TRANSGENIC AND CONVENTIONAL COTTON PRODUCTION SYSTEMS EVALUATION

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RESEARCH PROBLEM

The goal of state variety testing is to compare the agronomic potential of commercially available cotton cultivars. Due to the increasing number of both conventional and transgenic cultivars each year, uniform pest-management strategies are often utilized. Although these results are useful in making agronomic comparisons among cultivars, additional evaluations, involving their unique production systems, could allow for more realistic comparisons.

BACKGROUND INFORMATION

Transgenic cotton cultivars have been developed to provide growers with additional management options for weed and insect control. Growers now have the option to plant cultivars that express a toxin from the bacterium *Bacillus thuringiensis* (*Bt*). These *Bt* cultivars express a toxin in the foliage of the plant that is active against some lepidopteran pests once the foliage is eaten (Benedict, 1996). Additional cultivars have been developed with the ability to withstand non-selective herbicides such as glyphosate (Roundup Ready) or bromoxynil (BXN) (Collins, 1996; Stewart, 1996). Newer cultivars have incorporated both the herbicide and *Bt* expressions in order to optimize pest-management strategies.

These newly transformed cultivars have been widely accepted by producers. In 2000, the USDA-AMS Cotton Division reported that 65.8% of the cotton acreage in the south central region of the United States was planted to transgenic cultivars (Anonymous, 2000). More specifically, in Arkansas, 23.8% was planted to *Bt*, 21.9% was planted

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to BXN, 6.3% was planted to Roundup Ready, and 36.3% was planted to *Bt* + Roundup Ready cultivars in 2000.

Although these cultivars are widely adapted among growers, they have undergone only limited university research in evaluating their overall agronomic performance (Bourland et al., 1997). Thus, early research evaluating *Bt* cotton primarily had an entomological focus. This scenario was also observed with BXN and Roundup Ready cultivars for which previous work consisted mainly of weed control and crop tolerance evaluations. There is a current need for systems-level research evaluating how these cultivars will perform under a wide variety of pest complexes and cultural methods. Due to this limited research, many companies are encouraging the continual and sometimes sole use of a single pest-management strategy.

RESEARCH DESCRIPTION

Field studies were initiated in 2001 at the Northeast Research and Extension Center (NEREC) and the Southeast Branch Experiment Station (SEBES). Cotton was planted on 15 May at NEREC and 10 May at SEBES. Due to an early-season hail storm at SEBES, cotton was replanted on 7 June. Plot size was four rows (102 cm) by 15 m long. The experimental design was a randomized complete block with four replications.

Cultivars, consisting of conventional, Roundup Ready, BXN, *Bt*, and Roundup Ready/*Bt*, were chosen based on performance in the 2000 University of Arkansas Official Variety Tests (Benson et al., 2000) and percentage of acreage planted to each management type in Arkansas (Anonymous, 2000). These included: Stoneville ST 474, Stoneville ST 4793R, Stoneville ST 4892 BR, Stoneville, ST 4691 B, Stoneville, BXN 47, FiberMax FM 966, PhytoGen PSC 355, Suregrow SG 215 BR, Paymaster PM 1199 R, and Deltapine 20 B (Table 1).

Pest Management Inputs

All plots were managed to maximize yields according to University of Arkansas Cooperative Extension Service recommendations. Herbicide systems were chosen based on the genetic capabilities for each cultivar. For example, Roundup UltraMax was the primary herbicide for Roundup Ready and Roundup Ready/*Bt* cultivars, Buctril herbicide was used for BXN 47, and conventional herbicides were used for conventional cultivars. After emergence, plots were scouted weekly for insects. As with the herbicide systems, insecticide applications were based on the genetic capabilities of each cotton cultivar.

Data Collection

After first square, COTMAN data were collected weekly as described by Tugwell et al. (1998) and continued until all plots reached cutout (NAWF=5). At both locations, the two center rows of each plot were machine harvested. At NEREC, seed cotton samples were ginned to determine percent gin turnout and fiber-quality data were determined using HVI analysis. In addition, 5 plants per plot were box-mapped in order to determine individual boll number and corresponding weights for each cultivar.

Economic Analysis

Production input expenses such as seed, technology fees, herbicide, insecticide, and application costs were determined for each cultivar. These expenses, in combination with yield values and appropriate loan values, were used to determine net returns.

RESULTS AND DISCUSSION

Yield Data

No significant differences in yield were observed at NEREC and yields ranged from 1044 to 1220 lb/acre (Table 1). Lower yields (possibly due to late planting) were observed at SEBES and ranged from 704 to 1025 lb/A. At SEBES, higher yields of 1025, 974, and 885 lb/acre were observed with SG 215 BR, ST 4892 BR, and DP 20 B, respectively.

Individual Boll Data

End-of-season box mapping data allowed for comparison of individual boll number by node and position, and their corresponding weights for each of the cultivars (Table 2). When comparing first-position boll weights, FM 966 and SG 215 BR both averaged 5.2 g. The remaining cultivars were lower and averaged 4.3-4.7 g. These first-position bolls contributed at least 46% of the total bolls for all cultivars. No differences in second-position boll weights were observed and ranged from 3.9 to 4.7 g, which represented 21 to 29% of the total bolls for each cultivar. Mean boll weight (average boll weight per plant) followed the same trends as first-position boll weights, with FM 966 and SG 215 BR being the highest with 4.9 and 5.0 g, respectively.

Boll Distribution Data

End-of-season box-mapping data also allowed for comparison of boll distribution among cultivars (Table 3). When evaluating the lower portion of the plant (nodes 6 to 10), at least 30% of the bolls were located in this region for PSC 355, SG 215 BR, PM 1199 R, and DP 20 B. No differences among cultivars were observed for nodes 11 to 15 and ranged from 37 to 53%. Less than 14% of the bolls were observed above the sixteenth node.

Relative Maturity, Percent Turnout, and Fiber Quality Data

COTMAN results indicated only minor differences in relative maturity for the cultivars ranging from 82 to 85 days after planting (DAP) (Table 4). No differences in percent turnout were observed with values ranging from 39 to 42% for all cultivars. Fiber quality data indicated that length values ranged from 1.11 to 1.17. Higher length and strength values were reported with FM 966. Micronaire values ranged from 4.0 with DP 20 B to 5.1 with PSC 355.

Economic Analysis

The differences in costs between cultivars were due to herbicide programs and technology fees (Table 5). At each location, the cost advantage definitely favored the Roundup Ready cultivars. These results indicate that the highest yielding cultivars tend to produce the greatest net returns.

PRACTICAL APPLICATION

With the popularity of transgenic cultivars, additional research is needed to assist producers in properly choosing the most productive and economical cotton production systems. Since these individual technologies will be used in production cotton fields in combination with other transgenic and conventional production practices, it is important to begin learning more about how the combinations compare to each other with respect to pest-management options and economic returns.

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Table 1. Yield data from agronomic systems evaluation, Arkansas, 2001[z].

Cultivar	Lint yield[y]	
	NEREC[x]	SEBES
	(lb/acre)	
Stoneville 474	1044 a	846 bcd
Stoneville BXN 47	1154 a	822 cd
Stoneville 4892 BR	1063 a	974 ab
Stoneville 4793 R	1079 a	776 cd
Stoneville 4691 B	1095 a	819 bc
FiberMax 966	1146 a	879 bc
PhytoGen 355	1135 a	796 cd
Suregrow 215 BR	1220 a	1025 a
Paymaster 1199 R	1055 a	704 d
Deltapine 20 B	1097 a	885 abc

[z] Means followed by the same letter within a column are not significantly different according to Duncan's Multiple Range Test (P=0.05).

[y] Lint yield determinations based on individual plot gin turnout for NEREC and standard 35% for SEREC.

[x] NEREC: Northeast Research and Extension Center, Keiser, AR; SEBES: Southeast Branch Experiment Station, Rohwer, AR.

Table 2. Individual boll data, NEREC, 2001.[z]

Cultivar	Mean boll weight 1st position[y]	Percent 1st position bolls	Mean boll weight 2nd position	Percent 2nd position bolls	Mean boll wight
	(g)	(%)	(g)	(%)	(g/plant)
Stoneville 474	4.6 b	53 a	4.1 a	25 a	4.3 b
Stoneville BXN 47	4.3 b	57 a	4.0 a	25 a	4.0 b
Stoneville 4892 BR	4.6 b	54 a	4.2 a	21 a	4.3 b
Stoneville 4793 R	4.6 b	50 a	4.1 a	29 a	4.2 b
Stoneville 4691 B	4.6 b	53 a	3.9 a	27 a	4.3 b
FiberMax 966	5.2 a	59 a	4.7 a	23 a	4.9 a
PhytoGen 355	4.4 b	57 a	4.0 a	26 a	4.1 b
Suregrow 215 BR	5.2 a	55 a	4.8 a	26 a	5.0 a
Paymaster 1199 R	4.7 b	46 a	4.6 a	27 a	4.4 b
Deltapine 20 B	4.7 b	56 a	3.9 a	21 a	4.2 b

[z] Means followed by the same letter within a column are not significantly different according to Duncan's Multiple Range Test (P=0.05).

[y] Boll weight represents seedcotton weight.

Table 3. Boll distribution data, NEREC, 2001.[z]

	Main-stem nodes		
Cultivar	6-10	11-15	16-20
Stoneville 474	28 abcd	48 a	5 c
Stoneville BXN 47	25 cd	50 a	12 ab
Stoneville 4892 BR	27 bcd	43 a	9 abc
Stoneville 4793 R	22 d	53 a	9 abc
Stoneville 4691 B	26 bcd	49 a	7 bc
FiberMax 966	23 d	47 a	14 a
PhytoGen 355	33 abc	45 a	6 bc
Suregrow 215 BR	37 a	44 a	4 c
Paymaster 1199 R	35 ab	37 a	6 c
Deltapine 20 B	33 abc	43 a	7 bc

[z] Means followed by the same letter within a column are not significantly different according to Duncan's Multiple Range Test (P=0.05).

Table 4. Relative maturity, percent turnout, and fiber quality data, NEREC, 2001.[z]

Cultivar	Days to cutout[y]	Gin turnout	Length	Strength	Micronaire
	(%)	(%)	(inches)	(g/tex)	
Stoneville 474	84 b	39 a	1.15 abc	29.7 d	4.5 bc
Stoneville BXN 47	83 c	42 a	1.14 abc	29.6 d	4.3 cd
Stoneville 4892 BR	84 b	39 a	1.11 c	31.3 bcd	4.5 bc
Stoneville 4793 R	85 a	41 a	1.12 bc	30.3 cd	4.5 bc
Stoneville 4691 B	85 a	40 a	1.16 ab	30.3 cd	4.2 cd
FiberMax 966	82 d	39 a	1.17 a	35.0 a	4.4 bcd
PhytoGen 355	85 a	40 a	1.13 abc	33.0 b	5.1 a
Suregrow 215 BR	85 a	40 a	1.11 bc	27.8 e	4.8 ab
Paymaster 1199 R	83 c	40 a	1.11 bc	32.1 bc	4.5 bc
Deltapine 20 B	83 c	39 a	1.13 bc	26.7 e	4.0 d

[z] Means followed by the same letter within a column are not significantly different according to Duncan's Multiple Range Test (P=0.05).

[y] Days to Cutout: days after planting to reach five nodes above first position white flower (NAWF) = 5.

Table 5. Input costs and net returns for agronomic systems, 2001.

Cultivar	NEREC[z]		SEBES	
	Input costs[z]	Net returns[x]	Input costs	Net returns
	($/acre)			
Stoneville 474	157.60	405.72	197.49	244.97
Stoneville BXN 47	151.76	471.86	191.54	238.37
Stoneville 4892 BR	161.77	403.53	178.40	330.48
Stoneville 4793 R	131.98	452.62	149.14	256.71
Stoneville 4691 B	185.76	408.39	225.09	203.25
FiberMax 966	157.05	468.09	196.99	262.73
PhytoGen 355	156.50	413.66	196.49	219.82
Suregrow 215 BR	157.85	480.70	174.59	361.49
Paymaster 1199 R	131.08	439.69	148.33	219.86
Deltapine 20 B	184.86	403.24	224.28	238.58

[z] NEREC - Northeast Research and Extension Center, Keiser, AR; SEBES - Southeast Branch Experiment Station, Rohwer, AR.

[y] Input costs reflect seed, technology fee (when appropriate), herbicide, insecticide, and application costs.

[x] Net returns calculations based on yield, loan value, and input costs.