THE UNIVERSITY OF ARIZONA
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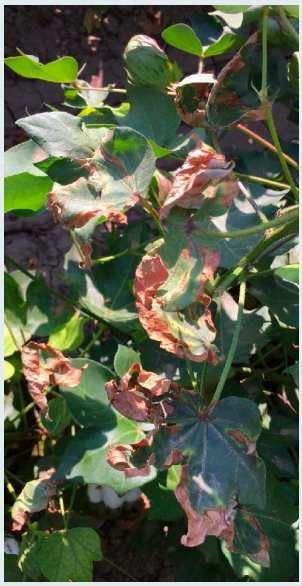
Verticillium Wilt of Cotton

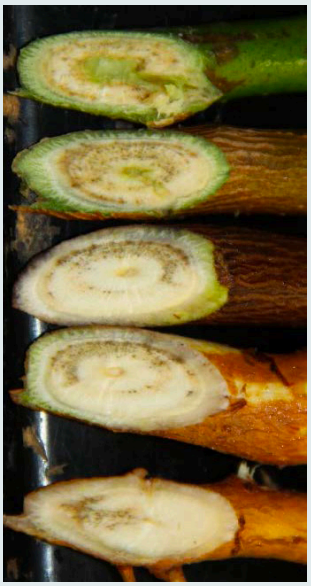
Jiahuai Hu

Introduction

Verticillium wilt is one of the most important diseases of cotton worldwide. This disease was first reported on Upland cotton in Virginia in 1918. Currently, Verticillium wilt is widespread in most of the cotton belt region of the U.S. and causes great economic losses in some cotton producing areas such as western Texas and San Joaquin valley of California. In Arizona, Verticillium wilt occurs only on Upland cotton, especially more severe in the regions at elevations above 3,500 feet in Cochise, Graham, and Greenlee counties where cooler air temperatures (70 to 80 °F) are more favorable for symptom expression from late summer to fall. A recent study showed that overwatering and heavy soil with higher composition of silt and clay led to an increased in disease incidence (Land *et al*., 2017). With adoption of tolerant cultivars, Verticillium wilt has not been a major problem in Arizona cotton in the recent past.



Interveinal chlorosis and necrosis of leaves from a plant infected with Verticillium wilt fungus



Dark brown streak in the main stem and taproot of a symptomatic cotton plant

Pathogens

Soilborne fungus *Verticillium dahliae* is the primary pathogen, though *V. albo-atrum* has also been reported in cotton. Two major strains of *V. dahliae* exist: defoliating strain and non-defoliation strain based on symptoms. To date, it is not clear which one or both strains of the pathogen are present in Arizona cotton.

Host Range

More than 400 plant species include numerous herbaceous and woody plant species. Important hosts in Arizona include: 1) vegetables: cucurbits, chile pepper, eggplant, and potato; 2) fruit nut trees: pistachio, olive, almond, strawberries and raspberries; 3) agronomic crops: cotton and alfalfa; and 4) landscape plants: rose, elm, and maple.

Symptoms And Diagnosis

Typical symptoms include interveinal chlorosis or necrosis, stunting, defoliation, and streak of light to dark vascular discoloration. These symptoms may occasionally occur on young plants, but often more pronounced on plants after flowering. Overall yellowing appearance may occur on plants co-infected with root-knot nematode in late summer. Symptom expression varies with variety, inoculum density in the foil, pathogen strains, and environmental conditions. The diagnostic symptom is the vascular staining of the main stem and root.

Disease Cycle

The fungus survives indefinitely in the soil as microsclerotia. Microsclerotia are produced copiously in roots, stems, and leaves of infected cotton plants during late summer, which are returned to soil during harvesting and land preparation. Microsclerotia germinate in the vicinity of actively growing roots and produce hyphae to infect roots. Subsequently, the fungus invades the

xylem vessels of roots and results in systemic infection of vascular system throughout the entire plant. Prolific fungal growth in the xylem channels restricts or disrupts the flow of water and nutrient. Disease development is favored by cold temperature, wet soil, and stressed conditions. Hot summer may inactivate the fungus in aboveground portions and re-infections from roots may occur as favorable conditions return. Temperature and moisture are the two most important environmental factors that contribute to the spread and proliferation of *Verticillium dahliae*, although Verticillium wilt development is also influenced by variety selection, plant density, pathogen aggressiveness, and inoculum density in the soil. The fungus are spread by contaminated soil, equipment, gin trash, and seeds.

Symptoms Can Be Confused With

Fusarium wilt and cotton (Texas) root rot . Verticillium wilt does not cause any browning or rotting of the root surface and cortex, but cotton root rot or Fusarium wilt does. Verticillium wilt has a distinct vascular staining in the xylem of taproot and stem. For a definitive diagnosis, symptomatic tissues should be collected and wrapped in a dry paper towel, cooled, placed in a plastic bag, and shipped OVERNIGHT to the University of Arizona's Extension Plant Pathology Laboratory in Tucson. All submissions should be accompanied by completed Plant Disease Diagnostic Form. Laboratory assays are available to determine Verticillium wilt risk levels by soil sampling.

Verticillium-wilt affected plants scattered in a field (the photos on top and bottom were taken on Aug 20 and Sep 10)

Management

Soil treatment with Vapam is not a cost effective option, a combination of cultivar selection and cultural practices is necessary for reducing the impact of Verticillium wilt: 1) plant tolerant cultivars at higher seeding rate (3-4 seeds per foot), 2) plant early maturing or short-seasoned cultivars, 3) rotate with non-host crop such as sorghum, corn, small grains and sudan grass to reduce disease incidence, 4) reduce irrigation during flowering in late July and August to avoid lowering soil temperature that will favor disease development, and 5) avoid excessive use of nitrogen.

References

Carpenter, C. 1914. The Verticillium wilt problem. Phytopathology, 4: p. 393

Land, C. *et al.* 2017. Cultivar, irrigation, and soil contribution to the enhancement of Verticillium wilt disease in cotton. Crop Protection 96: 1-6

Olsen, M., Silvertooth, J.C. 2001. Diseases and Production Problems of Cotton in Arizona. University of Arizona College of Agriculture and Life Sciences Cooperative Extension Service. az1245

An asymptomatic plant (red arrow) surrounded by a symptomatic plants at each side along a row

Symptomatic plants surrounded by asymptomatic plants at each side along a row

Interveinal chlorosis and necrosis of a leaf from a symptomatic plant caused by Verticillium wilt fungus

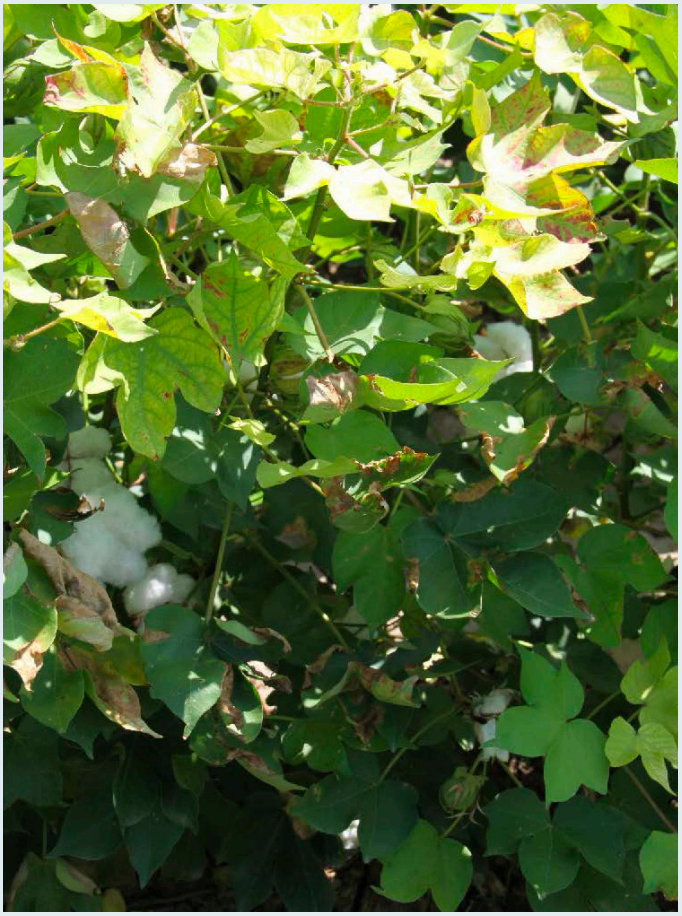
Dark brown streak in the main stem and taproot of a symptomatic plant (left: healthy)

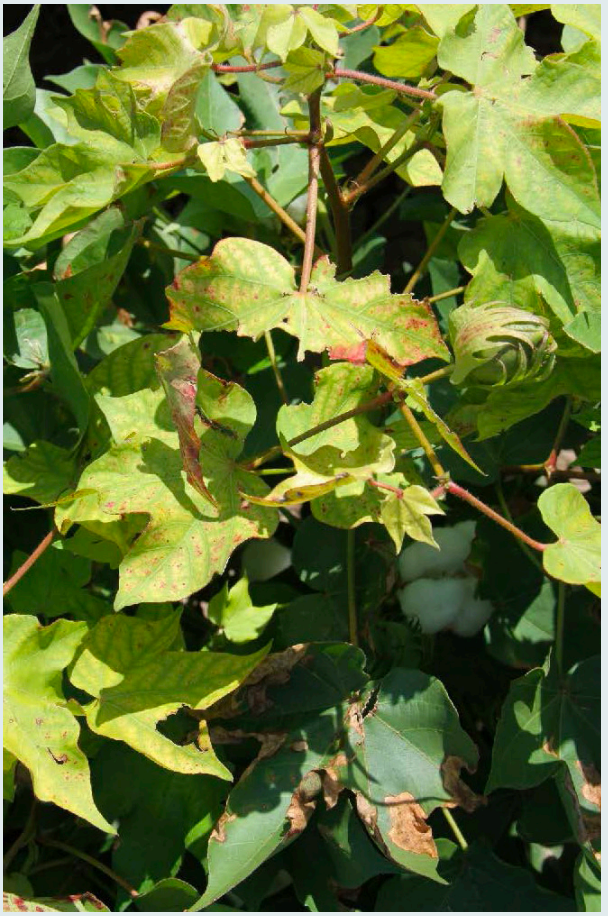
Streak of brown staining in the stem, but not in taproot of an symptomatic plant

Long streak of dark brown staining on the sapwood underneath bark

Leaf drop of a symptomatic plant in early September

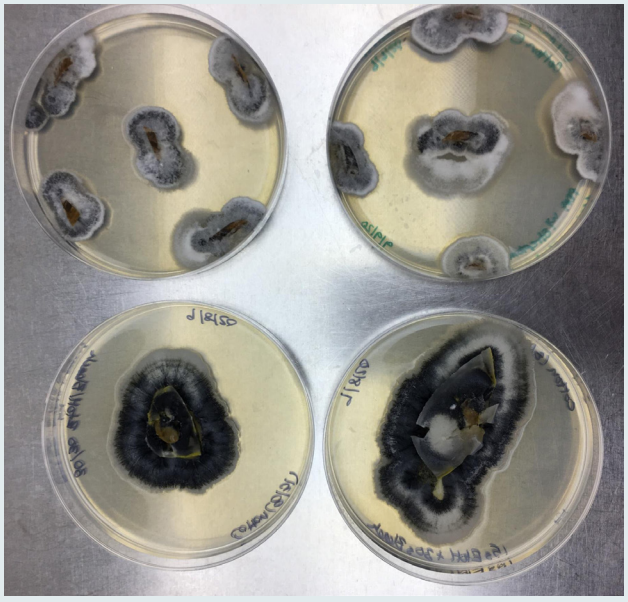
Moderately defoliated plant in early September





Yellowing appearance of a plant co-infected with verticillium wilt and root knot nematode

Plants in a portion of field that is infested with Verticillium wilt and root knot nematode (note: the degree of yellowing appearance correlates with the severity of galling by root knot nematode)



Colony morphology of *Verticillium dahliae* on the potato dextrose agar media (1-week-old culture)

Microsclerotia of *Verticillium dahliae* form in agar culture following isolation of the fungus (Photo source: Tom Creswell, Purdue University)

Microscopic view of Verticillium conidiophores and conidia (whorl)

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AUTHORS

Dr. Jiahuai Hu
Assistant Cooperative Extension Specialist and Plant Pathologist, School of Plant Sciences

CONTACT
Jiahuai Hu
epp@email.arizona.edu

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