PERFORMANCE OF BIO-ENGINEERED CORN HYBRIDS

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ABSTRACT: Bio-engineered corn hybrids are rapidly being introduced for commercial use in the United States. These bio-engineered hybrids contain various types of herbicide and/or insect resistance which may improve crop productivity. However, producer reports and limited research results indicate performance deficiencies can occur when comparing bio-engineered crops to their conventional isolines. Our objective was to compare bio-engineered corn hybrid performance to their genetically related conventional isolines in identical cropping systems in various Mississippi environments. Ten hybrids containing bio-engineered hybrid traits, including Roundup Ready, CLEARFIELD, Common Rust Resistance and YieldGard were evaluated compared to their conventional isolines in 2002. Grain yield of bio-engineered corn hybrids differed compared to their respective conventional isolines in 4 of the 10 genotypes evaluated in 2002. Two YieldGard Bt hybrids, Garst 8366Bt and Dekalb DKC68-70 produced a significantly higher yields than their respective conventional isolines, Garst 8366 and Dekalb DK687. Two herbicide resistant hybrids, Pioneer 34B28 and Terral TV2140RR yielded less than their conventional isolines. This indicates grain yield variability can occur in some bio-engineered hybrids. Hybrid phenotypical characteristics, including maturity, plant height, ear height and leaf number of bio-engineered compared to their conventional isolines appear similar.

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INTRODUCTION: Bio-engineered (also referred to as genetically modified organisms or transgenic) corn hybrids are rapidly being introduced for commercial use in the United States. These bio-engineered hybrids exhibit various types of herbicide and/or insect resistance which may improve crop productivity.

However, producer reports and limited research results indicate performance differences can occur when comparing bio-engineered crops to conventional hybrids (Graeber et al., 1999; Larson et al., 2000; Lauer and Wedberg, 1999). Furthermore, since the inception of the Mississippi Seed Arbitration Council in 1989, 94 percent (149 of 159) of the complaints filed involved bio-engineered crop performance (L. Daughtry - MS Dept. of Agriculture, Bureau of Plant Industry, personal communication). The biotechnology-related problems were first reported in 1997, with only one conventional case filed prior to 1997.

Biotechnology customers assume considerable risk from performance failures. Thus, customers need additional educational information before bio-engineered products can be incorporated into successful production and utilization systems. This will improve profitability and demand for producers, manufacturers, consumers and educators.

Our objective was to compare bio-engineered hybrid performance to their closely related conventional isolines in identical cropping systems grown in various Mississippi environments. Many bio-engineered hybrids are developed by incorporating desirable genes into currently successful hybrids. Corn grain yield and plant developmental parameters including plant and ear height, maturity, leaf number, lodging and pest resistance measured throughout the season.

KEYWORDS: Corn, hybrid evaluation, bio-engineering, transgenic, GMO, biotechnology, grain yield.

MATERIALS AND METHODS: Ten bio-engineered corn hybrids and their respective closely-related isolines were grown in field studies at five MAFES branch locations in 2002. The hybrids evaluated were (bio-engineered hybrid in parenthesis): Croplan 691(691Bt), DEKALB DK687 (DKC68-70 and DK687RR), DEKALB DK697 (DKC69-70), Garst 8366 (8366Bt), Pioneer 34B23 (34B28), Pioneer 3223 (31B13 and 32R25) and Terral TV2140 (TV2140RR). Field studies were grown at the Black Belt Branch (Brooksville) on a Brooksville silty clay, the Delta Research and Extension Center (Stoneville) on a Bosket very fine sandy loam, the North Mississippi Research and Extension Center (Verona) on a Leeper silty clay loam, and at Pontotoc Ridge-Flatwoods Branch Experiment Station (Pontotoc) on a Falkner silt loam. The study at Stoneville was furrow irrigated, while all other studies were non-irrigated (dryland).

Hybrids were grown in a randomized complete block design with split-plot arrangement with genotype as the main plot and presence or non-presence of the transgene as subplot with four replications at each location. Plots were four rows wide and varied in length (35-100 feet) depending upon location. Corn was planted in 30 inch rows at all locations except Stoneville, which was 40 inch width rows. Hybrids at the dryland locations were planted at a seeding rate of 28,000 seeds/acre, while hybrids at the irrigated location (Stoneville) were planted at 32,000 seeds/acre. Conventional herbicides were utilized to control weeds.

The middle two rows of each plot were harvested with a two-row plot combine. Shelled grain weight and moisture were measured and adjusted to 15.5% moisture to calculate grain yield. Data were analyzed using Statistical Analysis System (SAS) procedures for analysis of variance. Treatment means were compared using a significance level of $P\#0.05$.

RESULTS AND DISCUSSION: All locations produced moderate to excellent corn grain yields. Below-average air temperatures and timely rainfall predominated during June and July, contributing to relatively high grain yield production at all locations.

Effective weed control was accomplished using conventional herbicides, minimizing variability resulting from weed competition. However, Southwestern corn borers did infest plots at the Stoneville, Verona and Pontotoc locations. Field scouting revealed sufficient Southwestern corn borer egg masses present to warrant insecticide applications at Stoneville and Verona. Thus, insecticides were applied to minimize this source of variability at these locations. These applications achieved good control, minimizing corn borer infestation in all treatments.

There were significant grain yield differences between bio-engineered hybrids compared to their respective conventional isolines for four of the ten genotypes evaluated. Two YieldGard Bt hybrids, Garst 8366Bt and Dekalb DKC68-70 produced significantly higher yields than their respective conventional isolines, Garst 8366and Dekalb DK687 (Table 1). Garst 8366Bt produced 17 bushels per acre more than its conventional isoline, Garst 8366. Dekalb DKC68-70 yielded 14 bushels per acre more than its conventional isoline, Dekalb DK687. Two herbicide resistant hybrids, Pioneer 34B28 and Terral TV2140RR produced yields less than their respective conventional isolines. Pioneer 34B28 produced 10 bushels per acre less than its conventional isoline Pioneer 34B23. Terral TV2140RR yielded 11 bushels per acre less than its conventional isoline, Terral TV2140.

These results indicate grain yield performance variability can occur in some bio-engineered hybrids compared to their conventional isolines. Although yield performance differences appear to be related to specific hybrids rather than certain bio-engineered traits, some traits appear more likely to exhibit performance differences than others. Hybrids containing CLEARFIELD or Roundup Ready herbicide resistance exhibited lower grain yield than their conventional isolines in four of ten hybrids evaluated over the duration of this study (Larson et al., 2001; Larson et al., 2002). Hybrids containing Bt technology produced more grain yield than their conventional isolines in two of six hybrids evaluated over the duration of this study. Although corn borer damage is difficult to minimize when infestations are present (which would promote higher yield in Bt hybrids), grain yield improvement with Bt hybrids has been documented at locations with little or no Southwestern corn borer infestation (Larson et al., 2002).

Hybrid phenotypical characteristics, including maturity, plant height, ear height and leaf number of bio-engineered compared to their conventional isolines were similar.

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Table 1. Average grain yield of bio-engineered and conventional isolines at all locations during 2002.

Brand	Hybrid	Trait	Yield (bu./A.)
Croplan	691Bt	YieldGard Bt	164
	691	Conventional	171
Croplan	818RR	Roundup Ready	176
	818	Conventional	175
DEKALB	DKC68-70	YieldGard Bt	178*
	DK687	Conventional	164
DEKALB	DK687RR	Roundup Ready	171
	DK687	Conventional	171
DEKALB	DKC69-70	YieldGard Bt	176
	DK697	Conventional	181
Garst	8366Bt	YieldGard Bt	175*
	8366	Conventional	158
Pioneer	31B13	YieldGard Bt	166
	3223	Conventional	170
Pioneer	32R25	Common Rust R	179
	3223	Conventional	182
Pioneer	34B28	Clearfield	166*
	34B23	Conventional	176
Terral	TV2140RR	Roundup Ready	163*
	TV2140	Conventional	174
		LSD (0.05)	9

* Significantly different from the respective isoline at $P = 0.05$.