

Agronomic Evaluation of Transgenic Cotton Varieties

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Abstract

Four field tests were conducted at three Arizona locations in 1999 to evaluate the performance of transgenic cotton varieties in Arizona. We included a total of 34 varieties in one or more of these tests. Across locations and varieties, Bollgard (BG) and stacked BG and Roundup Ready (BGRR) varieties produced about 7 to 8% greater lint yields than the conventional varieties from which they were derived. Across all varieties and all tests, the average lint yield of the Roundup Ultra sprayed RR or BGRR treatments was 1569 lb./A, while the average yield of the unsprayed RR or BGRR treatments was 1580 lb./A. Roundup Ready (RR) varieties produced lint yields similar to the conventional varieties with a couple of exceptions. Roundup Ready varieties tended to be taller and more vigorous than the conventional parent. Transgenic varieties were often different from the conventional parent in one or more traits, such as fiber quality, lint percent, boll weight, or maturity, but the variation was not associated with a particular transgene.

Introduction

Arizona cotton growers have readily adopted transgenic varieties into their production programs. Many new transgenic varieties have been developed and released recently, but data on the performance of many of these varieties in Arizona is scarce. The purpose of this experiment was to evaluate the performance of transgenic varieties in Arizona relative to each other and relative to the conventional variety from which they were derived.

Materials and Methods

We conducted a total of four field tests at three different locations in Arizona in 1999. Two tests were located at the Maricopa Agricultural Center (MAC and MAC-E), one at the Marana Agricultural Center (MAR) and one at the Safford Agricultural Center (SAC). We used an unbalanced split-split plot design in the MAC, MAR, and SAC tests. Main plots were “conventional families”, which included all of the Roundup Ready (RR), Bollgard (BG) or stacked (BGRR) transgenic varieties derived from the same genetic (i.e., varietal) background. The first split plot consisted of the different transgenic versions within a family. For example, the main plot containing the ‘DP5415’ family included split-plots of DP5415, ‘NuCOTN 33B’, ‘NuCOTN 32B’, ‘DP448B’, ‘DP5415RR’, and ‘DP458BR’. Herbicide regime comprised the split-split plot treatments. The treatments were replicated four times in the MAR, SAC and MAC-E studies and five times in the MAC study. At MAC, MAR and SAC, we planted all the varieties with the Roundup Ready gene in paired plots and sprayed one plot with Roundup Ultra two or three times depending on the experiment while the other paired plot was not treated with Roundup Ultra. For the MAC-E test, we used a split plot design with conventional family as the main plot and variety as the split plot. All varieties with the RR gene in the MAC-E test received three applications of Roundup Ultra so this study did not include a comparison of sprayed and unsprayed plots of varieties containing the RR gene. This experimental design included

several side-by-side comparisons: 1) Roundup Ultra treated versus untreated plots were compared to evaluate the response of RR and BGRR varieties to the herbicide; 2) transgenic varieties and the recurrent parents from which they were derived were compared to evaluate their relative performance; and 3) the transgenic varieties were compared to evaluate their relative performance. To keep the experiments a reasonable size, we did not include all entries in all tests. For example, the MAC-E test included only earlier maturing varieties. A total of 34 varieties were included in one or more of the tests.

We planted each variety in two-row plots in the SAC and MAC-E tests and in four-row plots in the MAC and MAR tests. Various plot lengths between 38 to 42 ft long were used depending on the study site. Rows were spaced 36 in. apart in the SAC test and 40 in. apart in the other three tests. Preemergence herbicides were applied for weed control prior to planting; Prowl at 2 pt/A was applied at the MAC and MAC-E test sites, Prowl at 1.75 pt/A was applied at the MAR site, and Treflan at 2 pt/A was applied at the SAC site. The MAR and SAC test sites had Caparol applied for morningglory control at layby in July rates of 3 and 3.2 pt/A, respectively. The MAC, MAR, SAC and MAC-E tests were planted on April 16, April 23, April 23, and May 7, 1999, respectively. Plant populations were thinned a single plant/4 in. of row (i.e., 3 plants/ft of row) to obtain plant populations of 43,500/A at SAC and 39,200/A at the other three sites. All plots were kept weed free and we used standard cultural practices to produce the crop, including aggressive measures to control pink bollworm, lygus and whitefly.

All the varieties with the Roundup Ready gene were planted in treatments that were sprayed once over-the-top (i.e., topically) with Roundup Ultra at all four study sites. At the 3.75 true leaf growth stage of cotton, the appropriate plots at MAC were sprayed topically on May 17 with Roundup Ultra (RU) at 1 qt/A plus ammonium sulfate (AMS) at 17 lb/100 gal using a tractor mounted sprayer. The spray boom contained 8002 EVS flat fan nozzles (one per crop row) and the sprayer was operated at 23 PSI and at 3.2 MPH to spray 15.6 GPA. The appropriate treatments at the MAR were sprayed topically at the 3.5 true leaf growth stage on May 28 with RU at 1 qt/A plus AMS at 8.5 lb/100 gal using a broadcast boom and a CO₂ pressurized backpack sprayer. Due to windy conditions (6 MPH at the beginning and 3 MPH at the end of the spray operation), XR8003VS flat fan nozzles were used at MAR. The nozzles were mounted on 19 inch centers and pressurized to 20 PSI to spray 19.2 GPA at a ground speed of 3 MPH. The appropriate plots at SAC were sprayed topically at the 4 true leaf growth stage on June 1 with (RU) at 1 qt/A plus AMS at 8.5 lb/100 gal using a CO₂ pressurized backpack sprayer. The spray boom contained 8002 EVS flat fan nozzles (one per crop row) operated at 32 PSI and traveling at 3 MPH to spray 20.6 GPA. The topical application at the MAC-E site was made on June 7 to 4 true leaf cotton using the same spray parameters used for the SAC topical application.

Treatments that were sprayed topically with Roundup Ultra also received one (MAR) or two (MAR, SAC, and MAC-E) post-directed applications of RU. At MAC, a post-directed application of RU at 1 qt/A plus AMS at 8.5 lb/100 gal was applied at the 12 node cotton growth stage using a tractor mounted sprayer traveling at 4.4 MPH. A 15 inch band of herbicide was sprayed with a pair of flat fan 80015EVS nozzles per crop row operated at 22 PSI to apply 16.7 GPA. The two nozzles per crop row were on drop tubes 16 inches apart on either side of the seed line. The nozzles were oriented such that furrow side of the spray fan from the nozzles was vertical and the crop side of the spray fan was at a shallow angle that intercepted the cotton main stem at about the first true leaf node. This orientation resulted in some leaves at the base of the cotton canopy being sprayed depending on leaf orientation and position at the time of the application. The appropriate treatments at the MAR received a post-directed application of RU at 1 qt/A plus AMS at 8.5 lb/100 gal applied in a 20 inch band at the 10.8 node cotton growth stage using CO₂ pressurized backpack sprayer. Two flat fan 8001EVS nozzles per crop row mounted on drop tubes and operated at 24 PSI to spray 15.8 GPA at 3 MPH were used to make the post-directed application as described above. The appropriate treatments at the SAC and MAC-E were sprayed using the same applications parameters described for MAR on June 18 and June 22, respectively, when the cotton was at the 11.7 and 12.8 node growth stage, respectively. Layby RU applications at 1 qt/A were made when the cotton was 18 to 22 inches tall at MAR, SAC and MAC-E on July 14, 19, and 22, respectively. No AMS was added to the RU because commercially a layby herbicide such as Caparol would normally be tank-mixed with RU. RU was applied at MAR using a single XR11003VK flat fan nozzle mounted on a drop tube in each furrow. The sprayer was operated at 22 PSI and 3 MPH to spray 10.9 GPA with the spray pattern covering from the base of one cotton row's canopy to the base of the adjacent row's canopy. RU was applied at SAC and MAC-E using two flat fan 80015 EVS nozzles mounted in a double swivel on a single drop tube in each furrow operated at 22 PSI and 3 MPH to spray 12.7 or 11.5 GPA, respectively. The two nozzles in each furrow were oriented on the double swivel to give the same spray pattern as described for the MAR layby application.

The last or terminal irrigation was made on September 2, August 21, August 19, and August 31 at MAC, MAR, SAC and MAC-E, respectively. After defoliation, the center two rows of each plot (which was the entire plot at SAC and MAC-E) were harvested with a spindle plot picker at MAC, MAR, SAC, and MAC-E on November 29, November 15, November 9, and November 8, respectively. Prior to harvest, we hand picked a random 50 boll sub-sample from three replications of each treatment at each site. These sub-samples were weighed and then ginned on a 10-saw laboratory gin to determine lint and seed weights and percent weights. The lint sub-samples obtained from the boll sub-samples were sent to the International Textile Center in Lubbock, TX for HVI fiber quality analysis. After harvest, plant heights were measured in three replications of each treatment at all four study sites.

Results and Discussion

The average lint yield of the varieties in the tests ranged from 1264 lb./A at Safford to 1940 lb./A at Marana. Pink bollworm infestations were severe at SAC and MAC. Aggressive control programs were in place that minimized losses, however, there were probably still some yield losses in the conventional and RR varieties in these two tests due to Pink bollworm.

Bollgard varieties tended to produce lint yields equal to or significantly greater than their conventional parent. Across locations, six of the nine BG varieties tested were significantly higher yielding than their respective conventional parent (DP448B, NuCOTN33B, NuCOTN32B, NuCOTN35B, DP90B, and STX9901). One BG variety, PM1560BG yielded significantly less than its conventional parent. When averaged across all locations and all families, the BG varieties produced 7% greater lint yield than the conventional varieties from which they were derived. The highest yielding BG variety in these tests was STX9901 in the MAC, MAC-E, and MAR tests, and DP90B in the SAC tests (Tables 1, 3, 5 and 7).

Roundup Ready varieties produced lint yields that were, in most cases, similar to their conventional parent, although there were two exceptions. DP5690RR produced 118 lb./A less lint than DP5690 and DP436RR produced 196 lb./A less lint than DP50. Across varieties and locations, lint yield of RR varieties was similar to the respective conventional parent (averaging about 2% less). The highest yielding RR variety in all four tests was STX9903 (Tables 1, 3, 5 and 7). RR varieties tended to be taller than their conventional parent (about 5 cm taller on average), yet they produced 1 to 2 fewer total nodes, resulting in greater height-to-node ratios (Tables 2, 4, 6 and 8). These observations indicate that the RR varieties tended to be more vigorous than their conventional parents.

Roundup Ultra applications did not reduce lint yield of the RR or BGRR varieties included in these tests. Across all varieties and all tests, average lint yield of the Roundup Ultra sprayed plots was 1569 lb./A, while average yield of the unsprayed plots was 1580 lb./A, a difference of only 11 lb./A.

Like the BG varieties, BGRR varieties produced lint yields equal to or greater than their conventional parent. Four of the ten BGRR varieties we tested produced lint yields significantly greater than their conventional parent. Across locations and families the BGRR varieties produced lint yields about 8% greater than their conventional parents. The highest yielding BGRR varieties in these tests were STX9902 in the MAC, MAR, and MAC-E tests and DP655BRR in the SAC test (Tables 1, 3, 5 and 7). Like the RR varieties, BGRR varieties tended to be taller and more vigorous (i.e., greater height to node ratios) than their conventional parents (Tables 2, 4, 6 and 8).

We also observed variation between the transgenic varieties and their conventional parents for lint percent, boll weight, fruit retention and nodes above white bloom. The trends in these traits, however, were not associated exclusively with the transgenic trait – some of the transgenic varieties were greater than the conventional parents and some were less than the conventional parents.

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Table 1. Univ of Arizona Transgenic Comparison Test, Maricopa Agricultural Center 1999, **Lint yield and fiber properties.**

Entry	Roundup trtmnt ¹	Lint yield lbs/A	Mic	HVI	UR	HVI	HVI Elon	Rd	b+
				Fiber length in		Fiber str. g/tex			
DP20	U	1450	5.6	1.11	83.3	26.6	5.9	81.4	7.8
DP20B	U	1524	5.4	1.11	83.4	27.5	6.4	82.2	7.9
DP422BRR	S	1534	5.3	1.10	84.1	26.5	6.3	82.3	7.7
DP422BRR	U	1465	5.4	1.13	84.4	26.9	6.3	82.3	7.8
DP5409	U	1354	5.3	1.11	82.2	28.9	5.7	81.1	8.2
DP429RR	S	1361	5.1	1.11	83.3	27.7	5.9	81.4	8.2
DP429RR	U	1327	4.9	1.11	82.4	28.3	5.3	81.5	8.3
DP409BRR	S	1531	5.0	1.10	82.9	27.8	6.0	82.2	8.2
DP409BRR	U	1565	5.0	1.11	80.8	27.8	5.1	81.4	8.3
DP5415	U	1276	5.2	1.14	83.9	30.6	6.0	82.8	7.7
DP448B	U	1691	5.2	1.15	84.0	28.5	6.1	82.1	7.8
NuCOTN32B	U	1526	5.7	1.11	83.6	29.3	5.7	81.9	8.0
NuCOTN33B	U	1503	5.4	1.17	83.3	30.0	5.9	82.3	7.8
DP5415RR	S	1254	5.2	1.14	83.9	29.6	6.2	82.0	7.8
DP5415RR	U	1306	5.5	1.13	83.3	29.8	6.1	82.3	7.8
DP458BRR	S	1323	5.4	1.17	83.5	30.3	6.0	82.9	7.6
DP458BRR	U	1382	5.7	1.13	82.5	30.0	5.6	82.4	7.7
DP5690	U	1223	5.3	1.15	84.5	31.4	4.8	80.2	8.3
NuCOTN35B	U	1354	5.2	1.16	84.2	32.6	5.3	81.0	8.0
DP5690RR	S	1162	5.2	1.14	83.4	32.3	5.7	80.6	8.2
DP5690RR	U	1170	5.4	1.12	83.3	31.1	5.6	81.3	8.1
DP655BRR	S	1371	5.0	1.15	83.6	31.4	5.4	81.2	8.0
DP655BRR	U	1366	5.0	1.16	82.9	31.5	5.2	81.3	8.1
DP90	U	1245	5.1	1.14	82.8	31.2	5.7	80.5	8.2
DP90B	U	1407	5.3	1.13	82.8	31.8	5.1	80.9	8.2
SG125	U	1568	5.6	1.11	83.3	26.7	6.2	79.4	8.6
SG125BRR	S	1614	5.3	1.12	84.3	27.4	6.2	80.9	8.4
SG125BRR	U	1622	5.5	1.08	82.8	25.9	6.3	80.3	8.5
STV474	U	1606	5.5	1.11	83.7	29.4	6.0	79.0	8.6
STX9901BG	U	1839	5.7	1.09	81.9	27.0	4.9	79.0	8.6
STX9903RR	S	1704	5.6	1.07	84.7	27.9	5.4	78.9	8.5
STX9903RR	U	1686	5.6	1.10	83.5	28.0	5.7	79.8	8.5
STX9902BGRR	S	1788	5.8	1.07	83.6	27.8	5.4	78.8	8.9
STX9902BGRR	U	1779	5.8	1.10	82.5	27.4	5.3	79.2	8.7
Average		1467	5.4	1.12	83.5	29.2	5.8	81.0	8.2
LSD (0.05)		135	0.4	0.04	ns	1.3	0.6	0.9	0.3

¹U=unsprayed (no Roundup Ultra treatment); S=sprayed with Roundup Ultra

Table 2. Univ of Arizona Transgenic Comparison Test Maricopa Agricultural Center 1999, **Agronomic characteristics**

Entry	Roundup trtmnt ¹	Lint percent %	Boll weight g	Fruit retention %	Height to node ratio in/node	Nodes above white bloom	Plant height m
DP20	U	37.9	5.1	23.7	1.32	6.7	1.13
DP20B	U	39.7	5.2	20.3	1.53	6.2	1.13
DP422BRR	S	37.5	5.3	19.5	1.50	7.2	1.22
DP422BRR	U	36.8	5.2	24.6	1.46	7.1	1.15
DP5409	U	37.7	4.7	24.6	1.43	8.3	1.32
DP429RR	S	39.0	4.8	20.3	1.55	8.5	1.45
DP429RR	U	37.8	4.6	23.2	1.55	8.4	1.43
DP409BRR	S	38.5	4.8	19.3	1.62	7.9	1.35
DP409BRR	U	38.5	4.6	25.1	1.51	7.9	1.33
DP5415	U	37.2	4.9	18.8	1.52	8.1	1.37
DP448B	U	37.5	5.3	20.3	1.64	7.2	1.33
NuCOTN32B	U	38.5	5.4	19.2	1.66	8.2	1.30
NuCOTN33B	U	37.8	5.2	20.3	1.56	8.2	1.33
DP5415RR	S	38.8	5.1	15.9	1.66	8.2	1.42
DP5415RR	U	38.5	5.0	16.4	1.57	8.9	1.37
DP458BRR	S	38.4	5.0	17.3	1.67	8.5	1.45
DP458BRR	U	39.3	5.0	17.2	1.59	7.7	1.37
DP5690	U	38.0	5.4	13.5	1.67	8.8	1.47
NuCOTN35B	U	37.2	5.5	12.7	1.75	9.2	1.50
DP5690RR	S	36.7	5.4	16.0	1.72	9.0	1.53
DP5690RR	U	37.2	5.1	17.9	1.68	8.9	1.52
DP655BRR	S	37.2	5.4	15.5	1.75	8.8	1.52
DP655BRR	U	36.3	5.3	18.4	1.73	8.0	1.53
DP90	U	38.9	5.0	14.0	1.81	8.8	1.48
DP90B	U	38.1	4.7	17.4	1.69	8.3	1.60
SG125	U	39.3	5.0	27.2	1.69	6.8	1.13
SG125BRR	S	38.8	4.9	19.4	1.87	7.6	1.33
SG125BRR	U	38.1	4.9	22.5	1.89	8.2	1.38
STV474	U	41.4	5.1	24.0	1.55	7.2	1.20
STX9901BG	U	41.4	5.3	20.3	1.59	7.2	1.23
STX9903RR	S	42.1	5.3	22.4	1.69	7.8	1.30
STX9903RR	U	41.3	5.0	22.9	1.64	7.3	1.33
STX9902BGRR	S	42.1	5.1	22.9	1.71	7.3	1.32
STX9902BGRR	U	42.1	5.2	22.2	1.78	7.3	1.27
Average		38.8	5.1	19.3	1.63	7.9	1.35
LSD (0.05)		0.4	1.6	5.7	0.18	1.1	0.13

¹U=unsprayed (no Roundup Ultra treatment); S=sprayed with Roundup Ultra

Table 3. Univ of Arizona Transgenic Comparison Test Marana Agricultural Center 1999, **Lint yield and fiber properties**

Entry	Roundup trtmnt ¹	Lint	Mic	HVI	UR	HVI	HVI	Rd	b+
		yield		Fiber		Fiber			
		lbs/A	length		str.				
			in		g/tex				
DP5409	U	1907	4.8	1.11	82.0	27.3	6.2	81.7	8.4
DP429RR	S	1848	4.2	1.14	82.5	27.3	6.6	82.0	8.4
DP429RR	U	1888	4.7	1.10	80.5	26.6	6.5	82.1	8.4
DP409BRR	S	1946	4.4	1.12	80.7	26.8	6.6	82.3	8.5
DP409BRR	U	1964	4.3	1.13	81.9	28.0	6.7	82.3	8.2
DP5415	U	1906	4.8	1.16	83.1	28.5	7.0	82.5	7.8
DP448B	U	2116	4.4	1.18	83.9	27.4	6.6	83.8	7.8
NuCOTN32B	U	2049	4.9	1.14	83.4	28.2	6.3	82.0	8.0
NuCOTN33B	U	2065	4.5	1.18	82.9	29.1	6.6	83.2	7.8
DP458BRR	S	1921	4.7	1.18	82.8	29.8	6.7	83.5	7.8
DP458BRR	U	2030	4.7	1.17	83.8	29.7	6.8	83.4	7.7
DP5690	U	1783	4.5	1.16	84.4	29.9	5.7	81.7	8.3
NuCOTN35B	U	1907	4.7	1.16	82.2	30.6	5.8	81.6	8.4
DP5690RR	S	1562	4.5	1.17	83.0	30.7	6.2	80.9	8.4
DP5690RR	U	1589	4.4	1.17	83.3	30.9	6.0	81.8	8.1
DP655BRR	S	1867	4.3	1.15	82.9	30.6	6.3	81.8	8.3
DP655BRR	U	1872	4.4	1.16	83.1	30.7	6.4	81.5	8.1
DP90	U	1605	4.6	1.17	84.2	30.4	6.1	81.1	8.3
DP90B	U	1936	4.7	1.15	83.9	29.8	5.9	81.8	8.2
PM1560	U	1872	4.8	1.18	83.5	30.0	6.7	80.3	8.8
PM1560BG	U	1741	5.1	1.11	83.1	27.0	6.5	80.7	8.1
PM1560BGRR	S	1976	4.8	1.13	83.0	28.3	6.3	81.0	8.3
PM1560BGRR	U	1941	4.7	1.15	82.8	28.0	6.2	81.1	8.3
SG125	U	1815	4.9	1.13	83.3	25.5	6.9	80.0	8.6
SG125BRR	S	1966	4.9	1.12	83.2	25.4	6.8	80.9	8.5
SG125BRR	U	1961	4.8	1.10	83.4	26.4	7.1	81.3	8.4
SG501	U	1937	4.9	1.13	83.3	29.5	6.4	80.1	8.3
SG501BRR	S	1906	4.9	1.11	84.2	27.6	6.8	80.7	8.5
SG501BRR	U	1954	5.1	1.09	83.6	27.6	6.8	80.6	8.2
STV474	U	2136	5.3	1.11	83.3	27.2	5.8	78.8	9.0
STX9901BG	U	2147	5.0	1.13	83.0	26.9	6.2	79.8	9.0
STX9903RR	S	2179	5.3	1.11	84.5	27.0	6.1	79.5	9.0
STX9903RR	U	2236	5.0	1.14	83.3	27.5	6.4	80.4	8.7
STX9902BGRR	S	2166	5.2	1.11	83.1	27.3	6.3	79.6	9.0
STX9902BGRR	U	2187	5.3	1.12	83.4	27.3	5.9	79.4	9.0
Average		1931	4.8	1.42	83.2	28.3	6.4	81.3	8.4
LSD (0.05)		153	0.3	0.04	1.6	1.6	0.6	1.1	0.3

¹U=unsprayed (no Roundup Ultra treatment); S=sprayed with Roundup Ultra

Table 4. Univ of Arizona Transgenic Comparison Test Marana Agricultural Center 1999, **Agronomic characteristics**

Entry	Roundup trtmnt ¹	Lint percent %	Boll weight g	Fruit retention %	Height to node ratio in/node	Nodes above white bloom	Plant height m
DP5409	U	38.4	4.9	26.9	1.66	6.7	1.30
DP429RR	S	38.1	4.9	31.3	1.75	7.0	1.41
DP429RR	U	38.1	5.0	26.1	1.62	6.2	1.38
DP409BRR	S	38.4	5.0	31.9	1.71	6.5	1.28
DP409BRR	U	39.0	5.0	25.7	1.72	6.8	1.30
DP5415	U	39.1	5.1	26.5	1.87	6.9	1.36
DP448B	U	37.8	5.5	32.9	1.73	6.3	1.28
NuCOTN32B	U	39.0	5.4	29.1	1.63	6.5	1.30
NuCOTN33B	U	37.8	5.4	28.4	1.71	7.1	1.39
DP458BRR	S	38.7	5.1	30.7	1.88	7.3	1.50
DP458BRR	U	39.0	5.1	29.4	1.88	7.2	1.50
DP5690	U	37.6	5.6	23.7	1.85	7.4	1.68
NuCOTN35B	U	37.1	5.6	21.5	1.91	7.6	1.50
DP5690RR	S	37.5	5.5	18.2	1.97	7.1	1.62
DP5690RR	U	37.0	5.6	24.0	2.07	7.8	1.65
DP655BRR	S	38.2	5.4	29.9	2.18	6.9	1.71
DP655BRR	U	37.0	5.3	27.4	2.07	6.7	1.55
DP90	U	37.1	5.4	24.1	1.85	7.7	1.61
DP90B	U	38.4	5.2	21.5	1.99	6.3	1.60
PM1560	U	39.2	6.0	26.6	1.78	7.1	1.23
PM1560BG	U	39.2	5.4	29.4	1.59	4.3	1.16
PM1560BGRR	S	39.9	5.9	31.1	1.77	6.7	1.34
PM1560BGRR	U	39.4	5.4	24.9	1.89	6.8	1.26
SG125	U	39.8	5.6	24.6	1.77	6.1	1.22
SG125BRR	S	38.7	5.7	33.7	1.75	6.7	1.36
SG125BRR	U	38.8	5.7	28.0	1.90	6.1	1.24
SG501	U	41.1	5.6	31.0	1.80	6.2	1.21
SG501BRR	S	39.2	5.5	35.9	1.79	6.1	1.29
SG501BRR	U	38.8	5.4	29.9	1.88	5.6	1.13
STV474	U	40.9	5.2	27.8	1.60	6.0	1.15
STX9901BG	U	40.0	5.7	32.1	1.61	6.1	1.18
STX9903RR	S	42.4	5.7	28.8	1.67	5.9	1.09
STX9903RR	U	41.8	5.6	30.3	1.56	5.6	1.17
STX9902BGRR	S	40.3	5.7	25.0	1.72	5.4	1.19
STX9902BGRR	U	40.3	5.6	30.4	1.60	5.8	1.12
Average		39.0	5.4	27.9	1.80	6.6	1.40
LSD (0.05)		0.4	1.1	8.2	0.20	1.2	0.14

¹U=unsprayed (no Roundup Ultra treatment); S=sprayed with Roundup Ultra

Table 5. Univ of Arizona Transgenic Comparison Test Safford Agricultural Center 1999, **Lint yield and fiber properties**

Entry	Roundup trtmnt ¹	Lint yield lbs/A	Mic	HVI Fiber length in	UR	HVI Fiber str. g/tex	HVI Elon	Rd	b+
DP5415	U	1234	4.3	1.13	82.8	29.1	6.5	82.7	7.9
DP448B	U	1427	4.3	1.12	81.7	26.1	5.2	82.9	8.2
NuCOTN32B	U	1280	4.5	1.11	81.4	27.4	6.0	82.4	8.2
NuCOTN33B	U	1385	4.5	1.14	83.4	28.2	6.5	83.2	8.1
DP5415RR	S	1273	4.6	1.11	82.1	28.0	6.5	81.3	8.3
DP5415RR	U	1215	4.5	1.12	82.6	27.6	6.2	82.5	8.1
DP458BRR	S	1344	4.4	1.11	81.9	28.2	6.0	82.7	8.2
DP458BRR	U	1459	4.4	1.12	81.6	28.1	6.6	82.9	8.1
DP5690	U	1280	4.2	1.10	81.2	29.7	5.0	82.1	8.4
NuCOTN35B	U	1366	4.2	1.10	81.7	28.3	5.1	81.4	8.4
DP5690RR	S	1206	4.1	1.10	81.5	29.3	5.6	81.8	8.4
DP5690RR	U	1231	4.6	1.08	80.7	28.2	5.4	81.2	8.5
DP655BRR	S	1434	4.4	1.10	81.6	29.0	5.3	81.5	8.6
DP655BRR	U	1416	4.1	1.11	82.2	29.3	5.3	82.1	8.3
DP90	U	1306	4.5	1.10	80.9	28.6	5.0	79.9	8.6
DP90B	U	1397	4.5	1.13	82.5	29.3	5.3	81.4	8.5
PM1560	U	1126	4.6	1.13	82.5	28.2	6.4	80.5	9.1
PM1560BG	U	973	4.9	1.09	82.4	26.7	5.6	80.7	8.2
PM1560BGRR	S	1291	4.6	1.09	81.2	25.7	5.1	81.0	8.6
PM1560BGRR	U	1376	4.7	1.10	82.0	26.6	5.4	80.7	8.8
SG125	U	1049	4.5	1.11	81.4	25.1	6.7	80.2	9.0
SG125BRR	S	1101	4.6	1.08	81.9	24.8	6.1	80.9	8.5
SG125BRR	U	1286	4.6	1.10	82.9	26.1	6.6	81.8	8.7
SG501	U	1111	4.7	1.12	83.9	28.2	6.5	81.3	8.5
SG501BRR	S	1230	4.9	1.06	82.9	26.3	6.7	81.0	8.4
SG501BRR	U	1153	4.8	1.07	83.4	26.2	6.3	81.0	8.4
STV239RR	S	1057	4.8	1.05	82.0	25.2	5.7	81.2	8.4
STV474	U	1177	5.0	1.08	82.5	26.4	5.7	79.3	9.2
STX9901BG	U	1257	4.9	1.08	82.0	25.9	5.2	79.9	8.9
STX9903RR	S	1334	4.8	1.07	82.1	26.0	5.5	80.2	9.1
STX9903RR	U	1417	4.8	1.09	83.4	26.1	5.6	79.8	8.9
STX9902BGRR	S	1411	5.0	1.07	82.6	26.7	6.2	79.8	9.3
STX9902BGRR	U	1250	4.9	1.08	82.0	26.4	5.0	79.0	8.8
Average		1249	4.6	1.10	82.1	27.3	5.8	81.2	8.5
LSD (0.05)		212	0.4	0.03	0.9	1.7	0.9	1.3	0.3

¹U=unsprayed (no Roundup Ultra treatment); S=sprayed with Roundup Ultra

Table 6. Univ of Arizona Transgenic Comparison Test Safford Agricultural Center 1999, **Agronomic characteristics**

Entry	Roundup trtmnt ¹	Lint percent %	Boll weight g	Fruit retention %	Height to node ratio in/node	Nodes above white bloom	Plant height m
DP5415	U	39.2	4.3	44.7	1.13	5.4	0.84
DP448B	U	39.0	4.8	42.7	1.10	4.9	0.94
NuCOTN32B	U	39.2	4.6	47.8	1.19	5.4	0.90
NuCOTN33B	U	39.0	4.6	37.1	1.10	5.9	0.93
DP5415RR	S	40.5	4.4	41.6	1.20	5.1	0.91
DP5415RR	U	40.0	4.3	46.0	1.17	5.4	0.91
DP458BRR	S	39.0	4.5	47.3	1.37	6.1	1.02
DP458BRR	U	40.2	4.5	41.3	1.27	6.3	0.90
DP5690	U	39.8	4.6	36.1	1.43	6.6	0.98
NuCOTN35B	U	39.3	4.9	33.0	1.52	6.9	1.07
DP5690RR	S	39.0	4.9	39.4	1.59	6.6	1.06
DP5690RR	U	40.0	4.8	40.1	1.43	6.3	1.05
DP655BRR	S	39.2	4.9	33.7	1.41	6.2	1.12
DP655BRR	U	38.9	5.0	37.1	1.56	6.3	1.15
DP90	U	40.5	4.7	35.2	1.26	5.9	1.06
DP90B	U	39.1	4.5	42.8	1.31	6.0	1.05
PM1560	U	40.0	5.2	43.0	1.19	5.6	0.88
PM1560BG	U	39.4	4.7	55.7	1.14	3.8	0.85
PM1560BGRR	S	40.7	5.0	41.6	1.22	6.1	0.89
PM1560BGRR	U	40.3	5.0	39.7	1.21	5.0	0.92
SG125	U	39.1	4.8	49.5	1.33	4.9	0.90
SG125BRR	S	38.9	5.0	45.3	1.26	4.7	0.94
SG125BRR	U	38.7	4.9	47.1	1.31	4.8	0.95
SG501	U	40.8	4.7	48.6	1.30	5.2	0.84
SG501BRR	S	39.6	4.8	35.3	1.41	4.9	0.88
SG501BRR	U	39.1	4.9	38.0	1.38	4.9	0.90
STV239RR	S	40.5	5.0	49.1	1.11	5.0	0.86
STV474	U	41.7	4.7	46.5	1.12	5.3	0.87
STX9901BG	U	40.9	5.2	46.1	1.28	5.9	0.94
STX9903RR	S	41.5	4.8	45.7	1.33	6.1	0.93
STX9903RR	U	41.4	4.9	46.5	1.36	6.1	0.92
STX9902BGRR	S	41.5	5.2	47.8	1.34	6.2	0.90
STX9902BGRR	U	40.5	5.2	40.3	1.47	6.3	0.92
Average		40.0	4.8	43.1	1.27	5.6	0.94
LSD (0.05)		0.3	1.3	10.2	0.23	1.3	0.13

¹U=unsprayed (no Roundup Ultra treatment); S=sprayed with Roundup Ultra

Table 7. Univ of Arizona Transgenic Comparison (MAC-E) Test Maricopa Agricultural Center 1999, **Lint yield and fiber properties**

Entry	Roundup trtmnt ¹	Lint yield lbs/A	Mic	HVI Fiber length in	UR	HVI Fiber str. g/tex	HVI Elon	Rd	b+
AP7115	U	1420	4.8	1.16	84.3	28.6	5.8	82.8	7.7
DP20	U	1228	4.9	1.13	83.8	26.8	6.0	81.9	8.1
DP20B	U	1253	5.0	1.16	83.4	26.8	6.1	82.3	7.9
DP422BRR	S	1346	5.0	1.14	84.4	26.1	6.5	82.4	8.0
DP50	U	1259	5.1	1.18	84.3	27.7	5.9	82.4	7.8
DP50B	U	1291	5.0	1.19	83.7	28.0	6.3	83.1	7.7
DP436RR	S	1063	4.9	1.16	83.2	26.7	6.4	82.4	8.1
DP450BRR	S	1164	5.2	1.18	84.1	26.5	6.3	82.8	7.4
DP51	U	1026	5.0	1.17	83.8	27.0	5.6	83.1	7.5
DP428B	U	1053	5.1	1.16	83.8	28.0	6.0	82.1	7.9
DP425RR	S	1086	5.2	1.14	83.3	27.2	6.0	82.0	8.2
DP451BRR	S	1132	5.2	1.16	83.5	27.6	5.5	82.2	8.1
NuCOTN33B	U	1411	5.1	1.17	84.2	30.4	5.9	82.2	7.8
SG125	U	1253	5.3	1.16	84.7	27.5	6.4	80.8	8.3
SG125BRR	S	1197	5.1	1.14	83.7	26.7	6.1	82.3	8.3
SG747	U	1509	5.7	1.13	83.5	27.2	6.2	80.3	8.8
STV474	U	1720	5.3	1.16	85.7	29.4	6.0	79.4	8.6
STX9901BG	U	1896	5.5	1.17	84.9	28.5	6.1	79.5	8.5
STX9903RR	S	1734	5.6	1.15	84.0	27.1	5.5	79.0	8.6
STX9902BGRR	S	1746	5.4	1.13	84.3	28.8	5.9	78.8	8.7
Average		1308	5.2	1.16	84.0	27.4	6.0	81.5	8.1
LSD (0.05)		150	0.3	0.03	ns	1.1	ns	1.4	0.3

¹U=unsprayed (no Roundup Ultra treatment); S=sprayed with Roundup Ultra

Table 8. Univ of Arizona Transgenic Comparison (MAC_E) Test Maricopa Agricultural Center 1999, **Agronomic characteristics**

Entry	Roundup trtmnt ¹	Lint percent %	Boll weight g	Fruit retention %	Height to node ratio in/node	Plant height m
AP7115	U	37.6	5.9	19.7	1.74	1.34
DP20	U	34.6	5.7	14.4	1.71	1.24
DP20B	U	36.5	5.8	13.9	1.75	1.24
DP422BRR	S	34.8	5.6	16.4	1.77	1.46
DP50	U	32.8	6.2	16.3	1.70	1.26
DP50B	U	31.6	6.1	13.8	1.83	1.30
DP436RR	S	32.3	6.2	14.1	1.79	1.36
DP450BRR	S	31.9	5.8	13.1	1.78	1.36
DP51	U	33.5	5.7	13.1	1.86	1.37
DP428B	U	33.8	6.0	11.4	1.85	1.37
DP425RR	S	34.1	6.1	12.9	1.84	1.38
DP451BRR	S	33.8	5.9	10.9	1.78	1.42
NuCOTN33B	U	35.4	5.6	12.9	1.72	1.38
SG125	U	37.7	6.0	17.4	1.85	1.30
SG125BRR	S	36.3	5.8	17.6	1.93	1.38
SG747	U	39.2	5.8	14.1	1.98	1.36
STV474	U	39.1	5.7	21.6	1.75	1.24
STX9901BG	U	40.1	6.4	21.4	1.79	1.18
STX9903RR	S	40.4	5.9	19.1	1.78	1.27
STX9902BGRR	S	39.3	5.9	18.7	1.83	1.31
Average		35.2	5.9	15.7	1.80	1.32
LSD (0.05)		0.0	1.5	5.6	ns	0.15

¹U=unsprayed (no Roundup Ultra treatment); S=sprayed with Roundup Ultra