COTTON CULTIVAR DISEASE INCIDENCE, SEVERITY, AND YIELDS WHEN CHALLENGED WITH VERTICILLIUM WILT IN THE TENNESSEE VALLEY REGION, 2021

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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. 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 yield indicates DP 2115 B3XF, PHY 360 W3FE and NG 3195 B3XF were in the top five yielding cultivars over both locations. Comparing the data between disease incidence and severity indicated a significant positive correlation (R^2=0.8962; $P < 0.0001$) between visual symptoms and the signs of the disease in the vascular system. Negative correlations between Verticillium wilt incidence and lint cotton yield were not significant in 2021.

Introduction

Losses from Verticillium wilt for the U.S., according to disease loss estimates, the last five years of 2015-2020 are approximately 770,000 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 2021 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 in 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 ft 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 discoloured 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 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. 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 but similar between locations. Disease incidence in the Tate field ranged from 25 to 87 % of the plants of each cultivar. The lowest Verticillium wilt incidence was measured in NG 5150 B3XF, PHY 205 W3FE, PHY 360 W3FE, and DP 2012 B3XF in the Tate location. These cotton cultivars had the lowest percentage of plants with vascular discoloration and disease severity ratings of 2.0 to 2.5 (Fig. 3). Disease incidence was more severe in the Brown field ranged from 37 to 98 % of the plants of each cultivar with vascular staining. The lowest Verticillium wilt incidence percentage and disease severity was observed in Armor 9831 B3XF, DP 2127 B3XF, Armor 9371 B3XF and DP 2020 B3XF (Fig. 4). These cotton cultivars had the lowest percentage of plants with vascular discoloration and disease severity ratings of 2.7 or less. Combining the two locations, the number of plants with vascular staining due to Verticillium wilt was most severe in NG 3299 B3XF (88%), PHY 411 W3FE (87%), ST 5091 B3XF (85%), and PHY 400 W3FE (83%), with ARMOR 9371 B3XF (46%), NG 5150 B3XF (46%), and DP 2012 B3XF (47%) having the lowest level of infection respectively).

Yields indicated significant differences between cultivars when challenged with Verticillium wilt (Figures 5 and 6). Lint cotton yields varied by 749 and 1039 lb/A in the Tate and Brown fields respectively. Both locations experienced similar levels of Verticillium wilt in 2021; however, the disease symptoms were more uniform across the Tate field with more variability at the Brown location. Ranking the cultivars by yield indicates DP 2112 B3XF, PHY 332 W3FE, PHY 360 W3FE, NG 5150 B3XF, and NG3195 B3XF were the top five yielding cultivars in the Tate field (Figure 5). In the Brown field, NG 3195 B3XF, DP 2012 B3XF, DP 2239 B3XF, DP 2141 NR B3XF, and PHY 360 W3FE produced over 1175 lb/A of lint cotton. DP 2115 B3XF, PHY 360 W3FE and NG 3195 B3 XF were in the top five yielding cultivars over both locations Lint cotton yields averaged over both locations under these disease conditions and found cultivar selection increase yields 50 % when comparing the lowest and highest yielding cultivars. Comparing the data between disease incidence and severity indicated a significant positive correlation (R^2=0.8962; P < 0.0001) between visual symptoms and the signs of the disease in the vascular system. A correlation between Verticillium wilt incidence and lint cotton yield was not significant in 2021.

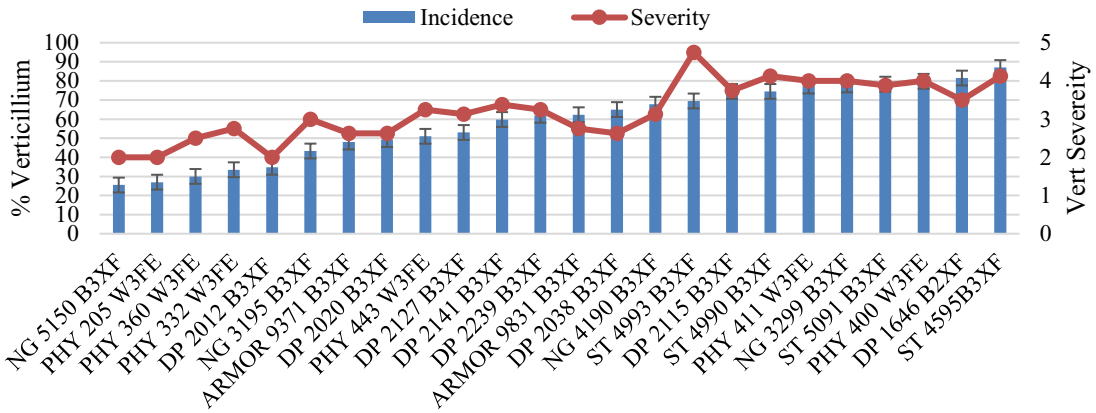

Figure 3. Verticillium wilt incidence and severity, Tate 2021.

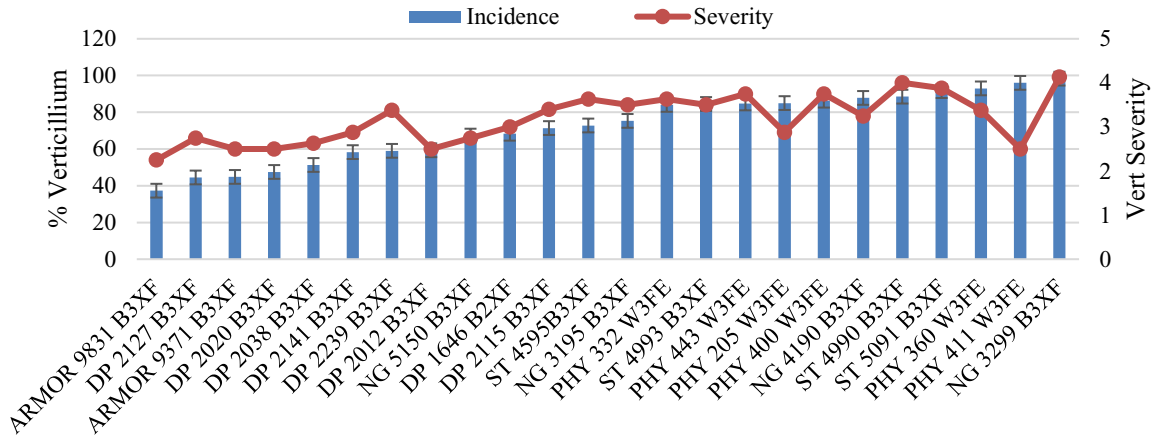

Figure 4. Verticillium wilt incidence and severity, Brown field 2021.

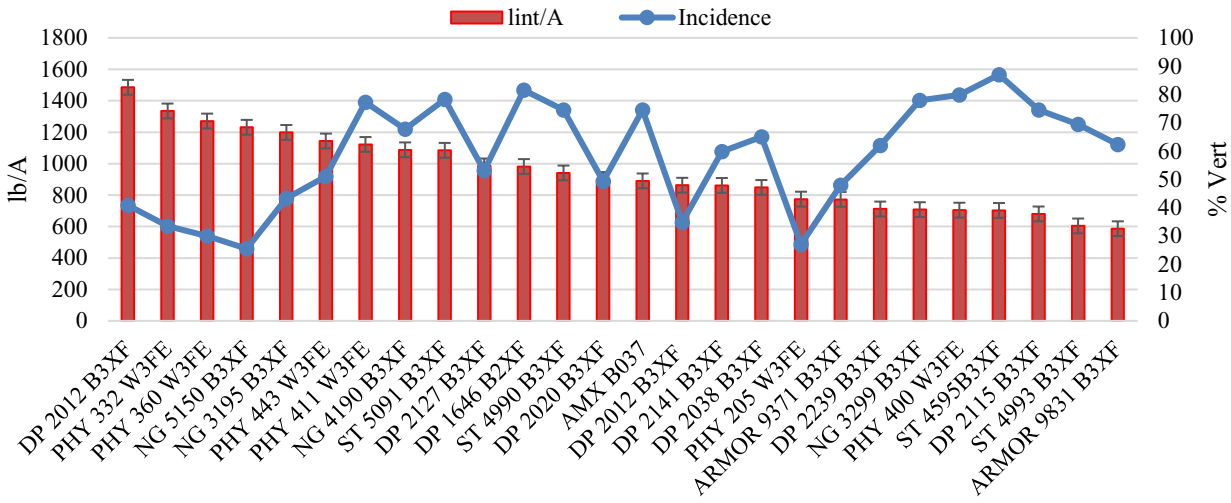

Figure 5. Cotton lint yield and Verticillium wilt incidence in the Tate field, 2021.

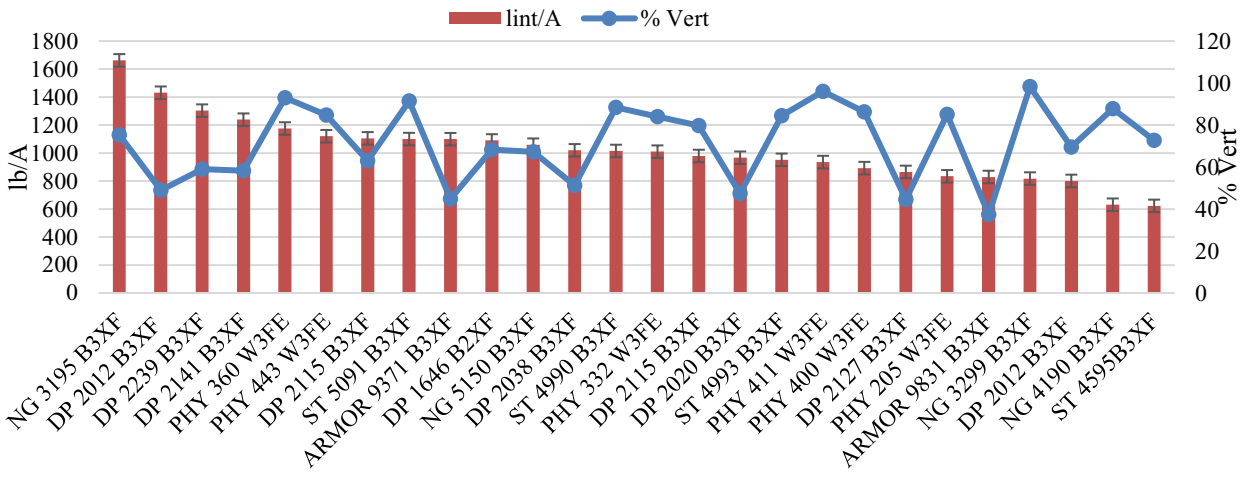

Figure 6. Cotton lint yield and Verticillium wilt indicidence in the Brown field, 2021.

Conclusions

Cotton cultivar selection is very important in a Verticillium wilt infested field. The highest yielding cultivars often have less Verticillium wilt. In 2021 new cultivar available to growers supported lower Verticillium wilt disease and sustained higher yields. Level of incidence, severity of symptoms, and yield all need to be considered when selecting a cultivar for a Verticillium wilt field.

References

El-Zik K.M. 1985. Integrated control of Verticillium wilt of cotton, Phytopathology 6:1025–1032.

Land, C. J., Lawrence, K. S., Newman, M., 2016. First report of *Verticillium dahliae* on cotton in Alabama. Plant Disease 100, 655 The American Phytopathological Society, St. Paul, MN. http://dx.doi.org/10.1094/PDIS-10-15-1143-PDN

Lawrence, Kathy S., Austin Hagan, Randy Norton, Jiahuai Hu, Travis R. Faske, Robert B Hutmacher, John Muller, Ian Small, Zane J. Grabau, Robert C. Kemerait, Doug Jardine, Paul Price, Thomas W. Allen, Calvin D Meeks, John Idowu, Lindsey D. Thiessen, Seth A. Byrd, Jerry Goodson, Heather Kelly, Terry Wheeler, Thomas Isakeit and Hillary L. Mehl. 2020. Cotton Disease Loss Estimate Committee Report, 2020. Proceedings of the 2020 Beltwide Cotton Conference Vol. 1: 117-119. National Cotton Council of America, Memphis, TN. http://www.cotton.org/beltwide/proceedings/2005-2020/index.htm

Palmateer A.J., McLean K.S., Morgan-Jones G. and van Santen E. 2004. Frequency and diversity of fungi colonizing tissues of upland cotton, *Mycopathologia* 157: 303–316.

Raper, T, B. Meyer, K. Lawrence, T. Sandlin, T. Cutts, N. Silvey, C. Burmester, T. Dill, P. Shelby, and H. Kely. 2017. Verticillium Wilt in Tennessee Valley Cotton.

Wheeler, T. A, J. P. Bordovsky, J. W. Keeling, and B. G. Mullinix, Jr. 2012. Effects of crop rotation, cultivar, and irrigation and nitrogen rate on Verticillium Wilt in cotton. Plant Dis. 96:985-989.

Xiao C.L. and Subbarao K.V. 2000. Effects of irrigation and *Verticillium dahliae* on cauliflower roots and shoot growth dynamics, *Phytopathology* 90: 995–1004.