COTTON CULTIVAR DISEASE INCIDENCE, SEVERITY, AND YIELDS WHEN CHALLENGED WITH VERTICILLIUM WILT IN THE TENNESSEE VALLEY REGION, 2020

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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 two locations. Ranking the cultivars by lint yield indicates DP 2020 B3XF, PHY 400 W3XF, DP 2012 B3XF, Armor 9831 B3XF and Armor 3527 B2XF were the top five yielding cultivars over both locations. Comparing the data between disease incidence and severity indicated a significant positive correlation (R^2=0.76954; $P < 0.000$) between visual foliar symptoms and the signs of the disease in the vascular system. Negative correlations between Verticillium wilt incidence and lint cotton yield (R^2= -0.77509; $P < 0.0001$) and Verticillium wilt severity and lint cotton yield (R^2= -0.38191; $P < 0.0105$) indicate that Verticillium wilt contributed to a 37% reduction of the cotton yield in 2020. 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 1965-2018 are approximately 10 billion bales (http://www.cotton.org/tech/pest/index.cfm). 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 as measured by disease severity and tolerance measured by yield to Verticillium wilt in the field.

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 2020 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 Greenpoint AG, LLC (Decatur, AL). Cotton cultivars and lines were planted in a strip plot design with four replications with plots being 1 row with a 40 inch row spacing by 150 to 200 linear row foot plots evenly spaced throughout the field locations. Verticillium wilt disease incidence and severity ratings were conducted near cotton plant maturity from 4 randomly selected 10 foot sections of row in each plot. Foliar symptoms of Verticillium wilt were evaluated on a scale from 1 to 5 as depicted in Figure 2. 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 a measured section (71-118 ft) 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 $P \leq 0.05$. PROC CORR was used to determine relationships between disease incidence, severity, and yield.

Figure 2. Verticillium wilt rating scale from left to right. Left image is 1 for no visual Verticillium wilt, 2 is some foliar chlorosis and necrosis, 3 is foliar chlorosis and necrosis over the entire plant, 4 is foliar chlorosis and necrosis with leaf drop, and the far right image is 5 a defoliated plant.

Results

Verticillium wilt disease percent incidence and severity ratings were variable between the cotton cultivars and locations. Disease incidence was more severe in TN and ranged from 51 to 91 % of the plants of each cultivar with vascular staining. The lowest Verticillium wilt incidence percentage was observed in ST 5471 GLTP, ST 5600 B2XF,

and NG 3930 B3XF in the Jones location (Fig. 3). These cotton cultivars had the lowest percentage of plants with vascular discoloration and disease severity ratings of 2.6 or less. Disease incidence in the Brown field ranged from 8 to 38 % of the plants of each cultivar which was significantly lower disease than in the TN location ($P > 0.05$). The highest Verticillium wilt incidence was measured in CP 9178 B3XF, PHY 400 W3FE, and NG 4936 B3XF in the Brown location. These cotton cultivars had the highest percentage of plants with vascular discoloration and disease severity ratings of 2.5 to 3.0 (Fig. 4). Combining the two locations, the number of plants with vascular staining due to Verticillium wilt was most severe in NG 4936 B3XF (78%) with DP 2127 B3XF and PHY 390 W3FE having the lowest level of infection (45 and 48% respectively).

Yields indicated significant differences between cultivars when challenged with Verticillium wilt (Figures 5 & 6). Lint cotton yields varied by 617 and 569 lb/A in the Jones and Brown fields respectively, with Jones supporting lower yields with more Verticillium wilt than the Brown location in 2020. Ranking the cultivars by yield indicates DP 2020 B3XF, PHY 400 W3FE, and DP 2012 B3XF produced over 1200 lb/A of lint cotton yields averaging in both locations under these disease conditions and these cultivar yields were 36 % greater than the lowest yielding cultivar DP 2115 B3XF with 784 lb/A of lint cotton. Comparing the data between disease incidence and severity indicated a significant positive correlation (R2=0.6248; $P < 0.000$) 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 (R2= -0.38191; $P < 0.0105$). The correlation between Verticillium wilt severity and lint cotton yield (R2= -0.35603; $P < 0.0177$). Verticillium wilt contributed to a 37% reduction of the cotton yield in 2020.

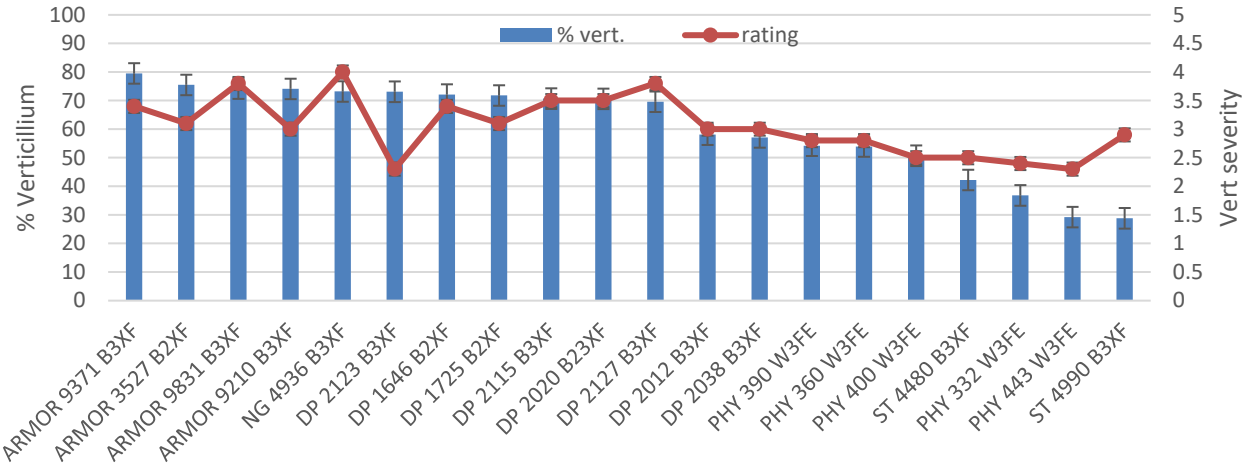

Figure 4. Verticillium wilt incidence and severity, Brown field 2020.

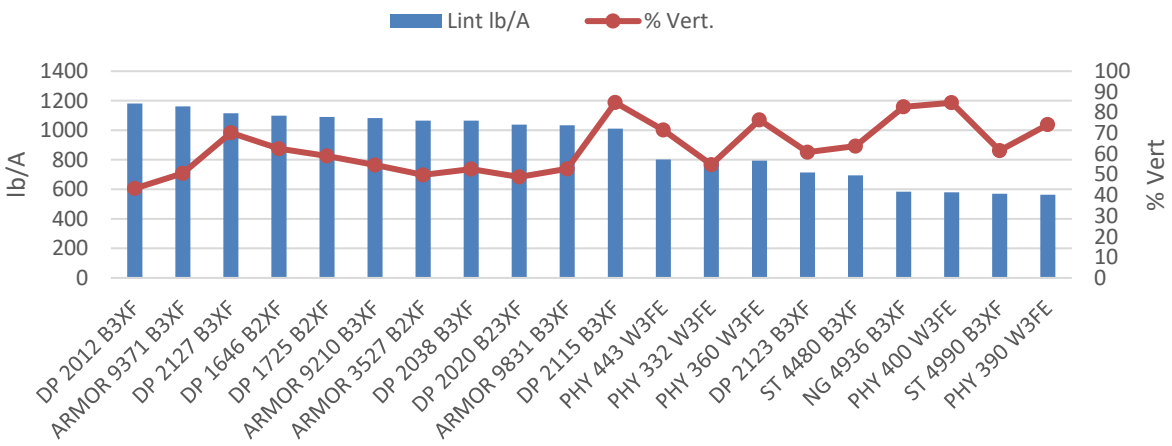

Figure 5. Cotton variety lint yield and Verticillium wilt incidence in the Jones field , 2020.

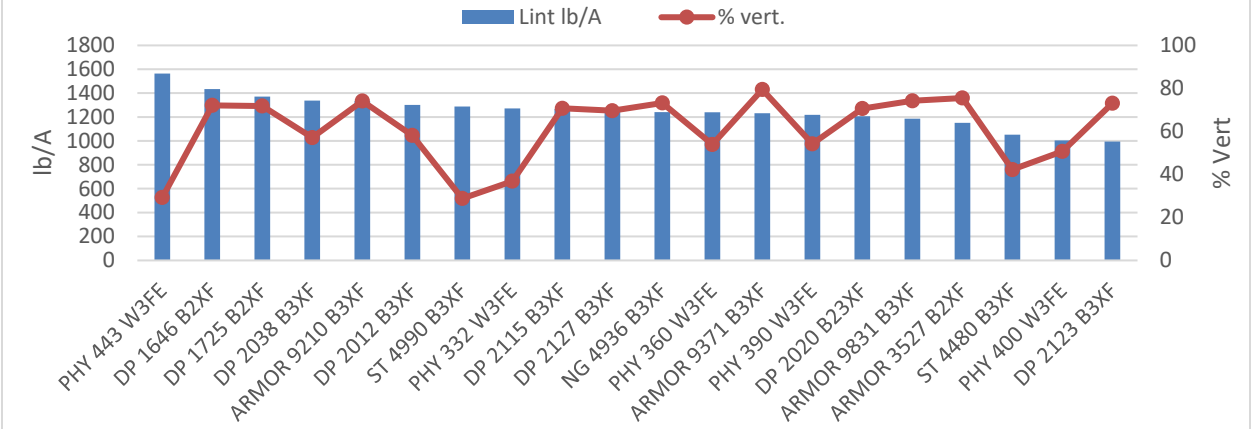

Figure 6. Cotton variety yield and Verticillium wilt incidence in the Brown field, 2020.

Conclusions

Cotton cultivar selection is very important in a Verticillium wilt infested field. The highest yielding cultivars often have less Verticillium wilt, although DP 1646 B2XF is a high yielding cultivar but does support a high level of Verticillium incidence. Level of incidence, severity of symptoms, and yield all need to be considered when selecting a cultivar for a Verticillium wilt field.

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