2003 BELTWIDE COTTON CONFERENCES, NASHVILLE, TN – JANUARY 6-10

EFFECTS OF NITROGEN AND POTASSIUM STRESS ON YIELD AND FIBER QUALITY IN POTTED PLANTS

John J. Read and James M. McKinion
USDA-Agricultural Research Service
Mississippi State, MS
K. Raja Reddy
Mississippi State University
Mississippi State, MS
Lee Tarpley
Texas A&M University
Beaumont, TX

Abstract

Profitable cotton growers strive to control fiber quality while maximizing crop yield. The objective of this research was to determine if changes in leaf nitrogen (N) and potassium (K) under nutrient stress are related to yield and quality of different fruiting zones in cotton. Plants were grown outdoors in 1999 and 2000 in large pots using half-strength Hoagland's (control) solution via drip irrigation system until some three-row plots received restricted N or K supply. Lint yield was determined from mature bolls that were ginned individually using a roller gin. Lint from only fruiting branches was grouped according to week of anthesis across a 35-d flowering period, giving five lint groups, from which fiber properties were measured. Yields decreased in plants supplied either 20% of control N at first square onward or 0% of control N from first flower onward. Fiber length and strength tended to be lower in these treatments, and lint group four in 1999 produced short, weak, low micronaire fibers. The year by N treatment interaction was significant for strength. As expected, K stress led to low micronaire. Values less than 3.7 were observed in lint groups three and five in 1999 when K was withheld from first flower onward, and in lint groups two and four in 2000 when K was withheld at first square onward. The year by K treatment interaction was significant for yield, due to larger stress-induced decrease in boll number and dry weight in 2000 than 1999. Results support evidence of strong environmental effects on cotton fiber development, and the negative impacts of K stress on both yield and quality.

Introduction

In cotton (*Gossypium hirsutum* L.), as in most crop plants, productivity and yield are closely associated with the amount of photosynthate produced in the season, a trait that can be enhanced by good management practices. While management certainly influences the quality of the fiber produced, the complex impact of environmental and management factors on fiber development and quality derives from the various developmental stages that individual bolls are in throughout the season and the different zones of the plant.

Materials and Methods

Lint yield was determined from each of 20 plants per row (replicate). Mature dry bolls were grouped according to week of anthesis into five "lint groups" in each of three replicates. Then the individual bolls were processed using a roller gin. In 1999, we calculated lint weight for each lint group by subtracting seed weight from seed cotton weight. Seed cotton weight was determined for each lint group and plant within a rep using a bulked sample of bolls collected within each of five lint groups. In 2000, lint weight was determined by ginning bolls individually and then weighing the amount of lint produced for every boll from each fruiting position on every plant. Fiber quality was determined from a 5 g sample of each "lint group" using individual instruments (Starlab, Inc., Knoxville, TN). Values are reported as inches for 2.5% span length, based on fibrograph readinings, as centiNewtons (cN) tex^{-1} for fiber strength, based on stelometer readings (g tex^{-1} x 1.25 ≅ HVI strength), and in dimensionless units for micronaire, which is a combined measure of fiber fineness and maturity.

References

Boquet, D.J. and E.B. Moser. 2003. Boll retention and boll size among intrasympodial fruiting sites in cotton. Crop Sci. 43:195-201.

Bradow, J.M. and G.H. Davidonis. 2000. Quntitation of fiber quality and the cotton production-processing interface: A physiologist perspective. Journal of Cotton Science 4:34-64.

Heitholt, J.J. 1997. Floral bud removal from specific fruiting positions in cotton: Yield and fiber quality. Crop Sci. 37:826-832.

Johnson, R.M. and J.M. Bradow. 1999. Spatial variability of cotton fiber yield and quality in relation to soil variability. *In*, P.C. Robert, R.H. Rust, W.E. Larson (ed.). Proc. Fourth International Conference on Precision Agriculture, 19-22 July, St. Paul, MN. ASA-CSSA-SSSA, Madison, WI.

Table 1. Week of flowering (anthesis) and number of bolls (lint weight per boll in parenthesis) harvested in each successive lint group from only the fruiting branches of cotton, and total number of bolls harvested from both the fruiting and vegetative branches in 1999 (n=283) and 2000 (n=268) across five nitrogen treatments. Open bolls were first observed on 22 August 1999 and on 17 August 2000. Irrigations were terminated on 29 September 1999 and on 22 September 2000.

	Week of flowering		**Total number of bolls (g boll^{-1})**	
Lint group	**1999**	**2000**	**1999**	**2000**
One	11-17 July	9 -16 July	705 (1.587)	1023 (1.842)
Two	18-24 July	17-23 July	1315 (1.794)	1357 (1.728)
Three	25-31 July	24-30 July	883 (1.884)	1018 (1.551)
Four	1-7 August	1-6 August	886 (1.909)	346 (1.481)
Five	8-14 August, and above	7-15 August, and above	75 (1.615)	81 (1.257)
Total, including vegetative branches in ~60 plants per treatment			5126 (2.082)	5173 (1.614)

Table 2. Probability (Pr > F) that differences in yield and quality factors in cotton grown under five N regimes (Control, N2B, N1F, N2F, and N1S) are due statistically to chance. Analysis of variance involved bolls collected from fruiting (sympodial) branches only. Tests within Lint Groups One – Four always involved 10 degrees of freedom for the error term; whereas, error degrees of freedom available for Lint Group Five were eight or fewer due to decreased boll production as plants matured that differed among the different treatments.

	Lint Weight, g		**Weight Boll^{-1}, g**		**2.5% Span Length, in.**		**Strength, cN tex^{-1}**		**Micronaire**	
Lint Group	**1999**	**2000**	**1999**	**2000**	**1999**	**2000**	**1999**	**2000**	**1999**	**2000**
One	0.038	0.752	0.77	< 0.01	0.24	0.82	0.16	0.053	< 0.01	0.79
Two	< 0.001	0.159	< 0.01	< 0.01	0.59	0.80	0.16	0.69	< 0.02	0.55
Three	0.035	0.019	0.10	< 0.05	0.54	0.62	< 0.05	0.12	0.13	0.12
Four	< 0.001	< 0.001	0.12	0.20	< 0.01	0.22	< 0.02	0.17	< 0.05	0.15
Five	0.012	0.008	0.99	0.18	0.30	0.94	0.42	< 0.05	0.52	0.08
Yr. x N regime Interaction										
One	0.62		0.86		0.49		< 0.05		< 0.05	
Two	<0.0014		< 0.001		0.62		0.38		0.11	
Three	0.81		0.10		0.53		0.55		0.67	
Four	< 0.001		0.33		<0.01		< 0.05		0.82	
Five	0.20		0.65		< 0.05		< 0.05		0.42	

n.b. In 1999, N1S and N2F had the shortest fiber, and N2F had the weakest fiber and the lowest micronaire. Short fibers with low strength and micronaire values were evident in Controls in 2000.

Table 3. Probability (Pr > F) that differences in yield and quality factors of cotton lint from plants grown under three potassium regimes (Control, K1, K2) are due statistically to chance. Analysis of variance involved bolls collected from fruiting (sympodial) branches only. Tests within Lint Groups One – Four always involved six (6) degrees of freedom for the error term; whereas, error degrees of freedom available for Lint Group Five was typically five for yield and quality due to decreased boll production as plants matured that differed among the different treatments.

	Lint Weight, g		**Weight Boll^{-1}, g**		**2.5% Span Length, in.**		**Strength, cN tex^{-1}**		**Micronaire**	
Lint Group	**1999**	**2000**	**1999**	**2000**	**1999**	**2000**	**1999**	**2000**	**1999**	**2000**
One	0.215	0.046	0.079	0.042	0.274	0.630	0.129	0.421	0.044	0.222
Two	0.278	0.002	0.805	<0.001	0.888	0.235	0.771	0.525	0.281	0.025
Three	0.537	<0.001	0.820	<0.001	0.591	0.501	0.689	0.153	0.222	0.313
Four	0.113	<0.001	0.374	0.004	0.205	0.431	0.726	0.098	0.377	0.067
Five	0.050	0.078	0.850	0.001	0.388	0.144	0.311	0.014	0.176	0.227
Yr. x K regime Interaction										
One	0.021		0.011		0.224		0.182		0.049	
Two	0.002		0.184		0.45		0.540		0.021	
Three	0.119		0.064		0.387		0.132		0.496	
Four	0.664		0.037		0.220		0.063		0.149	
Five	0.537		0.280		0.788		0.280		0.089	

n.b., Treatments in 1999 imposed at flowering stage; whereas, treatments in 2000 were imposed at squaring stage. Elimination of K at squaring in 2000 led to severe stress and secondary disease symptoms in most plants.