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DIFFERENTIAL WATERING REGIMES AS A MEANS TO EVALUATE DROUGHT TOLERANCE AMONG SELECTED COTTON LINES

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Abstract

Much work has been done over the years to establish testing methods for evaluating abiotic stress tolerance in crops, with no conclusive result. With new technologies being used to improve drought tolerance in crops, it is imperative that we develop methods for screening stress tolerance in crops. The primary objective of this study is to evaluate several cotton lines under differential watering regimes to establish a baseline for evaluating stress tolerance. There are several growth indices indicative of a cotton plant's stress level, including number of days to bloom, number of squares initiated, boll retention, number of seed per boll and fibers per seed. There are also other various plant stress responses including leaf and canopy temperature which differ between varieties. However, from an economical and commercial standpoint, lint yields and fiber quality produced under stress are the best indices. Preliminary testing was initiated at the Texas Tech Crop Research Laboratory in Lubbock, Texas, in the 2004 season. Thirty-six cotton lines were evaluated in the test including several conventional commercial varieties, selected obsolete varieties, selected experimental lines from the Bayer CropScience Breeding Program, and other varieties previously identified as having evidence of drought tolerance. Data from these preliminary tests provided criteria for establishing methods for future testing, in order to achieve a potential stress tolerance screening procedure.

Introduction

On the High Plains region of the cotton belt, annual average rainfall can vary from 12 to 18 inches, some of which may actually occur during the cotton growing season. Due to this limited rainfall and a slowly dwindling irrigation water supply, which is becoming more costly to pump because of rising costs in electricity and natural gas, there is an increasing need and awareness for drought tolerant varieties. There has been substantial work devoted to the development of a screening method to identify drought tolerance in cotton, however, there has been no industry wide accepted method. As the demand for drought tolerant varieties increases, it becomes imperative that the cotton industry identify methods for identification of drought tolerance among cotton lines.

The objective of this study was to evaluate several cotton varieties under separate watering regimes to identify lines that exhibit stability in yield and fiber quality across irrigation levels. Then to identify plant characteristics that can be correlated to yield and fiber quality stability under limited water supply. The final goal is to develop an evaluation method for future testing of drought tolerance.

Materials and Methods

Thirty-six conventional varieties were chosen for inclusion in this inaugural testing, with the intent of covering a broad range of plant maturities and characteristics. Twenty-seven of the varieties were commercial lines including: Coker 312, Coker 315, FM 819, FM 832, FM 958, FM 966, FM 989, FM 991, FM 5013, PM HS26, PM 280, PM 145, PM 183, Delta Pearl, DP 491, DP 2379, SG 747, ST 474, LA 887, BCG 245, BCG 295, AFD Raider 271, Acala 1517-99, Acala Maxxa, Lankart 57, Western 44 and Gazuncho II. There were three individual tests, each with a different watering rate, the high rate was 0.25"/day, the mid rate was 0.15"/day, and the low rate was 0.05"/day. The tests were designed using an RCB method with two row plots thirty foot long and replicated four times. Irrigation was metered using the drip irrigation system at the Texas Tech Research Farm. End of season plant map data was gathered on a limited basis two weeks prior to harvest. Tests were harvested on December 15, 2004 using the four row (two-plot) experimental stripper from Bayer CropScience. Fiber quality data was received from the International Textile Center of Texas Tech.

Results and Discussion

The 2004 season in Lubbock, Texas, was the second wettest in recorded history, with approximately 20" of rain during the growing season. As a result, the high irrigation rate test at harvest was only 30-40% open, and therefore, was left in the field. The remaining two tests, low and mid rates, showed promising data even with the significant levels of rainfall. The average yield difference was 500 lbs/acre, CV's were 9.6 and 8.8 for the low and mid rate tests, respectively (Table 1). Variety performance was evaluated for yield and fiber characteristics by comparing the difference between individual varieties versus the test means. Stability among varieties was determined by calculating the slope using the yield in lbs/acre with irrigation amount in inches for each test. Stability performance was then identified by running a percent difference comparison between the individual varieties versus the average slope across irrigation levels. Yield indicators were then identified, V5 and V36 for high yield and V21 for stability of yield (Table 2). Fiber length indicators were also identified, V30 for longest fiber length and V21 for stability of fiber length (Table 3).

Based upon this year's data five varieties were identified as useful indicators for future testing. V5 and V36 will be used as indicators for lint yield level. V30 will be used as an indicator for a fiber length. V21 will be used as an indicator for stability across irrigation levels for both lint yield and fiber length.

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Table 1. Test Information

Low Rate Test (0.05"/day)

Yield Min/Max: 885 – 1413 lbs/acre
Yield Average: **1167** lbs/acre
CV: 9.6

Mid Rate Test (0.15"/day)

Yield Min/Max: 1200 – 1913 lbs/acre
Yield Average: **1681** lbs/acre
CV: 8.8

Table 2. Yield Indicators

	Low Yield	Mid Yield	% of Slope Mean	% of Low Rate Mean	% of Mid Rate Mean
V5	**1413**	**1866**	**88**	**121**	**111**
V36	**1383**	**1826**	**86**	**118**	**109**
V21	**1219**	**1395**	**34**	**104**	**83**

Table 3. Fiber Length Indicators

	Low Rate Length	Mid Rate Length	% of Slope Mean	% of Low Rate Mean	% of Mid Rate Mean
V5	**1.13**	**1.16**	**127**	**103**	**104**
V21	**1.14**	**1.15**	**39**	**104**	**103**
V30	**1.16**	**1.19**	**127**	**105**	**106**

V36	**1.12**	**1.16**	**156**	**102**	**104**