Verticillium Wilt in Tennessee Valley Cotton

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Unbiased assessments of varietal tolerance to Verticillium wilt provide growers with information they need to select the most tolerant varieties and minimize impacts of the disease. This publication provides background on Verticillium wilt, summarizes recent variety trial results, and highlights other practices that can reduce the impact of the disease.

Introduction

Verticillium wilt of cotton has significantly reduced yields throughout the U.S. Cotton Belt and across the world for decades; U.S. loss estimates in 1961 equaled 580,000 bales, Soviet Union loss estimates in 1966 equaled 760,000 and Chinese losses reached 460,000 bales in 1982. As of 2016, U.S. loss estimates caused by Verticillium wilt exceeded 185,000 bales.

According to the 2014, 2015 and 2016 Cotton Disease Loss Estimate Committee Reports, yield losses in Alabama and Tennessee exceeded 29,100 bales across those three seasons (Lawrence et al., 2014, 2015, 2016). The estimated $11.2 million dollar loss of income due to Verticillium wilt in these two states over three years is not evenly distributed; although rarely noted in West Tennessee and Central or South Alabama, the disease is very common in the Tennessee Valley regions of North Alabama and the cotton producing counties of Central Tennessee. Subsequently, yield losses within these regions are frequently substantial.

Identification

Visual Characteristics

Often, Verticillium wilt first appears as stunting of the infected plant relative to healthy adjacent plants. Should conditions supporting the disease persist, inconsistent mottling of leaf tissue typically develops (Figs. 1 & 3). Patterns on leaf blades are much more erratic than with nutrient deficiencies; quadrants of leaves, a partial leaf edge or complete leaf blade may begin to turn yellow or become chlorotic. Chlorotic regions may become necrotic (die) rather quickly after symptoms are first noted. Other regions of the leaves may continue to grow and maintain a dark green color or the infected leaves may abort and shed.

Figure 1: As the disease progresses, mottling of leaf tissue becomes evident. Patterns on leaf blades are erratic as edges, quadrants and/or entire leaf blades become chlorotic and die.

Incidence and severity typically vary within a row. Often, infected plants may be immediately adjacent to a plant that is not impacted by the disease (Fig. 2). These adjacent, healthy plants greatly contrast neighboring infected plants since infected plants commonly have far fewer fruiting positions and are notably shorter with less branching.

Figure 2: Incidence commonly varies through a row; infected plants may be immediately adjacent healthy plants.

In order to isolate either Verticillium or Fusarium wilt as the cause of the stunting and leaf mottling, the stem of the infected plant should be sliced to inspect for staining (title image, Fig. 3). Brown or black staining within the pith (specifically the xylem) is indicative of Verticillium or Fusarium Wilt. In Verticillium infected plants, this coloration is caused by the colonization of the causal agent *Verticillium dahliae* in the xylem tissue. Given the xylem's role in transporting water from the roots to the leaves, the fungal infection within the xylem tissue results in earlier onset of drought stress symptoms. As a result, infected plants often appear to have a 'wilted' appearance. The blocked xylem and water stress cause earlier stomatal closure and a reduction in carbon dioxide available for photosynthesis. Reduced photosynthesis limits available resources and reduces yields. Leaf abortion from severe infestations further exacerbates the problem.

Conditions which promote the disease

Environment

Verticillium wilt spreads and proliferates quickly in cool, moist, heavy-textured soils. Due to evaporative cooling of water, higher disease pressure has been noted in irrigated acres. Recent work examining the response of Verticillium wilt to a variety of soil types and irrigation regimes noted trends of increasing incidence and severity with increasing clay and silt content and with the addition of irrigation (Land et al., 2017).

Genotype

Estimated yield reductions due to Verticillium wilt have declined over the past 60 years. Much of this decline is attributed to selection of varieties that are less susceptible to the disease. Still, commercially available cultivars vary greatly in tolerance to Verticillium wilt. One of the most practical and effective methods for minimizing the impact of Verticillium wilt is selection of a tolerant variety.

Figure 3: TOP: Leaves of infected plants typically have erratic mottling of chlorotic and necrotic regions. BOTTOM: Staining of the xylem is evident by slicing into the stem. Brown or black within the vascular tissue indicates the plant is infected with either Fusarium or Verticillium wilt.

Management

Variety selection

To minimize the potential negative impacts of Verticillium wilt, varieties that display low levels of infection, low visual severity ratings, and high yield potential should be placed on farms with history of Verticillium wilt. These varietal characteristics are evaluated within the Tennessee Valley region each year. Mr. Brad Meyer, Director of Agronomy & Cooperative Services with AGRI-AFC and Mr. Nathan Silvey, Agronomist and Consultant with Madison Farmers Cooperative, established and maintained four variety trials in the Tennessee Valley and in Central Tennessee during 2017. Trials were placed within fields with history of Verticillium wilt pressure.

Figure 4: LEFT: Mr. Brad Meyer slices stems to check for staining. CENTER: Mr. Shawn Butler rates severity of Verticillium wilt symptoms. RIGHT: A modified John Deere 9900 picker harvests strips to determine lint yield and fiber quality.

During mid-September, variety trials were assessed for percent infection by counting the number of plants with stained vascular tissue within a 10' section of row (Fig. 4) and severity of Verticillium wilt symptoms was rated. Yield data were collected and samples were ginned at the UT Cotton MicroGin to determine turnout and fiber quality was assessed at the USDA Classing office in Memphis, TN (Figs. 4 & 5). Results from these assessments are summarized in Figure 5 and Table 1 below.

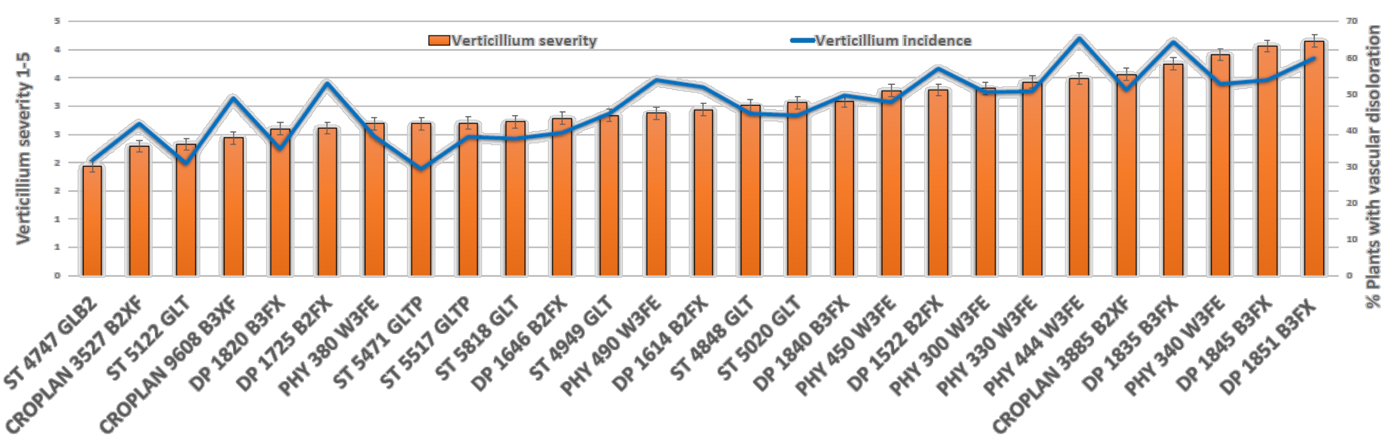

Figure 5: Percent infection of evaluated plants within 10 row feet and severity of Verticillium wilt symptoms noted within each variety in four 2015 and 2016 Tennessee Valley locations. A severity rating of 5 indicates severe visual disease symptoms while a rating of 1 indicates no visual symptoms. Means followed by the same letter are not significantly different (p=0.05).

Figure 5: After harvesting, seedcotton was weighed and subsampled in preparation for ginning at the UT Cotton MicroGin.

Table 2: Yield and fiber quality properties averaged across the two strip locations harvested during the 2017 season. Means followed by the same letter are not significantly different (p=0.05).

Cultivar	Seed cotton lb/A	Lint cotton lb/A	Turnout %
ST 5471 GLTP	2358 a	868 a	37 abcdefg
DP 1646 B2FX	2267 ab	855 a	38 abcde
CROPLAN 3527 B2XF	2080 abc	784 ab	38 abcdef
DP 1614 B2FX	2009 abc	761 ab	38 abcd
ST 4747 GLB2	1991 abc	739 abc	37 abcdefg
DP 1820 B3FX	1899 abc	729 abc	38 abc
ST 5122 GLT	2032 abc	729 abc	36 bcdefg
ST 4949 GLT	1876 abc	728 abcd	39 ab
ST 5818 GLT	2005 abc	713 abcd	36 cdefg
PHY 330 W3FE	1884 abc	697 abcd	37 abcdefg
PHY 380 W3FE	2038 abc	696 abcd	34 gf
ST 5020 GLT	1942 abc	688 abcd	35 defg
PHY 300 W3FE	1833 abc	686 abcd	37 abcdef
CROPLAN 9608 B3XF	1759 abc	686 abcd	39 a
ST 4848 GLT	1861 abc	682 abcd	37 abcdefg
ST 5517 GLTP	1874 abc	665 abcd	35 defg
DP 1522 B2FX	1890 abc	647 abcd	34 gf
DP 1725 B2FX	1674 abc	637 abcd	38 abc
PHY 490 W3FE	1746 abc	628 abcd	36 abcdefg
DP 1840 B3FX	1714 abc	599 abcd	35 defgh
CROPLAN 3885 B2XF	1660 abc	575 abcd	35 fgh
PHY 450 W3FE	1489 abc	517 abcd	35 efgh
PHY 340 W3FE	1252 abc	455 abcd	37 abcdefg
DP 1835 B3FX	1099 bc	412 bcd	38 abcdef
PHY 444 W3FE	1153 bc	405 bcd	35 defgh
DP 1851 B3FX	938 c	323 cd	34 gf
DP 1845 B3FX	909 c	294 cd	32 h

Column LS-mean values with different letters are significantly different by Tukey Kramer's at P > 0.05.

ST 4747 GLB2, CROPLAN 3527 B2XF, ST 5122 GLT, CROPLAN 9608 B3XF, DP 1820 B3XF and DP 1725 B2XF were characterized by low levels of infestation and low visual severity ratings. Generally, low levels of infestation corresponded to low visual severity ratings.

Lint yields were generally higher in varieties with less Verticillium wilt. The highest yields were noted from ST 5471 GLTP, DP 1646 B2XF, Croplan 3527 B2XF, DP 1614 B2Xf and ST 4747 GLB2. Of the six varieties characterized by the lowest levels of infection and lowest visual severity ratings, all fell within the top-yielding 'a' group.

Irrigation

Although irrigating cotton can increase the spread and incidence of the disease, irrigated cotton within the region consistently out-yields dryland cotton. In order to reduce the impact of irrigation on the spread of Verticillium wilt, use extension recommendations to properly initiate, time, and terminate irrigation events through the season and only apply necessary amounts. Over-irrigating can reduce yields by increasing disease incidence and severity.

Crop Rotation

Rotation is an effective method of reducing disease inoculum. Several grass species including barley, wheat, sorghum, perennial ryegrass and fescue can reduce disease inoculum. Legumes including several clovers (Hubam, sweet, white), alfalfa, lespedeza, peas and soybeans as well as several mustard and rape species have also shown to decrease inoculum. However, several winter weeds can increase disease inoculum and should be controlled to minimize the impact of the disease if cotton is to be planted the following season.

Figure 6: Wheat in rotation has successfully reduced disease inoculum and is a good approach to mitigating the impacts of Verticillium wilt on cotton. Additionally, chopping stalks to speed organic matter breakdown can reduce disease incidence and severity.

Other Approaches

Practices that increase soil temperatures and/or increase soil drainage can also reduce the impact of the disease. Planting on raised beds and minimizing crop residues on the soil surface over winter by chopping stalks and/or tillage are effective ways of reducing disease inoculum. Although some high value crops can support the use of soil fumigants to reduce inoculum, fumigation is currently not a practical approach to managing the disease in cotton. Additionally, seed treatments, in-furrow or foliar applications of fungicides are not currently effective for controlling Verticillium wilt.

Conclusions

Verticillium wilt is a major disease in many Tennessee Valley fields. Disease symptoms include stunting, erratic chlorosis and necrosis of portions of the leaf tissue, poor fruit retention, and staining of vascular tissue. Verticillium wilt severity tends to be worst in cool, irrigated, heavier textured soils planted to susceptible varieties. Increasing irrigation efficiency, increasing soil temperatures through tillage and bedding, and rotating to non-hosts can reduce disease inoculum and severity. However, one of the best management strategies is to select tolerant varieties. In fields with a history of Verticillium wilt, plant varieties that display low levels of infestation, low visual severity ratings, and high yield potential.

References/Additional Resources

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