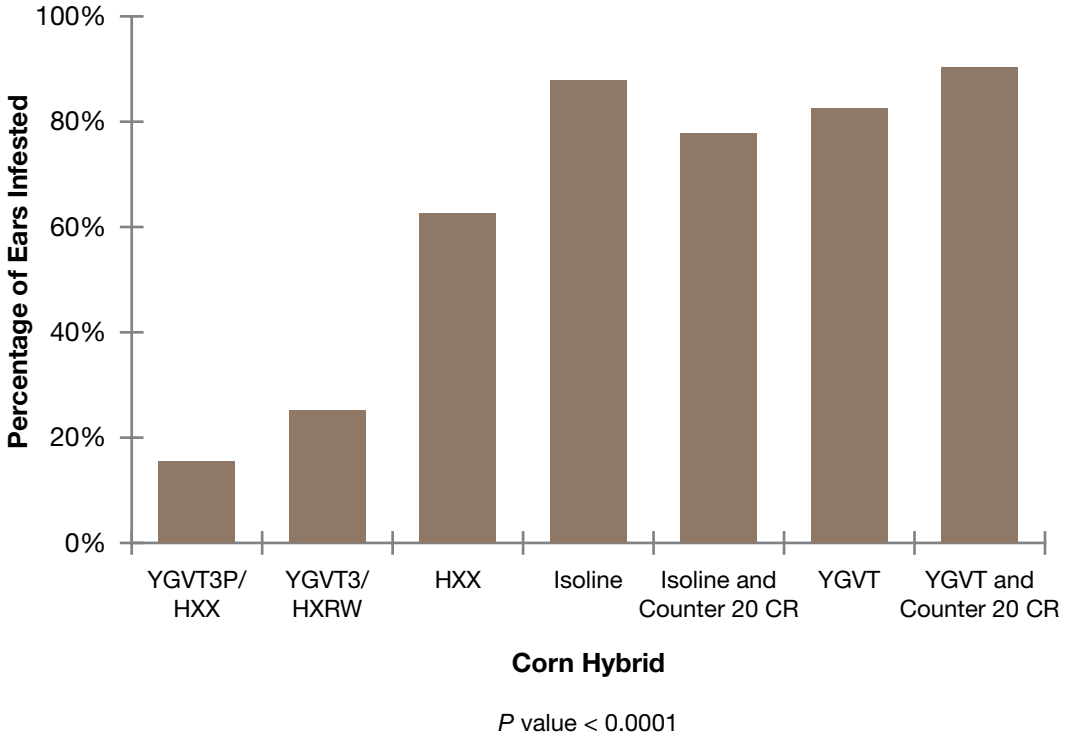

Figure 5. Infestation of corn ears, Oct. 13, 2008.

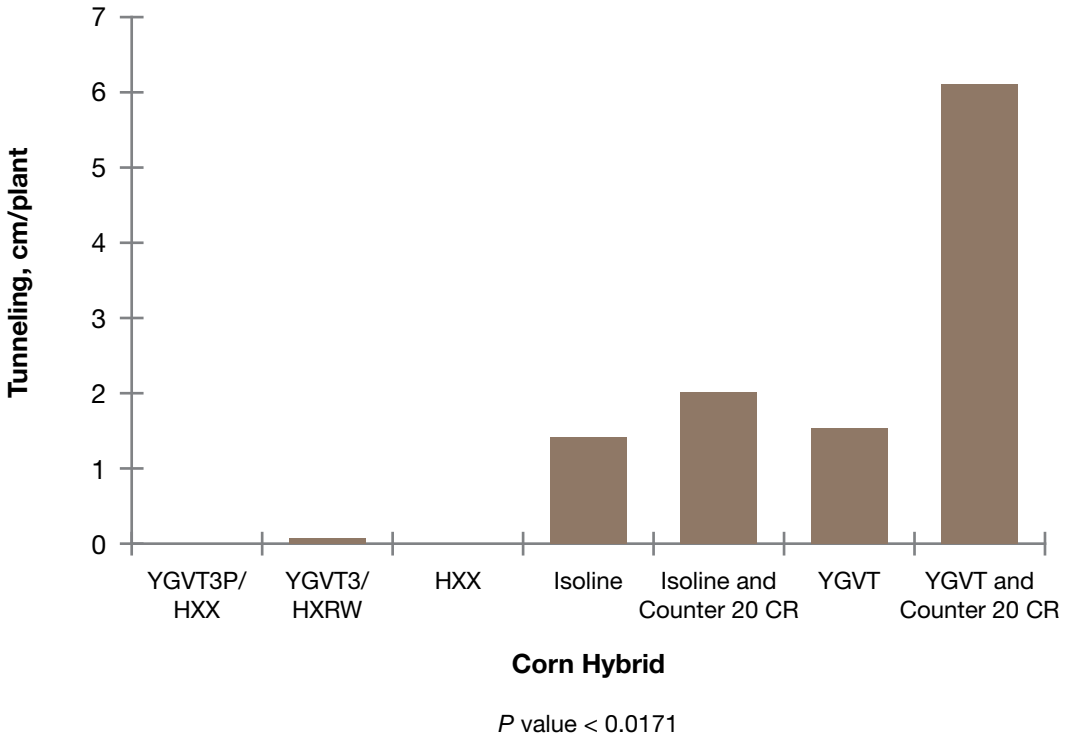

Figure 6. Second generation southwestern corn borer stalk tunneling, Oct. 13, 2008.

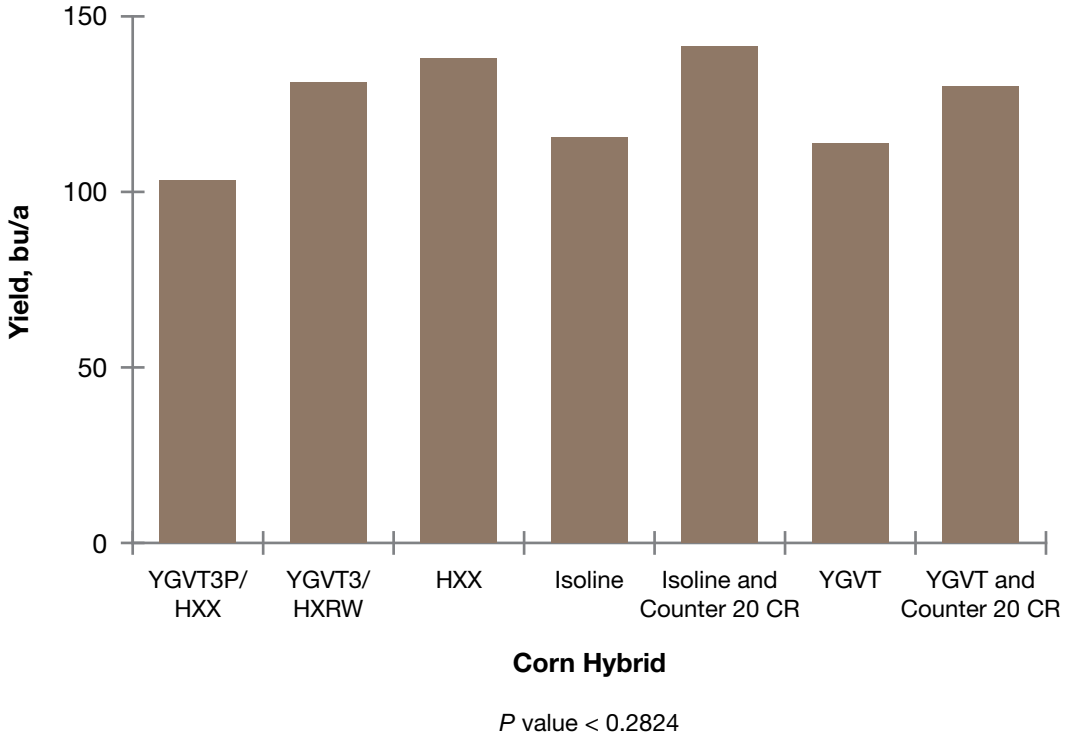

Figure 7. Grain yield from corn hybrids, Oct. 13, 2008.

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