

TIMELY INFORMATION

Agriculture & Natural Resources

Performance of *B.t.* Corn in North Alabama in 2010 (revised)

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Background: There are different kinds of *B.t.* corn,* depending on which *B.t.* genes have been inserted. Some *B.t.* genes protect against stalk borers, others help prevent leaf and ear damage from various caterpillars including corn earworm and fall armyworm. Still other genes protect the roots from western corn rootworm. These genes are bundled together in various combinations, with or without herbicide tolerance genes. See Table 3 for details regarding transgenic products that include *B.t.* insect resistance.

The cost of *B.t.* technology that protects against corn borers and other caterpillars is about \$3.70 per acre for older products such as YieldGard Corn Borer, Agrisure CB/LL, and Herculex I. The cost of Genuity VT Triple PRO is about \$10.50 per acre. Genuity VT Triple PRO contains two genes for aboveground caterpillar resistance, in addition to protection from western corn rootworm.

B.t. corn is really a form of crop insurance that comes in the seed bag. The presence of one or more *B.t.* genes in a corn hybrid will not increase yield potential. Instead, the gene(s) prevent yield losses from certain insects. Therefore, the most important thing to remember is that if the population of the target insect in your field or area is high enough, *B.t.* corn will pay off. If the “insect pressure” is not there, then you won’t get your money back. So it is a matter of deciding if the risk is high enough to warrant purchasing “insurance.”

In 2010 a series of field trials included *B.t.* corn hybrids paired with their non-*B.t.* counterparts (isolines). Two *B.t.* corn traits were tested: Genuity VT Triple PRO and Herculex I (see Table 3 at the end of this information sheet). This information sheet summarizes the yield results from the north Alabama trials, which were heavily infested with southwestern corn borer and/or European corn borer. An additional information sheet will discuss the performance of *B.t.* corn in central and south Alabama, which did not have corn borers.

*Corn that contains insect resistance genes from the bacterium *Bacillus thuringiensis*

Experimental Design: Corn was planted on two dates, standard recommended planting date for the particular area, and a later planting date, approximately 6 weeks later. The same trials were planted at the Upper Coastal Plain Research and Extension Center in Winfield, AL; the Tennessee Valley Research and Extension Center in Belle Mina, AL; and the Sand Mountain Research and Extension Center in Crossville, AL. Three pairs of hybrids were evaluated. One hybrid in each pair contained either the Genuity VT Triple PRO or the Herculex I *B.t.* corn trait. The other hybrid in each pair did not contain a *B.t.* trait but was otherwise genetically identical to its *B.t.* counterpart. All seed was treated with clothianidin (Poncho or Acceleron) at the rate of 250 mg. a.i./kernel. Plots were 8 rows wide by 30 ft long. There were four replications of each corn hybrid, planted in a randomized complete block design. The first planting in Crossville was destroyed prematurely so no data is available. Stand counts and ear feeding damage were evaluated for each of the remaining locations. Stalk borer infestations were rated in Belle Mina and Crossville. Yields were recorded for all but the second planting date in Winfield, which was excessively damaged by birds and raccoons. The plots in Belle Mina were irrigated, and were therefore planted at a higher seeding rate than the other two locations. Plots in Belle Mina were sprayed with a pyrethroid insecticide at planting for cutworm.

Results

Yield differences between the hybrids: Yields from Belle Mina and Winfield (Table 1, Fig. 1) were higher for hybrids that contained a *B.t.* corn trait than for the same hybrid without *B.t.*. However, this response was not always statistically significant. In the late planting in Crossville, yields were very low due to extreme drought stress. At this location, two of the three *B.t.* hybrids out-yielded their non-*B.t.* isolines. Corn planted six weeks after the standard planting date had lower yields, particularly in the non-irrigated locations.

What caused the difference in yields between *B.t.* and non-*B.t.* hybrids? The field trials in north Alabama (Belle Mina, Crossville and Winfield) received high pressure from Southwestern corn borer and moderate corn earworm pressure. Fall armyworm pressure was higher in the late planted tests. There was no western corn rootworm pressure.

Hybrids with a *B.t.* corn trait had significantly fewer corn borers than their non-*B.t.* counterparts (Table 1). Hybrids with the Genuity VT Triple PRO trait had fewer caterpillar damaged kernels per ear than their non-*B.t.* counterparts. This difference was statistically significant in all locations/planting dates except for Crossville when corn was planted later than the standard planting date. The hybrid with the Herculex I trait had less ear feeding in the later planting dates. Hybrids with *B.t.* corn traits tended to have higher stand counts than their non-*B.t.* counterparts in the first planting date, although this difference was not significantly different. In the later planting dates, the hybrid with the Herculex I trait tended to have higher stand counts than its non-*B.t.* counterpart. This difference was statistically significant at Belle Mina.

Does it pay to plant *B.t.* corn hybrids in north Alabama? Table 2 shows the estimated economic return of two *B.t.* corn traits at varying corn prices. This data is reported on a farm wide basis, where 80% of the corn could legally be planted to Genuity VT Triple PRO, or 50% could be legally planted to Herculex I.**

Using a market value of \$4/bushel for corn, estimated economic return, above the cost of the technology, at a standard planting date ranged from \$3-64 per acre for Genuity VT Triple PRO and \$4-18 per acre for Herculex I. For the late planting date, estimated economic return, above the cost of the technology, ranged from a loss of \$16 to a profit of \$67 per acre for Genuity VT Triple PRO and from \$11-19 for Herculex I. Note that the "economic return" does not include other costs of production. For example the highest yield in the late

planting in Crossville was 19 bu/A, which would not have been profitable when other production costs were factored in. Late planted corn in the irrigated test at Belle Mina yielded much better but still may not have been profitable, depending on production costs (average yields 147-170 bu/A, depending upon the hybrid).

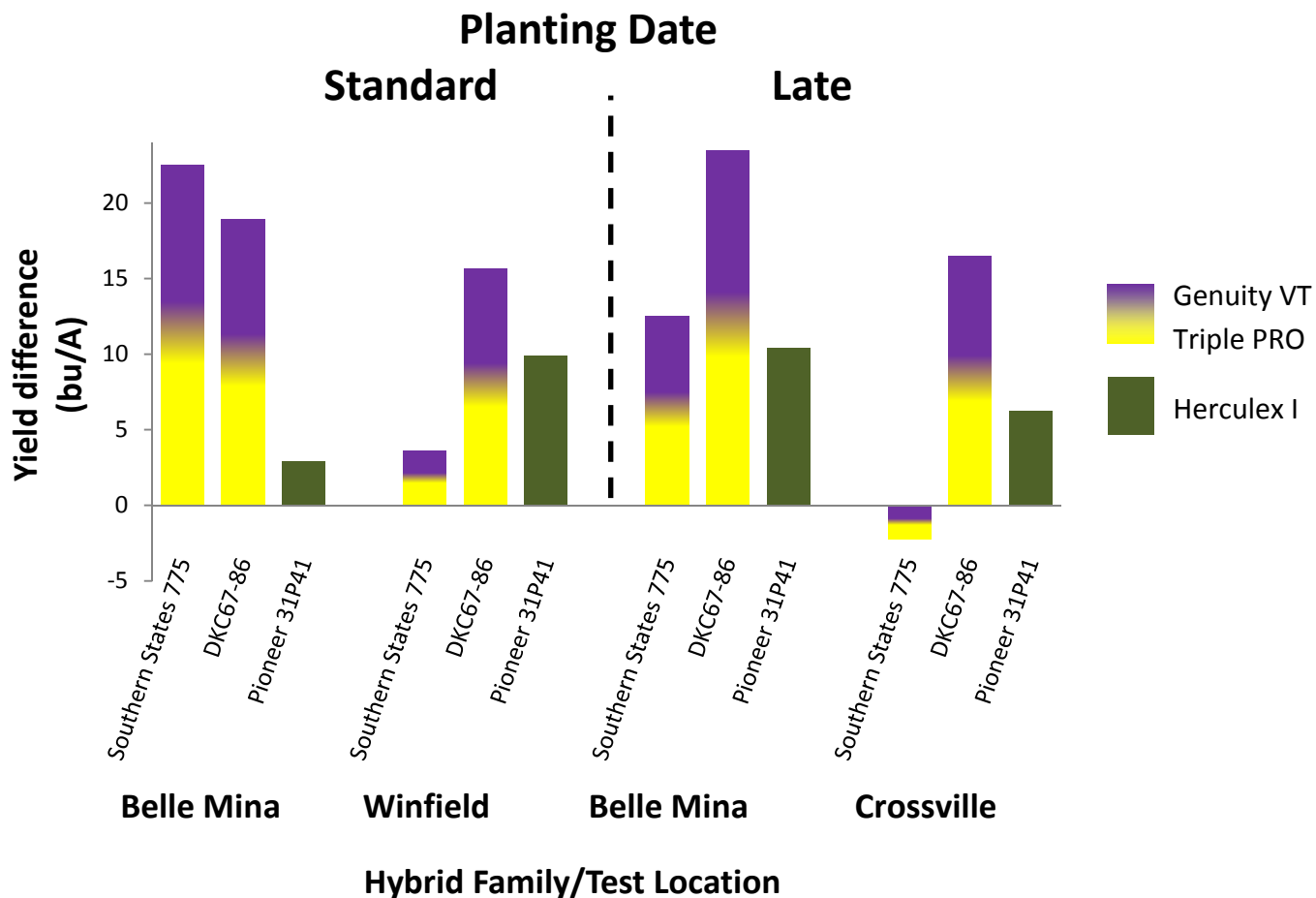


Figure 1. Yield difference between *B.t.* corn hybrids and their non-*B.t.* isolines,

Table 1. Corn Yields, Caterpillar Damage, Stalk Damage, and Stand Counts in Replicated Field Plots, North Alabama, 2010.

Hybrid	Traits*	Standard Recommended Planting Date***		Late Planting Date***		
		Belle Mina	Winfield	Belle Mina	Winfield	Crossville
Yield (Bu/A)**						
SS 749VT Triple PRO	GENVT3P	214 a***	110 a	160 ab	-	9 bc
SS 775RR2	RR2	191 c	107 a	147 c	-	11 ab
DKC67-88	GENVT3P	210 ab	109 a	170 a	-	19 a
DKC67-86	RR2	191 c	93 a	147 c	-	3 bc
Pioneer 31P42	HXI, RR2, LL	201 bc	113 a	158 bc	-	8 bc
Pioneer 31P40	RR2	198 bc	103 a	147 c	-	2 c
Caterpillar Damage on the Ear (cm² damage per ear)						
SS 749VT Triple PRO	GENVT3P	14 a	7 c	4 c	11 c	10 a
SS 775RR2	RR2	25 b	20 a	24 ab	21 ab	16 a
DKC67-88	GENVT3P	14 a	9 c	4 c	10 c	11 a
DKC67-86	RR2	27 b	19 ab	25 a	20 ab	19 a
Pioneer 31P42	HXI, RR2, LL	21 ab	13 bc	10 c	16 bc	9 a
Pioneer 31P40	RR2	21 ab	13 bc	18 b	24 a	19 a
Southwestern Corn Borer (Percent Infested Plants)						
SS 749VT Triple PRO	GENVT3P	3 a	-	3 b	-	0 b
SS 775RR2	RR2	60 b	-	60 a	-	85 a
DKC67-88	GENVT3P	13 a	-	3 b	-	0 b
DKC67-86	RR2	47 b	-	57 a	-	83 a
Pioneer 31P42	HXI, RR2, LL	0 a	-	0 b	-	0 b
Pioneer 31P40	RR2	53 b	-	60 a	-	80 a
Plants per 30 row-ft						
SS 749VT Triple PRO	GENVT3P	55 a	34 a	53 ab	27 ab	47 a
SS 775RR2	RR2	55 ab	27 ab	53 a	32 a	48 a
DKC67-88	GENVT3P	56 a	30 ab	52 bcd	26 ab	47 a
DKC67-86	RR2	54 ab	26 ab	52 cd	25 ab	45 a
Pioneer 31P42	HXI, RR2, LL	54 ab	28 ab	53 abc	21 ab	45 a
Pioneer 31P40	RR2	54 b	25 b	51 d	19 b	43 a

*see Table 3 for explanation of *B.t.* corn traits

**Bu/A determined by combining two (Crossville) or four (Belle Mina) 30 foot rows per plot, then adjusting to 15.5% moisture and a 56 lb bushel. In Winfield, 4 1-m sections of row were hand harvested from plot. Lb of earcorn was adjusted to 15.5% percent moisture and a 75 lb. bushel. Yields in Crossville were very low, due to an extreme drought.

***Values within a column followed by the same letter are not significantly different ($\alpha=0.05$). Each location was a separate experiment, so comparing data across a row is not statistically valid.

Table 2. Estimated Per Acre Return of *B.t.* Corn Traits on a Farm-wide Scale, at Varying Prices of Corn

	Hybrid Family	Price of Corn		
		\$2/bu	\$4/bu	\$6/bu
Genuity VT Triple PRO				
Belle Mina Standard Planting	Southern States 775	\$28	\$64	\$100
	DKC67-86	\$22	\$52	\$82
Winfield Standard Planting	Southern States 775	-\$3	\$3	\$9
	DKC67-86	\$17	\$42	\$67
Belle Mina Late Planting	Southern States 775	\$12	\$32	\$52
	DKC67-86	\$29	\$67	\$104
Crossville Late Planting	Southern States 775	-\$12	-\$16	-\$19
	DKC67-86	\$18	\$44	\$71
Herculex I				
Belle Mina Standard Planting	Pioneer 31P41	\$1	\$4	\$7
Winfield Standard Planting	Pioneer 31P41	\$8	\$18	\$28
Belle Mina Late Planting	Pioneer 31P41	\$9	\$19	\$29
Crossville Late Planting	Pioneer 31P41	\$4	\$11	\$17

*To help preserve the usefulness of *B.t.* corn, the Environmental Protection Agency requires that non-*B.t.* corn be planted on part of the corn acres on each farm as a refuge. This difference in the refuge requirement affects the farm-wide economic returns from a particular *B.t.* technology.

Summary

Always pick hybrids with good a good agronomic fit for your farm, and make sure the hybrid has good disease resistance. Always consider the yield potential of the hybrid family involved, and make sure the hybrid is adapted for planting in the Southeast. Then think about what other value-added traits are available, such as herbicide resistance or *B.t.* corn technology. Results from the 2010 yield trials showed that Genuity VT Triple PRO and Herculex I would have paid off in north Alabama, where there was considerable southwestern corn borer pressure in addition to caterpillar damage in the ears.

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Table 3. Relative Efficacy of Various *B.t.* Corn Products (with Emphasis on the Southeastern United States). Version 2011.1¹

Product Trade Name (Abbreviation)	Corn Earworm (ear)	Fall Army-worm (whorl)	Corn Borers ² (stalk)	Western Corn Root-worm ³ (roots)	Black Cutworm (seedling) ⁴	Lesser Corn-stalk Borer ⁵	Refuge Requirement ⁶	Original Target Pests (<i>B.t.</i> Protein)	Event(s)
<i>B.t.</i> Corn for Controlling Above-Ground Caterpillars (Lepidoptera) and Below-Ground Rootworms (Coleoptera)									
Agrisure Viptera 3111	Excellent	Excellent	Excellent	Fair-Good	Good	Good	20%	Corn earworm, western bean cutworm, black cutworm, and fall armyworm control (Vip3Aa20), corn borer protection (Cry1Ab), Liberty (glufosinate) and Roundup (glyphosate) herbicide tolerance and corn rootworm protection (mCry3A)	MIR162, Bt11, GA21, MIR604
Agrisure 3000GT	Fair	Good	Excellent	Fair-Good	Poor	Good	50%	Corn borer protection (Cry1Ab), Corn rootworm protection (mCry3A), glyphosate herbicide tolerance, Liberty (glufosinate) herbicide tolerance	Bt11, MIR604, GA21
Agrisure CB/LL/RW	Fair	Good	Excellent	Fair-Good	Poor	Good	50%	Corn borer protection (Cry1Ab), Corn rootworm protection (mCry3a), Liberty (glufosinate) herbicide tolerance	Bt11, MIR604
Genuity SmartStax (GENSS) or DowAgro Sciences SmartStax (SSX)	Very Good	Excellent	Excellent	Excellent	Good	Very Good	20%	Corn borer, fall armyworm, corn earworm, western bean cutworm, black cutworm protection (Cry1A.105, Cry2Ab2, Cry1F), Corn rootworm protection (Cry3Bb1, Cry34Ab1/Cry35Ab1), Roundup (glyphosate) and Liberty (glufosinate) herbicide tolerance	MON89034, MON88017, TC1507, DAS-59122-7
Genuity VT Triple PRO (GENVT3P)	Good-Very Good	Excellent	Excellent	Excellent	Poor	Very Good	20%	Corn borer, fall armyworm, corn earworm protection (Cry1A.105 and Cry2Ab2), Corn rootworm protection (Cry3Bb1), Roundup (glyphosate) herbicide tolerance	MON89034, MON88017
Herculex XTRA (HXX)	Poor	Very Good	Excellent	Excellent	Good	Very Good	50%	Corn borer, western bean cutworm, black cutworm and fall armyworm resistance (Cry1F), Corn rootworm resistance (Cry34Ab1/Cry35Ab1), Liberty (glufosinate) herbicide tolerance	TC 1507, DAS-59122-7
YieldGard Plus (YGPL)	Fair	Good	Excellent	Good	Poor	Good	50%	Corn borer protection (Cry1Ab), Corn rootworm protection (Cry3Bb1)	MON810, MON863
YieldGard VT Triple (VT3)	Fair	Good	Excellent	Excellent	Poor	Good	50%	Corn borer protection (Cry1Ab), Corn rootworm protection (Cry3Bb1), Roundup (glyphosate) herbicide tolerance	MON810, MON88017
<i>B.t.</i> Corn for Controlling Above-Ground Caterpillars (Moths, Lepidoptera)									
Agrisure CB/LL	Fair	Good	Excellent	None	Poor	Good	50%	Corn borer protection (Cry1Ab), Liberty (glufosinate) herbicide tolerance	Bt11

Table 3. (cont.)

Product Trade Name (Abbreviation)	Corn Earworm (ear)	Fall Army-worm (whorl)	Corn Borers ² (stalk)	Western Corn Root-worm ³ (roots)	Black Cutworm (seedling) ⁴	Lesser Corn-stalk Borer ⁵	Refuge Requirement ⁶	Original Target Pests (<i>B.t.</i> Protein)	Event(s)
<i>B.t.</i> Corn for Controlling Above-Ground Caterpillars (Moths, Lepidoptera) (continued)									
Agrisure Viptera 3110	Excellent	Excellent	Excellent	None	Good	Good	20%	Corn earworm, western bean cutworm, black cutworm, and fall armyworm control (Vip3Aa20), corn borer protection (Cry1Ab), Liberty (glufosinate) and glyphosate herbicide tolerance	MIR162, Bt11, GA21
Genuity VT Double PRO (GENVT2P)	Good-Very Good	Excellent	Excellent	None	Poor	Very good	20%	Corn borer, fall armyworm, corn earworm protection (Cry1A.105 and Cry2Ab2), Roundup (glyphosate) herbicide tolerance	MON89034, NK603
Herculex I (HXI)	Poor ⁷	Very Good	Excellent	None	Good	Very good	50%	Corn borer, western bean cutworm, black cutworm and fall armyworm resistance (Cry1F), Liberty (glufosinate) herbicide tolerance	TC 1507
YieldGard Corn Borer (YGCB)	Fair	Good	Excellent	None	Poor	Good	50%	Corn borer protection (Cry1Ab)	MON810
<i>B.t.</i> Corn for Controlling Below-Ground Rootworms (Beetles, Coleoptera)									
Agrisure RW	None	None	None	Fair-Good	None	None	20%	Corn rootworm protection (mCry3A)	MIR604
Herculex RW (HXRW)	None	None	None	Excellent	None	None	20%	Corn rootworm resistance (Cry34Ab1/Cry35Ab1) Liberty (glufosinate) herbicide tolerance	DAS-59122-7
YieldGard Rootworm (YGRW)	None	None	None	Good	None	None	20%	Corn rootworm protection (Cry3Bb)	MON863
YieldGard VT Rootworm/RR2 (VTRR2)	None	None	None	Excellent	None	None	20%	Corn rootworm protection (Cry3Bb1) Roundup (glyphosate) herbicide tolerance	MON88017

¹ Most of these insect resistant products are marketed as stacks with herbicide resistant products.

² Southwestern corn borer, European corn borer, and sugarcane borer.

³ There are several species of corn rootworm in the Southeast. Southern corn rootworm is the most prevalent species. These "rootworm" products are not effective against southern corn rootworm. They are effective against western corn rootworm larvae, which occur in areas such as north Alabama and north Georgia

⁴ Based on limited data

⁵ Lepidopteran *B.t.* traits do not specifically list lesser cornstalk borer as a target pest

⁶ See product Insect Resistance Management (IRM) documentation from the seed companies for more details.

⁷ The meaning of these terms is somewhat arbitrary. Excellent usually means better than 95 percent control. Poor means about 30% control. Rankings are meant to be relative.