EFFECT OF NITROGEN ON FIBER QUALITY OF COTTON VARIETIES WITH VARYING REACTIONS TO VERTICILLIUM WILT

C. R. Albers
Texas Tech University
J. E. Woodward
Texas Tech University
Texas AgriLIFE Extension Service
P. A. Dotray
Texas Tech University
Texas AgriLIFE Research
Texas AgriLIFE Extension Service
Lubbock, TX
E. C. Best
Monsanto, Deltapine Co.
Lubbock, Tx
D. J. Jost
Monsanto, Deltapine Co.
St. Lawrence, Tx

Abstract

Field trials were conducted in the 2011 growing season to evaluate the effect of increasing nitrogen rates (0-250 lb/A) on disease incidence, lint yield and fiber quality of four varieties (Deltapine 0912 B2RF, Deltapine 104 B2RF, Fibermax 9160 B2F and NexGen 3348 B2RF). The application of nitrogen resulted in taller plants with an increased number of nodes; however, the severe drought conditions experienced throughout the growing season negatively affected growth. Differences in stem discoloration were observed for the two highest nitrogen rates, despite conditions that were not conductive for Verticillium wilt development. Foliar symptoms of Verticillium wilt were observed at one of the locations, and the application of nitrogen generally increased disease incidence. Lint yields were increased with the application of nitrogen over the non-treated control; however, differences between the application rates were not observed. Lint yields were greatest for DP 0912B2RF and similar for all other varieties. Subtle differences in fiber quality parameters were observed for the varying nitrogen rates; while varietal effects were observed for most parameters.

Introduction

Verticillium wilt, caused by the soilborne fungus *Verticillium dahliae*, is an economically important disease of cotton on the High Plains of Texas (Woodward and Wheeler, 2009). According to Bell (1992), there are two strains of *V. dahliae*, (P-1) known as the defoliating strain and (P-2) known as the non-defoliating strain, present in the United States, with the former being predominant in the High Plains of Texas. The fungus has a broad host range and is capable of persisting in the soil for long periods of time as microsclerotia (Bell, 2001). Temperatures below 30°C are optimum for infections to occur and subsequent symptom development. Under optimal conditions, susceptible hosts can be killed by a combination of toxic fungal metabolites, accumulated fungal material and host responses to infection, leading to vascular occlusion and moisture deficit (Bruehl, 1987). Symptoms consist of yellowing, defoliation of leaves, epinasty, and ultimately plant mortality (Bell, 2001). Infected plants may develop a mosaic patterns on the infected leaves (Fig. 1), these patterns will start at the base of the plant and move up towards the top. Discoloration of the vascular tissue can be observed in infected plants (Fig. 2).

Figure 1. Foliar symptoms of Verticillium wilt in cotton.

Figure 2. Vascular discoloration of cotton stem, characteristic of Verticillium wilt.

Management of Verticillium wilt is achieved through and integrated approach (El-Zik, 1985), with variety selection being the most effective (Woodward and Wheeler, 2009). Cultural controls methods such as crop rotation, proper irrigation, reducing plants density and weed control are known to affect density of the pathogen and in turn disease development (Paplomatas, et al. 1992). Increased rates of nitrogen are known to affect the disease and pathogen in other crops (Rowe and Powelson, 2002). Little information on nitrogen and Verticillium wilt interactions exist in cotton; therefore, the objective of this study was to determine the effect of increasing nitrogen rates on disease development, lint yield and fiber quality.

Materials and Methods

There were four locations across the High Plains of Texas (Fig. 3), with locations in Crosby Co., the Texas Tech New Deal Research Farm (Lubbock, Co.), and the Texas Tech Quaker Research Farm (Lubbock, Co.) having sub-surface drip irrigation and the fourth location at the Texas AgriLIFE Research Halfway Station in Hale Co. being irrigated with a center pivot. All locations had a history of low to moderate Verticillium wilt. Soil from trial areas were assayed for *V. dahliae* prior to the establishment of plots. The experimental design was a split-plot where six nitrogen levels (0, 50, 100, 150, 200 and 250) served as whole plots, and four varieties (Deltapine 0912B2RF, Deltapine 104B2RF, Fibermax 9160B2F and NexGen3348 B2RF) served as sub-plots. The varieties were chosen because of their maturity and susceptibility to Verticillium wilt (Table 1). Treatments were arranged in a randomized complete block with four replications. The fertilizer type used was Urea Ammonium Nitrate, and applications were made using a four row side dress rig (Fig. 4). Stand counts were made approximately 30 days after planting in order to determine disease incidence, which was assessed throughout the season by counting the number of plants within a plot exhibiting foliar symptoms (Fig.1). Vascular discoloration was determined by destructively sampling five plants, and looking for discoloration within the stem (Fig. 2). Plant height and total number of nodes was taken twice throughout the growing season. Lint yields were determined for each plot and grab samples were taken for turnout. Sub-samples of line were subjected the HVI analysis at the Texas Tech University, Fiber and Biopolymer

Institute. Statistical comparisons were made using a mixed model procedure, and means were separated using Fisher's Protected LSD ($P \leq 0.05$).

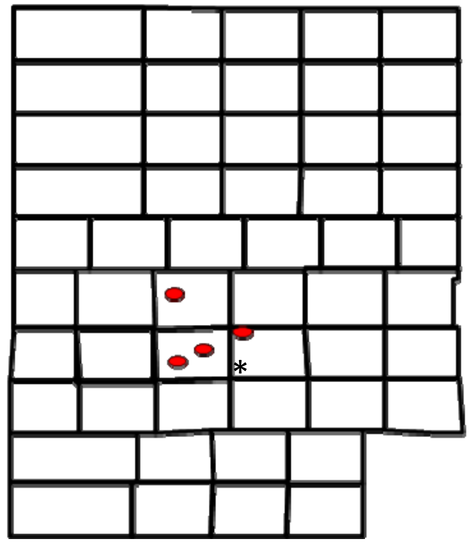

Figure 3. Location of field trials in the High Plains of Texas 2011. * denotes the approximate location of Texas Tech University.

Table 1. Characteristics of varieties included in field studies.

Variety	Maturity	Verticillium wilt reaction
FiberMax 9160B2F	Medium	Partially resistant
NexGen 3348B2RF	Medium	Susceptible
Deltapine 104 B2RF	Early	Partially resistant
Deltapine 0912 B2RF	Early	Susceptible

Figure 4. Application of nitrogen treatments using a four row side-dress rig.

Results and Discussion

Growing conditions throughout the 2011 season were extremely harsh. Temperatures were well above and rainfall well below average throughout all of the growing season for the Lubbock County (Fig. 5). These conditions are representative of four locations where trials were conducted. An increase in plant height was observed with increasing nitrogen rates with all nitrogen treatments resulting in heights greater than the non-treated control (Fig. 6). Height increases appeared to follow a linear trend (data not shown). Differences in height among the varieties evaluated were also observed (Fig. 6). Heights were greatest for DP 0912B2RF and FM 9160B2F at 19.6 and 19.2 inches, respectively. The number of nodes were followed an almost identical trend that plant height (Fig. 7). A significantly higher number of nodes were observed for FM 9160B2F compared to other varieties, which can be explained by the higher fruiting habit of this variety.

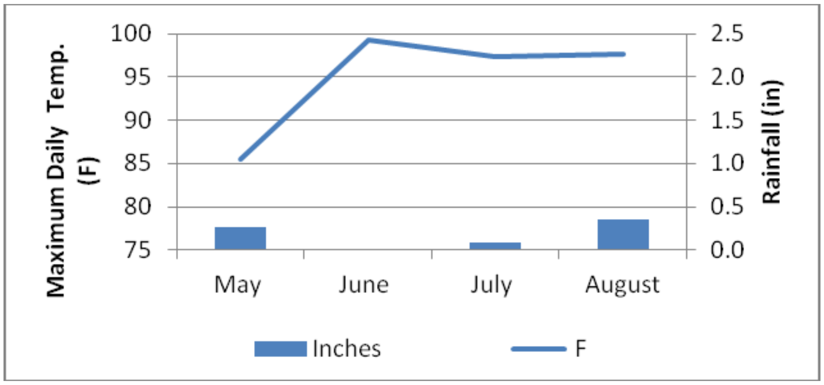

Figure 5. Temperature and rainfall records (May-August) for Lubbock Co. during the 2011 growing season.

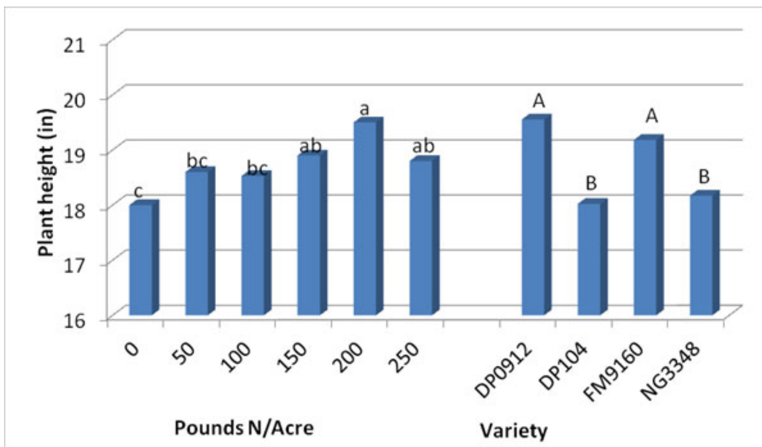

Figure 6. Effect of increasing nitrogen rates on height of four cotton cultivars. Bars with the same letter are not different according to Fisher's Protected LSD ($P \leq 0.05$).

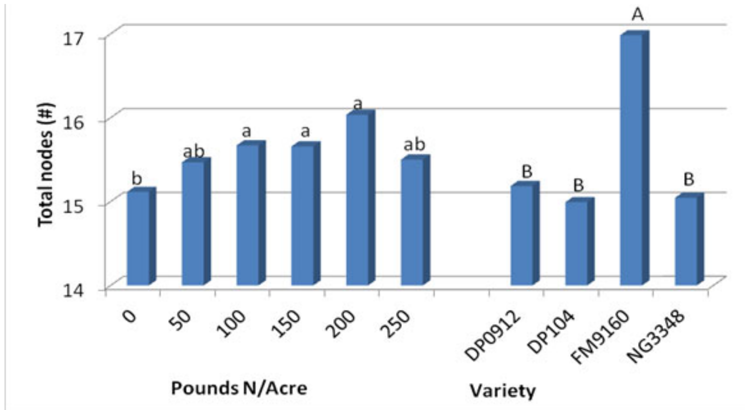

Figure 7. Effect of increasing nitrogen rates on the number of nodes of four cotton cultivars. Bars with the same letter are not different according to Fisher's Protected LSD ($P \leq 0.05$).

Despite poor conditions for disease development, differences in stem discoloration were observed between the nitrogen rates (Fig. 8). The application of 200 and 250 lb/N per acre lead to an increase the percentage of stems exhibiting vascular discoloration; however, these differences were relatively low. There were no differences in vascular discoloration for the four varieties. The higher levels of nitrogen applied increased of plant growth, thus increasing the demand for water and nutrient uptake which may have lead to more colonization of the vascular system by *V. dahliae*. Appreciable levels of foliar disease were only observed at the Halfway location; therefore, they are presented independently. While disease incidence levels at this location were much less than what has been observed previous years (Woodward, *unpublished*), the addition of nitrogen generally resulted in increased incidence of foliar symptoms (Fig. 9).

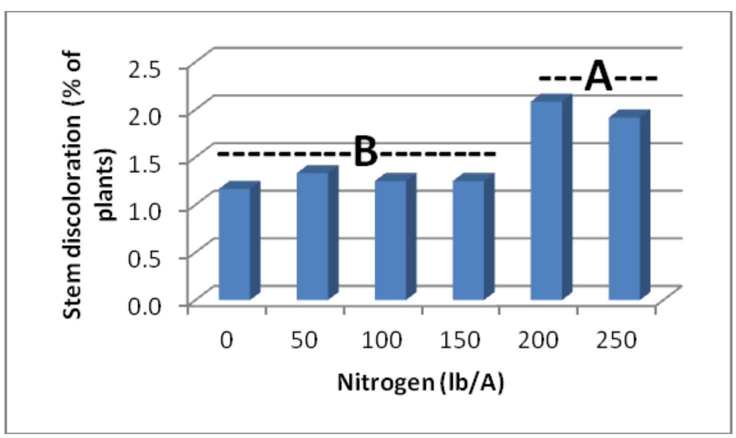

Figure 8. Effect of increasing nitrogen rates on stem discoloration associated with Verticillium wilt. Bars with the same letter are not different according to Fisher's Protected LSD ($P \leq 0.05$). Data are combined across locations and varieties (N=64).

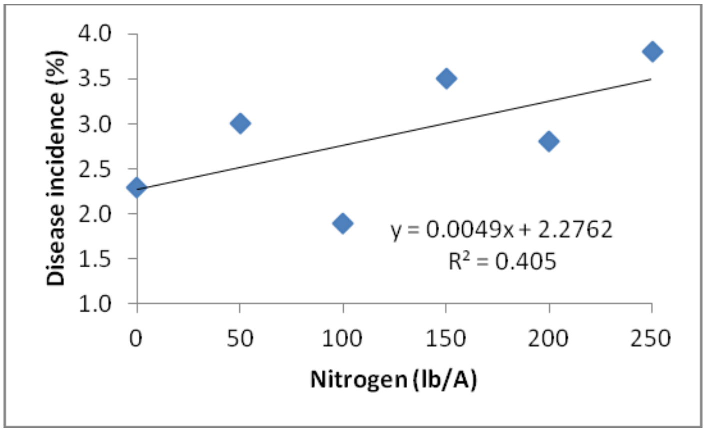

Figure 9. Effect of increasing nitrogen rates on Verticillium wilt incidence at Halfway, TX. Data are the means of 16 observations.

The application of nitrogen improved lint yields approximately 85 lb/A when compared to the non-treated control; however, yields were similar for all nitrogen applications (Fig. 10). Differences in lint yield were observed between the varieties, with the susceptible check DP 0912B2RF yielding 108 lb/A more than the other varieties, which can be explained by the high yield potential of this variety under relatively low disease pressure. Subtle differences in fiber quality parameters were observed for the differing nitrogen levels (Table 2). Higher nitrogen rates resulted in higher strength values and the addition of 250 lb/A led to an increase in micronaire. Excessive nitrogen fertility has been shown to negatively affect micronaire in Texas (CITE); however, the drought conditions experienced during the growing season may have impacted the plants ability to absorb nitrogen. Significant differences in fiber quality parameters were observed among varieties (Table 2). Micronaire, Uniformity, Strength and Elongation values were greatest for DP 0912B2RF, FM 9160B2F, DP 104B2RF and DP 104B2RF, respectively. These studies will be repeated in 2012 and a complete economic analysis will be performed so that producers can maximize yield and profitability as it relates to nitrogen application in fields with a history of Verticillium wilt.

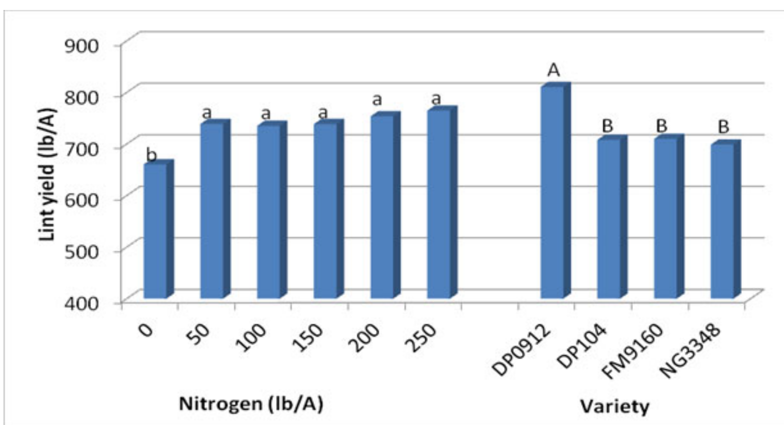

Figure 10. Effect of increasing nitrogen rates on the number of lint yield of four cotton cultivars. Bars with the same letter are not different according to Fisher's Protected LSD ($P \leq 0.05$).

Table 2. Effect of nitrogen and cotton variety on several fiber quality parameters.

Factor, level	Micronaire (units)	Uniformity (%)	Strength (g/tex)	Elongation (%)
Nitrogen (lb/A)				
0	4.19 b	80.34 ab	28.71 b	6.24 a
50	4.19 b	80.41 ab	28.91 b	6.24 a
100	4.21 b	80.29 b	28.67 bc	6.30 a
150	4.21 b	80.42 ab	28.96 a	6.31 a
200	4.20 b	80.25 b	28.96 a	6.18 b
250	4.26 a	80.51 a	29.05 a	6.34 a
Variety				
DP0912B2RF	4.69 A	80.22 B	28.17 C	6.76 B
DP104B2RF	3.88 C	80.69 D	29.83 A	7.12 A
FM9160B2R	4.25 B	80.74 A	29.19 B	5.25 D
NG3348B2RF	4.02 C	79.84 C	28.31 C	5.95 C

Acknowledgements

This research was funded in part by Cotton Incorporated, Texas State Support Committee and Monsanto. The technical support of Brant Baugh, Becky Grubbs, Ellen Ryan, Justin Spradley, Lindsey Thiessen and Ira Yates is greatly appreciated. Special thanks to farm managers Andy Cranmer, Paul Green and Steve Oswalt, and producer Eddie Griffis for their assistance in maintaining these trials.

References

Bell, A.A. Bell, A.A. 1992. Verticillium wilt. *in* Cotton Diseases. R.J. Hillocks eds. CAB International, pp. 87-126.

Bell, A.A. Bell, A.A. 2001. Verticillium wilt. *in* Compendium of Cotton Diseases 2nd Edition. T.L. Kirkpatrick and C.S. Rothrock eds. APS Press, pp. 28-31.

Bruehl, G. 1987. Soilborne Plant Pathogens. New York: Macmillan.

El-Zik, K.M. 1985. Integrated Control of Verticillium Wilt in Cotton. Plant Disease 69: 1025-1032.

Paplomatas, E. J., Bassett, D. M., Broome, J. C., and DeVay, J. E. 1992. Incidence of Verticillium wilt and yield losses of cotton cultivars (*Gossypium hirsutum*) based on soil inoculum density of *Verticillium dahliae*. Phytopathology 82:1417-1420.

Parajulee, M.N, Carroll, S.C., Shrestha, R.B., Kesey, R.J., Nesmith, D.M., and Bordovsky, J.P. 2010. Effect of nitrogen fertility on agronomic parameters and arthropod activity in drip irrigated cotton. Proceedings of the Beltwide Cotton Conferences. (cd-rom).

Rowe, R.C and Powelson, M.L. 2002. Potato early dying: Management challenges in a changing production environment. Plant Disease 86:1184-1193.

Woodward, J.E. and Wheeler, T.A. 2009. Integrated management of Verticillium wilt in cotton. Texas *Agrilife Extension Service*, p. 1-9.