Agronomic Evaluations of New Transgenic and Non Transgenic Cotton Varieties in La Paz and Mohave Counties

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Abstract

In 1996 transgenic Bt cotton was first grown on a commercial level in Arizona. In 1997 transgenic Roundup and Buctril herbicide resistant cotton varieties were introduced and grown on commercially in Arizona. Furthermore, in 1997, four new heat tolerant non-transgenic cotton varieties for commercial release in 1998 were available for University field tests. Prior to 1997, the agronomic characteristics of these new cotton varieties had not been evaluated in side by side replicated field comparisons beyond the level of the developing companies. Field tests were conducted in La Paz and Mohave Counties in 1997 examining agronomic characteristics of new transgenic Bt (Deltapine 5415 vs. Deltapine 32 B and 33B) and herbicide resistant (Paymaster 1220 BGRR vs. 1244 BGRR and Stoneville 474 vs. BXN 47) and non transgenic heat tolerant (SureGrow 125 vs. 180 and 821, Stoneville 474 vs. 468, and Germain's GC 9230) cotton varieties.

Introduction

Spring 1996 was the first year Deltapine (DP) transgenic Bt cotton was commercially available in Arizona. Companion varieties DP 5415 and NuCotn 33B were evaluated for agronomic performance (ie. growth, development, lint quality and yield) at nine locations across cotton producing regions of Arizona (Silvertooth et. al., 1997). Only slightly higher vigor or growth rates were noted for 33B over 5415, and higher lint yields for 33B over 5415 were observed in most cases. It was concluded that 33B, as a transgenic version of 5415, is indeed very close in agronomic performance to its non-Bt counterpart.

In 1997, Deltapine commercially introduced another new transgenic cotton variety called NuCotn 32B, which is a companion variety to DP 5432 and 5415. Spring 1997 was the first year transgenic cotton varieties with the stacked Bt (Bollgard or BG) plus Roundup Ready (RR herbicide resistant) genes were commercially available in two new varieties, Paymaster 1220 BGRR and 1244 BGRR which were companion varieties to 1220 and 1244, respectively . Prior to this introduction, Paymaster cotton varieties had been grown only on a limited number of Arizona farms. Additionally, in 1997, Stoneville released a new transgenic Buctril herbicide resistant variety called BXN 47 which was a companion variety to 474. Insecticidal or herbicidal properties of these new transgenic varieties and their non-transgenic counterparts were evaluated extensively prior to their release, however their agronomic properties had not been evaluated to any sufficient extent beyond the level of the developing companies.

Heat stress has been assigned much of the blame for the relatively poor performance of low desert cotton crops in recent years. In 1997, four new cotton advanced strains with potential for heat tolerance were available for

University of Arizona (UA) evaluations of agronomic performance. These new varieties should be commercially available in 1998 and included SureGrow 180 and 821 which were compared to 125, Stoneville 468 which was compared to 474, and Germain's GC 9230.

The objectives of this study were to conduct side by side replicated agronomic evaluations of: 1) two transgenic Bt cotton varieties (DP 32B and 33B), compared to their non-Bt counterpart (DP 5415); 2) two transgenic stacked Bt and Roundup Ready (RR) cotton varieties (Paymaster 1220 BGRR and 1244 BGRR), compared to DP 32B and 33B; 3) one transgenic Buctril resistant cotton variety (Stoneville BXN 47), compared to its non-BXN counterpart (Stoneville 474) and the varieties examined in objectives 1 and 2 above; and 4) four new heat tolerant non-transgenic cotton varieties (SureGrow 180 and 821, Stoneville 821, and Germain's 9230), compared to their recurrent or non-transgenic parents (SureGrow 125 and Stoneville 474) and the varieties outlined in objectives 1 through 3 above.

Materials and Methods

Two experiments associated with the UA upland cotton variety testing program was conducted during 1997 in Parker Valley (located in southwestern La Paz County) and Mohave Valley (located in western Mohave County).

Greg Sprawls, farm manager for CRIT Farms was the Parker Valley site cooperator. Deltapine 5415, 32B, and 33B; Paymaster 1220 BGRR and 1244 BGRR; Stoneville 474 and BXN 47; SureGrow 125 and 180; and Germain's GC 9230 were planted wet on April 11 with a John Deere 7300 Maxi-Merge Vacuum Plate Planter that hill dropped 3 seed every 10 inches of row. Each variety was replicated four times in a randomized complete block experimental design. Individual plots were 4 rows wide (40 inch rows) by the length of the irrigation run (1250 feet long). The field was managed by the grower-cooperator. A complete set of plant measurements were collected on monthly intervals. Measurements taken included: initial population, plant height, number of mainstem nodes, first fruiting branch, total number of aborted sites (1st and 2nd position), and the number of nodes above the uppermost white bloom. Seed cotton yields were estimated by mechanically harvesting each plot, and determining plot weights by the use of electronic scales placed at the end of the field on October 23. Subsamples of seed cotton were ginned for lint turnout estimates and lint samples were subjected to HVI analysis. Data was analyzed statistically in a manner consistent with the experimental design using ANOVA methods.

Del Wakimoto, farm manager for Ft. Mojave Tribe Avi Kwa 'Ame Farms was the Mohave Valley site cooperator. Deltapine 32B and 33B; Paymaster 1220 BGRR and 1244 BGRR; Stoneville 474 and 468; and SureGrow 125 and 821 were planted wet on April 9 with a John Deere 7100 Maxi-Merge Planter calibrated for 14 lbs Deltapine 33B seed per acre. Each variety was replicated four times in a randomized complete block experimental design. Individual plots were 6 rows wide (40 inch rows) by the length of the irrigation run (810 feet long). A complete set of plant measurements were collected on monthly intervals. Measurements taken included: initial population, plant height, number of mainstem nodes, first fruiting branch, total number of aborted sites (1st and 2nd position), and the number of nodes above the uppermost white bloom. Seed cotton yields from four center rows of each plot were determined on October 16.

Results and Discussion

Cotton plant populations at the Parker Valley site were minimal ranging from 19,675 to 24,725 plants/acre. From the plant mapping data presented in Tables 1 through 4 for Parker Valley and Tables 5 through 8 for Mohave Valley, evidence is presented that supports the claims that DP 32B and 33B are indeed very similar to their non-Bt counterpart, DP 5415. Although plant vigor was relatively high at both sites, no differences were detected with respect to vigor or growth rates and fruit retention when comparing DP 5415, 32B, and 33B. However, at the Parker

Valley location, DP 33B plant populations were approximately 10% lower than DP 5415 and 32B seeded at identical rates. This supports some field observations during the 1997 cotton growing season in these valleys indicating that DP 33B planted into cool soil had slightly lower seedling vigor compared to DP 5415.

Paymaster 1220 BGRR and 1244 BGRR was 2 to 5 inches taller and had 15 to 25% higher height to node ratios through the peak bloom growth stage compared to DP 5415, 32B, and 33B. In fact, Paymaster 1220 BGRR and 1244 BGRR had the highest vigor or growth rates prior to peak bloom compared to all the other cotton varieties examined in this study. Paymaster 1244 BGRR was slightly more vigorous in growth rate compared to 1220 BGRR. These two relatively large seeded varieties also had lower final plant populations compared to DP 5415, 32B, and 33B. Both the Paymaster 1220 BGRR and 1244 BGRR could have possibly benefitted from early to mid season growth regulator (Pix) applications due to low fruit retention and high height to node ratios.

A fair evaluation of heat tolerance can be made by comparing August and September fruit retention levels among the upland cotton varieties tested in this study. There were no significant differences observed among the varieties examined in this study in fruit retention levels at the 1st and 2nd positions during August and September. Fruit retention levels for all varieties ranged from 42.6 to 57.4% during this time. This would indicate that the varieties examined in this study were similar in their ability to tolerate the relatively minimal heat stress encountered during the 1997 growing season.

At the Parker Valley site, lint yields of the two DP transgenic Bt cotton varieties (32B and 33B) were not significantly different from each other or from their parent non-Bt variety (5415) at the October 23 harvest (Table 4). Of the two transgenic stacked Bt and RR cotton varieties, lint yield of Paymaster 1244 BGRR was comparable to the DP Bt and non-Bt cotton varieties, however lint yield of Paymaster 1220 BGRR was lower than DP 32B. Lint yield of Stoneville 474 was statistically equivalent to its transgenic Buctril resistant counterpart BXN 47. Nevertheless, lint yield of Stoneville 474 was significantly higher compared to the other cotton varieties grown in this test (DP 5415, 32B, and 33B; Paymaster 1220 BGRR and 1244 BGRR; and SureGrow 125). SureGrow 125 had the lowest lint yields observed in this study, possibly due to a late replant of one row in each plot caused by a clogged planter hose.

At the Mohave Valley site, lint yields of the two DP transgenic Bt cotton varieties (32B and 33B) were not significantly different from each other at the October 16 harvest (Table 8). Of the two transgenic stacked Bt and RR cotton varieties, lint yield of Paymaster 1244 BGRR was comparable to the DP Bt varieties (33B and 35B), however lint yield of Paymaster 1220 BGRR was lower than that of the other varieties examined in this study (DP 32B and 33B; SureGrow 125 and 821; and Stoneville 474 and 468). The heat tolerant SureGrow 832 did not significantly outyield its counterpart, SureGrow 125. Another heat tolerant cotton variety, Stoneville 468, had lint yield that was not significantly different from its counterpart, Stoneville 474.

At both sites, DP 5415, 32B, and 33B lint yields were not significantly different, indicating that they are quite similar in yield, growth habit, and fruit retention. Paymaster 1220 BGRR had lower lint yields than Paymaster 1244 BGRR, however lint yield of Paymaster 1244 BGRR was comparable to that of the DP varieties examined in this study (5415, 32B, and 33B). Lint yield of Stoneville 474 was comparable to or greater than that of the DP varieties, and lint yields of Stoneville BXN 47 and 468 were comparable to Stoneville 474. Lint yield of SureGrow 821 was comparable to SureGrow 125, however SureGrow 821 seemed to be somewhat more heat tolerant than SureGrow 125. Yield comparisons of the varieties examined in this study were conducted under a relatively short growing season and light pink bollworm pressure. Consequently, their relative lint yields could be somewhat different under higher pink bollworm infestations or when subjected to full or long season production systems.

References

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Table 1. Parker Valley upland cotton variety evaluation. Measurements taken: June 3, 1997 at 1099 heat units after planting.

Variety	Plants/ Acre (#)	Plant Height (inch)	First Fruiting Branch	Height: Node Ratio	Fruit Retention (%)
Deltapine 5415	24,100 ab	13.4 de	6.1 a	1.00 cd	66.5 abcd
Deltapine 32B	23,425 abc	12.7 e	6.1 a	0.94 d	71.2 ab
Deltapine 33B	20,975 cd	12.9 e	6.2 a	0.95 d	67.6 abc
Paymaster 1220 BGRR	19,675 d	17.3 a	5.5 c	1.24 a	58.2 def
Paymaster 1244 BGRR	20,100 d	17.7 a	5.6 c	1.24 a	55.0 ef
SureGrow 125	20,575 d	14.1 cd	5.7 bc	1.06 bc	72.2 a
SureGrow 180	22,150 a-d	15.0 bc	6.0 ab	1.05 bc	59.9 cdef
Stoneville 474	22,000 bcd	13.7 de	6.0 ab	1.01 cd	68.1 abc
Stoneville BXN 47	22,400 a-d	15.6 b	6.1 a	1.09 b	62.4 bcde
Germaine's GC 9230	24,725 a	14.1 cd	6.0 ab	1.03 bc	52.3 f
Suggested Baseline	25,000	------	5-7	1.08	71.8

Table 2. Parker Valley upland cotton variety evaluation. Measurements taken: July 1, 1997 at 1762 heat units after planting.

Variety	Plant Height (inch)	Nodes Above White Bloom	Height: Node Ratio	Fruit Retention (%)
Deltapine 5415	44.2 cd	6.5 a	2.21 a	66.5 a
Deltapine 32B	45.8 bcd	6.8 a	2.18 a	67.6 a
Deltapine 33B	46.3 bcd	6.6 a	2.25 a	71.9 a
Paymaster 1220 BGRR	47.8 ab	6.6 a	2.30 a	69.2 a
Paymaster 1244 BGRR	50.0 a	7.0 a	2.36 a	67.2 a
SureGrow 125	43.7 d	7.0 a	2.23 a	73.1 a
Stoneville 474	45.5 bcd	6.8 a	2.05 a	70.6 a
Stoneville BXN 47	47.5 abc	6.3 a	2.37 a	65.3 a
Suggested Baseline	------	6-8	1.41	63.9

Table 3. Parker Valley upland cotton variety evaluation. Measurements taken: August 1, 1997 at 2576 heat units after planting.

Variety	Plant Height (inch)	Nodes Above White Bloom	Height: Node Ratio	Fruit Retention (%)
Deltapine 5415	54.2 a	5.3 abc	1.89 a	55.9 a
Deltapine 32B	52.9 a	5.8 a	1.82 a	55.4 a
Deltapine 33B	53.0 a	5.6 ab	1.81 a	57.4 a
Paymaster 1220 BGRR	53.1 a	5.1 bc	1.91 a	57.4 a
Paymaster 1244 BGRR	56.3 a	5.6 ab	1.95 a	56.3 a
SureGrow 125	52.6 a	5.6 ab	1.89 a	58.4 a
Stoneville 474	52.3 a	5.6 ab	1.82 a	57.2 a
Stoneville BXN 47	54.5 a	4.8 c	1.90 a	56.5 a
Suggested Baseline	------	5-6	1.63	54.6

Table 4. Parker Valley upland cotton variety evaluation. Final measurements taken: September 4, 1997 at 3556 heat units after planting. Plots were harvested on October 23, 1997.

Variety	Plant Height (inch)	Nodes Above White Bloom	Height: Node Ratio	Fruit Retention (%)	Lint Yield (lbs/acre)
Deltapine 5415	62.1 a	0 a	1.67 a	55.3 a	1106 bc
Deltapine 32B	62.1 a	0 a	1.65 a	54.1 a	1214 ab
Deltapine 33B	60.8 a	0 a	1.61 a	54.1 a	1096 bc
Paymaster 1220 BGRR	62.3 a	0 a	1.74 a	53.3 a	1035 c
Paymaster 1244 BGRR	63.9 a	0 a	1.70 a	55.0 a	1191 b
SureGrow 125	61.9 a	0 a	1.68 a	55.4 a	990 c
Stoneville 474	61.7 a	0 a	1.64 a	53.8 a	1348 a
Stoneville BXN 47	62.6 a	0 a	1.71 a	54.1 a	1224 ab
Suggested Baseline	------	0-2	1.67	43.5	------

Table 5. Mohave Valley upland cotton variety evaluation. Measurements taken: June 11, 1997 at 1361 heat units after planting.

Variety	Plants/ Acre (#)	Plant Height (inch)	First Fruiting Branch	Height: Node Ratio	Fruit Retention (%)
Deltapine 32B	44,850 bc	18.9 cd	6.2 b	1.24 b	72.1 b
Deltapine 33B	49,075 ab	17.6 d	6.6 a	1.20 b	71.7 b
Paymaster 1220 BGRR	39,175 cde	20.7 b	5.6 c	1.40 a	76.5 b
Paymaster 1244 BGRR	34,000 e	22.7 a	5.6 c	1.47 a	70.4 b
SureGrow 125	42,100 bcd	18.2 cd	5.6 c	1.24 b	78.4 ab
SureGrow 821	52,825 a	19.4 c	5.9 bc	1.25 b	71.7 b
Stoneville 474	37,600 de	18.9 cd	5.9 bc	1.23 b	74.6 b
Stoneville 468	42,900 bcd	17.6 d	5.7 c	1.23 b	84.5 a
Suggested Baseline	25,000	------	5-7	1.25	68.6

Table 6. Mohave Valley upland cotton variety evaluation. Measurements taken: July 3, 1997 at 1858 heat units after planting.

Variety	Plant Height (inch)	Nodes Above White Bloom	Height: Node Ratio	Fruit Retention (%)
Deltapine 32B	31.1 bcd	6.9 a	1.64 cd	84.3 d
Deltapine 33B	30.2 cd	6.0 a	1.69 bcd	85.5 cd
Paymaster 1220 BGRR	31.5 bc	6.3 a	1.72 bc	86.4 bcd
Paymaster 1244 BGRR	34.8 a	6.0 a	1.92 a	84.0 d
SureGrow 125	31.1 bcd	6.5 a	1.81 ab	89.1 abc
SureGrow 821	29.4 d	6.3 a	1.56 d	82.9 d
Stoneville 474	31.9 b	6.5 a	1.71 bcd	90.6 ab
Stoneville 468	29.7 d	6.1 a	1.69 bcd	91.6 a
Suggested Baseline	------	6-8	1.44	62.8

Table 7. Mohave Valley upland cotton variety evaluation. Measurements taken: August 4, 1996 at 2670 heat units after planting.

Variety	Plant Height (inch)	Nodes Above White Bloom	Height: Node Ratio	Fruit Retention (%)
Deltapine 32B	31.7 bc	4.8 a	1.51 bc	42.6 a
Deltapine 33B	30.6 cd	4.3 a	1.43 cd	43.8 a
Paymaster 1220 BGRR	32.4 b	4.5 a	1.52 bc	46.5 a
Paymaster 1244 BGRR	36.0 a	4.3 a	1.63 a	47.9 a
SureGrow 125	31.2 bc	4.0 a	1.54 ab	49.1 a
SureGrow 821	30.1 cd	4.5 a	1.43 cd	43.9 a
Stoneville 474	35.3 a	4.4 a	1.59 ab	48.1 a
Stoneville 468	29.8 d	4.2 a	1.41 d	51.3 a
Suggested Baseline	------	5-6	1.65	53.6

Table 8. Mohave Valley upland cotton variety evaluation. Final measurements taken: September 2, 1997 at 3460 heat units after planting. Plots harvested October 16.

Variety	Plant Height (inch)	Nodes Above White Bloom	Height: Node Ratio	Fruit Retention (%)	Lint Yield (lbs/acre)
Deltapine 32B	39.0 bc	0 a	1.34 cd	52.5 a	1347 a
Deltapine 33B	38.3 bc	0 a	1.36 bcd	48.7 a	1344 a
Paymaster 1220 BGRR	39.8 b	0 a	1.39 abc	52.4 a	1176 b
Paymaster 1244 BGRR	41.7 a	0 a	1.46 a	51.2 a	1407 a
SureGrow 125	38.5 bc	0 a	1.35 bcd	52.6 a	1290 ab
SureGrow 821	38.6 bc	0 a	1.37 abcd	49.3 a	1424 a
Stoneville 474	41.8 a	0 a	1.45 ab	51.9 a	1382 a
Stoneville 468	37.2 c	0 a	1.29 d	49.6 a	1346 a
Suggested Baseline	------	0-2	1.67	44.6	------