COTTON CULTIVAR DISEASE INCIDENCE, SEVERITY, AND YIELDS WHEN CHALLENGED WITH VERTICILLIUM WILT IN THE TENNESSEE VALLEY REGION, 2018

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Abstract

Verticillium wilt most often occurs in the Tennessee Valley region of Alabama and Tennessee causing a decline in plant health and yield. The only effective management option producers have is to select a Verticillium wilt tolerant cotton cultivar. The life span of cotton cultivars is often less than 5 years, thus a producer must constantly look for cultivars that yield well when challenged with Verticillium wilt. Thus, the goal of this study is to identify cotton cultivars for best management by evaluating cotton cultivars for resistance as measured by disease severity and tolerance and by yield when challenged in Verticillium wilt fields. Cotton cultivars and lines were planted in commercial cotton fields naturally infested with *V. dahlia* in a strip plot design with four replications and at three locations. Ranking the cultivars by lint yield indicates PHY 350 W3FE and PHY 320 W3FE produced numerically greatest yield under these disease conditions and these cultivar yields were 30% greater than the lowest yielding cultivars. Comparing the data between disease incidence and severity indicated a significant positive correlation (R^2=0.82509; $P \leq 0.0003$) between visual symptoms and the signs of the disease in the vascular system. The correlation between Verticillium wilt severity and lint cotton yield (R^2= -0.59431; $P \leq 0.025$) did indicated that Verticillium wilt contributed to a 59% reduction of the cotton yield in 2018. Cotton cultivar selection is very important in a Verticillium wilt infested field.

Introduction

Losses from Verticillium wilt for the U.S., according to disease loss estimates, between the years of 1990-2016 are approximately 480 million bales (Lawrence et al., 2018). Verticillium wilt most often occurs in the Tennessee Valley region of Alabama and Tennessee causing a decline in plant health and yield. Two *Verticillium* species have been found in in the Tennessee Valley region, *V. albo-atrum* Reinke and Berthold (Palmateer et. al., 2004) and *V. dahliae* Kleb., (Land et. al., 2016). *Verticillium dahliae* is considered the primary causal agent of Verticillium wilt in cotton and first colonizes the root and then moves upward through the vascular system of the plant (El-Zik, 1985). Typically, symptoms include wilting, lack of lateral growth, and decreases in yield, fiber quality, and seed quality (Wheeler et. al., 2012; Xiao et. al., 2000). Defoliation is thought to lead to yield reductions resulting from the lack of photosynthetic activity. Disease incidence is higher on heavier soils with higher clay and silt content and may be linked to the lower temperatures and higher moisture levels. Moist soils from irrigation enhance the incidence of Verticillium wilt in cotton. Irrigation cools the soil thereby enhancing pathogen survival and increasing infection rates. As the timing intervals of watering regiments increase, so do the disease incidences of cotton plants (Schneider, 1948). There are no fungicides recommended for management of Verticillium wilt in cotton. The only effective management option producers have is to select a Verticillium wilt tolerant cotton cultivar (Raper, et al. 2017). The number of cotton cultivars available to producers, however, is limited. The life span of cotton cultivars is often less than 5 years, thus a producer must constantly look for cultivars that yield well when challenged with Verticillium wilt. The overall goal of this study is to identify cotton cultivars for best management by evaluating cotton cultivars for resistance to Verticillium wilt as measured by disease severity, tolerance, and yield.

Figure 1. Verticillium wilt symptomatic cotton plant (left); foliar symptoms including necrosis and chlorosis of the leaves (middle); and vascular browning discoloration typical of a Verticillium wilt infected cotton plant with a non-symptomatic plant adjacent to it (right) (infected plant on the right side) and *Verticillium dahlia* culture (right top) and whirled conidiophore (right bottom).

Materials and Methods

Cotton cultivars were planted in commercial cotton fields naturally infested with *V. dahliae* to determine cultivar disease response to Verticillium wilt under field conditions. Two field locations were selected for the 2018 tests based on severity of Verticillium wilt and the willingness of growers to participate in this research. Seed of adapted cultivars and experimental lines expected to be released in the next season were provided by AGRI-AFC, LLC of Land O'Lakes (Decatur, AL). Cotton cultivars and lines were planted in a strip plot design with four replications with plots being 1 row with a 1.02 m row spacing by 150 to 200 m plots evenly spaced throughout the field locations. Verticillium wilt disease incidence and severity ratings were conducted near cotton plant maturity from 4 randomly selected 3 m sections of row in each plot. Foliar symptoms of Verticillium wilt were evaluated on a scale from 1 to 5 with 1 = no foliar wilting, 2 = interveinal chlorosis and necrosis of the leaves, 3 = interveinal chlorosis and necrosis of the leaves with 10-30% of the plant defoliated, 4 = interveinal chlorosis and necrosis of the leaves with 40-60% of the plant defoliated, and 5 = 70-100% defoliation. Plants were individually rated and averaged for a total plot disease severity rating. Vascular discoloration was determined by cutting the plant stem longitudinally exposing the vascular cylinder and the number of plants with a discolored vascular cylinder indicated the percent incidence (Figure 1 middle). Stem section with discoloration were collected for fungal isolation to confirm Verticillium spp. presence. Yields were collected at plant maturity from 75 feet of each cultivar within each strip trial using a two row plot cotton picker. Samples were ginned at the UT Cotton MicroGin to determine turnout. Data collected from the field trials were analyzed in SAS 9.4 (SAS Institute, Cary, NC) using the PROC GLIMMIX procedure. LS-means were compared between the cultivars using the Tukey- Kramer test at significant level of P d 0.05.

Results

Verticillium wilt disease incidence and severity ratings were variable between the cotton cultivars. Disease incidence ranged from 30 to 70 % of the plants of each cultivar with the lowest Verticillium wilt incidence percentage in PHY 320 W3FE, ST 5517 GLTP, ST 5471 GLTP, and DP 1820 B3XF. These cotton cultivars had the lowest percentage of plants with vascular discoloration. The severity of the Verticillium wilt foliar symptoms was also lowest for these same four cultivars. ($P \geq 0.05$). CP 9178 B3XF and DP 1646 B2XF were the cultivars with the highest level of infection by Verticillium wilt. The vascular staining in the stems of these two were above 70%. All the remaining cultivars had similar levels of Verticillium wilt incidence and severity (Figure 2). Yields indicated significant differences between cultivars when challenged with Verticillium wilt (Figure 3.). Lint cotton yields varied by 528 lb/A. Ranking the cultivars by lint yield indicates PHY 350 W3FE and PHY 320 W3FE produced numerically greatest yield under these disease conditions and these cultivar yields were 30 % greater than the lowest yielding cultivars PHY 440 W3FX and CP 9178 B3XF.

Comparing the data between disease incidence and severity indicated a significant positive correlation (R^2=0.82509; $P \leq 0.0003$) between visual symptoms and the signs of the disease in the vascular system. A correlation between Verticillium wilt incidence and lint cotton yield did indicate a negative relationship but was not significant (R^2= -

0.35915; $P \leq 0.2073$). The correlation between Verticillium wilt severity and lint cotton yield (R^2= -0.59431; $P \leq$ 0.025) did indicated that Verticillium wilt contributed to a 59% reduction of the cotton yield in 2018.

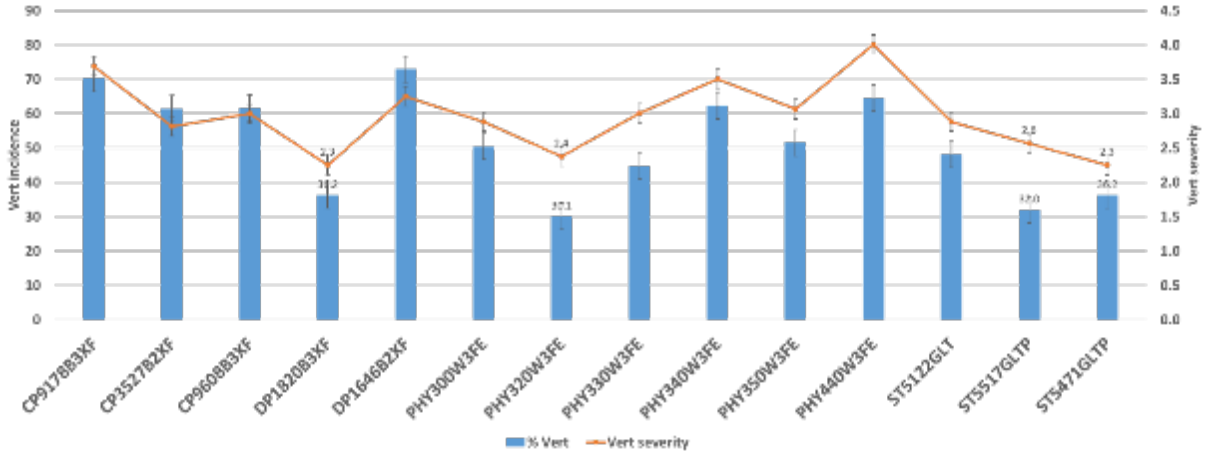

Figure 2. Verticillium wilt incidence and severity within cotton varieties, 2018.

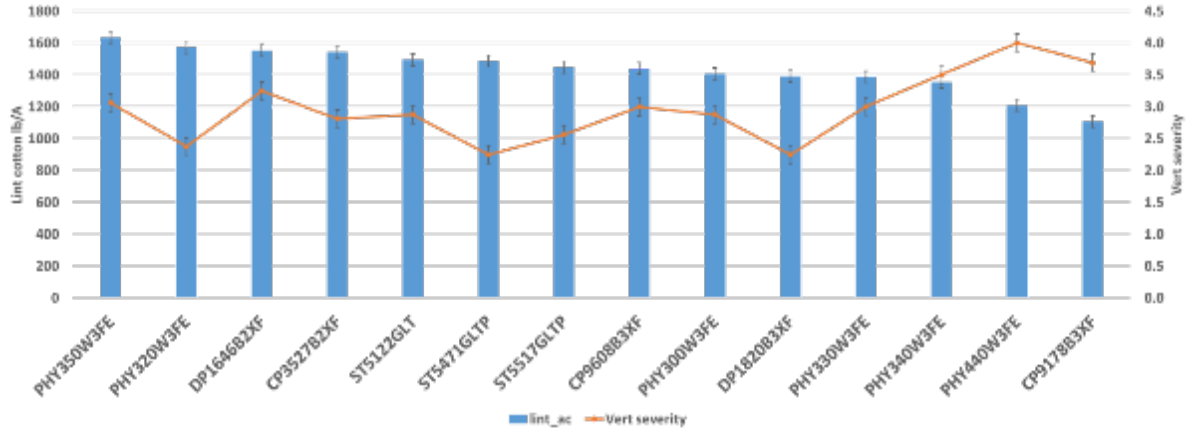

Figure 3. Cotton yield as influence by Verticillium wilt severity over two locations, 2018.

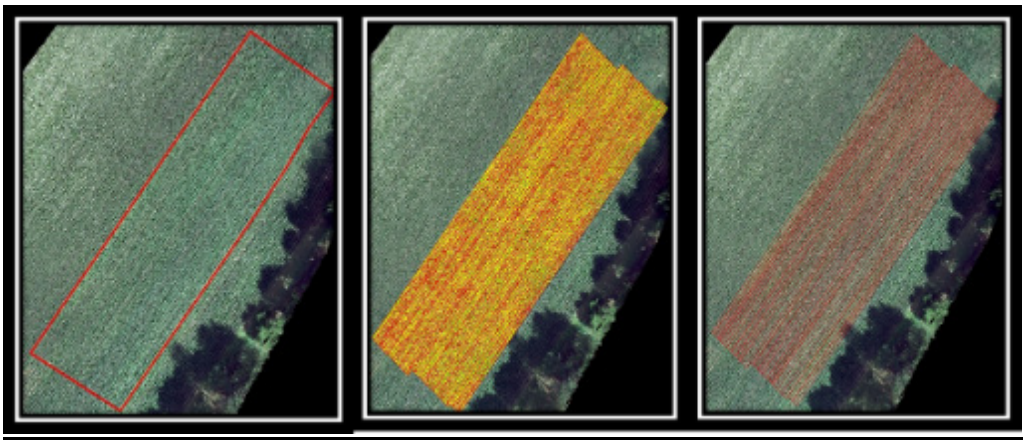

Figure 4. Left figure is the Brannon Verticillium wilt test outlined in the field; Middle is the NDVI image; and Right is the reverse. Images by Shawn Butler.

Conclusions

Cotton cultivar selection is very important in a Verticillium wilt infested field. The highest yielding cultivars were moderately susceptible to Verticillium wilt. With the exception of DP 1646 B2XF, cultivars with the highest levels of Verticillium wilt incidence were the lowest yielding. This exception points to the complexity of selecting a cultivar for a Verticillium wilt infested field. DP 1646 B2XF had high incidence levels and high severity ratings, but relatively high yield. DP 1820 B3XF had low incidence levels and low severity ratings, but relatively lower yield. Level of incidence, severity of symptoms, and yield all need to be considered when selecting a cultivar for a Verticillium wilt field.

Figure 5. Verticillium wilt crew: from left to right top row: Shawn Butler , Nathan Silvey, Hanna Whitecotton, WinDi Sanchez, Cheyanne Kaitlin Gattoni, Charlie Burmester, Marina Rondon, Bisho Lawaju, Brad Meyer, Tyler Sandlin and Andy Page.

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