Varietal Responses of Cotton to Nitrogen Fertilization

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BACKGROUND INFORMATION AND RESEARCH PROBLEM

Optimizing yield and earliness of cotton (*Gossypium hirsutum* L.) varieties with nitrogen fertilization is an ongoing concern of cotton producers in Arkansas (Maples and Frizzell, 1985; McConnell et al., 1993). Genetically engineered cotton varieties are currently being used in increasingly larger portions of the cotton-producing acreage of Arkansas and the Cotton Belt. Producers have been quick to utilize 'Bollgard' and Roundup®-Ready varieties, as well as 'stacked gene' varieties that combine these two technologies into one cotton variety. Advantages of these new varieties include higher yield potential, enhanced pest resistance, resistance to herbicides, superior lint quality, faster maturity, and other new characteristics. With the increase in new cotton varieties into Delta production systems, the N requirements of the new varieties are often questioned by producers. The objective of this study was to determine the responses of new, genetically engineered cotton varieties to N-fertilization rate.

New cotton cultivars have increased the genetic diversity of cotton grown in the Delta. The genetic variability of currently available varieties indicates that crop management practices, such as fertilization, required to achieve optimal yields and earliness might differ from older varieties. Optimizing N fertilization for individual cotton varieties is one possible way of tailoring production practices to achieve optimal economic returns.

PROCEDURES

Studies of the responses of cotton varieties to N fertilization were begun at the Southeast Branch Experiment Station in 1989 (McConnell et al., 1993). Tested varieties have changed as new varieties have been introduced into the Delta region. Varieties currently under evaluation include Stoneville 4892 BR (ST 4892BR), FiberMax 960 BR (FM 960BR), Pay Master (PM 1281BR) and Deltapine 555 BR (DP 555BR). All varieties tested are genetically engineered to tolerate early-season applications of Roundup® herbicide and to resist damage from heliothis species insect pests. This is the first year of results from tests including these new varieties.

Nitrogen fertilizer rates were 0, 50, 100, and 150 lb N/acre. The source of the N was urea. The N fertilizer rates were split-applied with one-half the total N rate applied after emergence and one-half when the crop reached the first-square stage. The urea-N was incorporated with shallow plowing after each application. The same N rates have been applied to the same plots since the inception of testing (1989). Phosphorus and potassium fertilizer were annually applied as a preplant, blanket treatment to all plots at rates of 46 lb-P_2O_5/acre and 60 lb-K_2O/acre. The test was furrow-irrigated using tensiometers to trigger irrigation. The varieties were planted on 12 May 2003 and 11 May 2004. The soil (Hebert silt loam) at the test site was sampled and analyzed for nutrient content in 1999 (Table 1).

The measurements taken on the cotton varieties included seedcotton yield, plant height, plant population, and node development information. All data were analyzed using the Statistical Analysis System (SAS). The experimental design was a randomized complete block design with a factorial arrangement of cultivars and N rates. F-tests and least significant differences (LSD) were calculated at the α=0.05 level of probability. Only yield responses of cotton to N-fertilization and variety selection are presented in this report.

The 2003 growing season was marred by abnormally wet and cool growing conditions in May and most of June. These inclement conditions were responsible for a substantial delay in maturity for the 2003 crop. In 2003, cotton yields were lower than expected and lower than other years of similar testing (McConnell et al., 2003). Growing conditions were more moderate in 2004 resulting in more rapid crop maturity and greater overall yields.

RESULTS AND DISCUSSION

No significant differences in the yield of cotton occurred as a function of the interaction between cotton variety and N-fertilizer rate in 2003 or 2004 (Tables 2 and 3). The lack of significant interactions between varieties and N-rates indicates that these cotton varieties respond similarly, if not equally, to N fertilizer rate.

Seedcotton yields among varieties, averaged across N rates, were not statistically different in 2003 (Table 2). The mean yield of PM 1281BR, the numerically greatest yielding variety, was only 233 lb seedcotton/acre greater than the yield of ST 4892BR, the numerically lowest yielding variety. Although yields were lower in 2003 than in preceding years, significant cotton-yield differences were observed among N rates, averaged across varieties (Table 2). The 50 lb N/acre rate produced a 73% increase in yield from the untreated control. The 100 lb N/acre rate produced a 24% increase in yield above 50 lb N/acre. The 150 lb N/acre rate produced the maximum yields and was 12% greater than the mean cotton yield from 100 lb N/acre. All differences among the N-treatment means were statistically significant.

Both variety and N rate (main treatment effects) significantly influenced cotton yields in 2004 (Table 3). DP 555BR was significantly lower yielding than the other three varieties tested. PM 1218BR, ST 4892BR, and FM 960BR did not significantly differ in yield and differed numerically by only 159 lb seedcotton/acre. The effect of N rate on yields in 2004 was similar to 2003. Seedcotton yield significantly increased with each 50 lb N/acre addition. The average yield produced by the untreated check was less than half of the 150 lb N/acre rate.

PRACTICAL APPLICATION

These initial results suggest that genetically engineered cotton varieties have similar N fertilizer requirements and do not likely require different N-fertilizer management strategies than conventional cotton varieties. Significant yield loss may occur if these varieties are not adequately fertilized. Additionally, the varieties may respond differently as growing conditions vary.

ACKNOWLEDGMENTS

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LITERATURE CITED

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Table 1. Residual nitrate-nitrogen (NO_3^--N), phosphorus (P), potassium (K), soil pH, and electrical conductivity (EC) to a depth of two feet in six-inch increments from the variety by N-fertilization rate in test site in 1999.

Depth	NO_3-N	P[z]	K[z]	pH[y]	EC[y]
(in.)	--------- (lb/acre)		----------		(µS/m)
0 - 6	1.8	70	260	6.3	26
6 - 12	1.7	30	125	6.4	20
12 - 18	1.7	29	149	6.1	21
18 -24	2.4	22	243	6.0	44
LSD(0.05)	0.4	6	18	0.1	3

[z] Mehlich-3 extractable (1:7 extraction ratio).
[y] Soil pH and EC measured in a 1:2 soil-water mixture.

Table 2. Seedcotton yields of four genetically engineered cotton varieties as affected by N-fertilizer rate at the Southeast Branch Experiment Station near Rohwer, Ark., during 2003.

	Cotton variety				N-rate
N rate	ST 4892BR	FM 960BR	PM 1281BR	DP 555BR	mean
(lb/acre)	------------------ (lb seedcotton yield/acre[z]) --------------------				
150	3590	4219	3903	3805	3869
100	3514	3570	3476	3246	3467
50	2616	2788	3095	2648	2787
0	1820	1721	1428	1479	1612
LSD(0.05) to compare N-rate means = 67 lb/acre					
Cultivar mean[y]	2807	2980	3040	2869	--

[z] Lint yield may be estimated by dividing seedcotton yield by 3.
[y] Mean yields of varieties, averaged across N rates, were not different.

Table 3. Seedcotton yields of four genetically engineered cotton varieties as affected by N-fertilizer rate at the Southeast Branch Experiment Station near Rohwer, Ark., during 2004.

	Cotton variety				N-rate
N rate	ST 4892BR	FM 960BR	PM 1281BR	DP 555BR	mean
(lb/acre)	------------------ (lb seedcotton yield/acre[z]) --------------------				
150	5140	5058	5044	4318	4890
100	4448	4390	4670	3872	4353
50	3630	3509	4084	3255	3615
0 2541	2444	2221	1651	2214	
LSD(0.05) to compare N-rate means = 330					
Cultivar means[y]	3925	3850	4009	3275	--
LSD (0.05) to compare cultivar means = 299					

[z] Lint yield may be estimated by dividing seedcotton yield by 3.
[y] Mean yields of varieties, averaged across N rates, were not different.