A New Virus Disease in Alabama Cotton

Cotton plants in some areas of Alabama have displayed symptoms of a new virus disease, US-CLRDV. Learn about this new threat, its symptoms, and recommended control.

Introduction

With an estimated farm gate income of $325 million and yield of 899 pounds lint per acre on 470,000 acres in 2018, cotton (Gossypium hirsutum) is Alabama’s most economically important agronomic crop. With the exception of the whitefly-transmitted cotton leaf crumple virus in California and Arizona, virus-incited diseases have not previously caused significant losses in the southeastern United States cotton production region. In late August through October of 2017, cotton plants displaying symptoms of a possible virus disease were observed in producer fields across Alabama. Subsequently, a virus called Cotton leafroll dwarf virus (US-CLRDV) (genus Polerovirus, family Luteoviridae), was identified in samples collected from Barbour County.

In September 2018, cotton plants with similar symptoms were collected from the Alabama Agricultural Experiment Station Plant Breeding Unit in Elmore County, and the presence of the virus was confirmed by both the Auburn University Plant Diagnostic Lab and the University of Arizona. Whole genome sequences were derived from symptomatic samples collected during 2018 from Barbour and Macon Counties, which matched most closely to CLRDV isolates from South America, confirming the identity of cotton leafroll dwarf virus in Alabama (CLRDV-AL). Currently, whole genome sequences of US-CLRDV isolates collected from Mississippi and Georgia are being completed to compare identities across the southeast United States.

In Brazil, yield losses of up to 80 percent have been reported for susceptible cultivars. On the basis of observations made in producer cotton fields across Alabama, yield loss to the CLRDV-AL strain in 2017 was estimated at $19 million. To date, the virus has been detected, through molecular methods (PCR) in samples collected from commercial fields and AAES outlying units in 24 counties across cotton producing regions of Alabama (figure 1), along with multiple counties in the cotton producing regions of the Florida Panhandle, Georgia, and Mississippi. Incidence of symptomatic cotton plants approached 100 percent in some commercial fields in southwest Alabama.

The CLRDV genome encodes six predicted coding regions, or open reading frames (ORFs), ORF0 to ORF5. The ORF0 encodes for a putative viral suppressor of host gene silencing and the majority of mutations in the genome. When compared to isolates from South America, the ORF0 was found to be the most divergent among the ORFs, but not sufficiently divergent to be considered a new species. The ORF0 sequences from sixteen isolates collected from across Alabama representing different symptomologies and geographic locations were compared to determine if differences were observed. The ORF0 sequences were almost identical, indicating that the same viral strain is present across Alabama and is most likely a recent introduction to the southeast United States.
Symptoms

Cotton blue disease (CBD), caused by the typical CLRDV strain, was first described in Africa in 1949 and more recently in Brazil, Argentina, India, Thailand, and Timor-Leste. Infected plants exhibit stunting due to shortened internodes, leaf rolling, leaf petiole and vein reddening, distorted juvenile leaves, reduced flower and boll size, and sterility. In Brazil during 2006, a new or atypical CLRDV strain was identified in CBD-resistant cotton. Virus-infected plants exhibited mild CBD symptoms characterized by red, withered leaves and accentuated verticality (i.e., long terminal whips with numerous blank fruiting nodes). The new US-CLRDV virus in Alabama cotton is related to the above typical and atypical strains of CLRDV, although it is most closely related to the atypical strain.

In 2018, symptoms were first observed in early to mid-September at multiple locations across Alabama. Symptoms were particularly severe in June-planted as compared with May-planted cotton, where rugosity (puckering) of the juvenile leaves in the main and lateral shoot terminals (figure 2) along with upward or downward cupping of the leaves (figure 3) and red to maroon discoloration of leaf veins (figure 4) were first observed. Similar leaf symptoms were also noted in Alabama cotton in 2017. Noticeable rugosity along with cupping of leaves on regrowth emerging from the base of mature virus-infected cotton was also common in October and November (figure 5). Aphid feeding alone can cause leaf curling and cupping, and whitefly feeding can cause leaf deformation. In addition, reddish to maroon discoloration of the petioles and stems just below the shoot terminals with shortened internodes in a zig-zag pattern have also been observed (figure 6). Severely damaged plants develop a Christmas tree or triangular shape with elongated whips or shoots with many fruiting nodes and squares, which were later shed and resulted in few blooms and bolls set on the main terminal whips and lateral branches (accentuated verticality) (figures 7
Failure of diseased plants to retain squares and set blooms or bolls on the whips, which was consistent across a limited range of commercial cultivars, was likely responsible for top crop loss. Occasionally, shedding of nearly mature bolls was also observed. Severely stunted, nonboll bearing plants collected in Escambia County tested positive for the virus.

Vector

Like other Polerovirus species, this new virus is transmitted by the cotton aphid (Aphis gossypii) in a persistent and circulative manner. Alates can transmit the virus in as little as 40 seconds, and viruliferous aphids can transmit up to 12 days. Whiteflies, which have become a serious pest in Georgia cotton and occasionally in adjacent states, do not transmit CLRDV or related poleroviruses.

Control

While this virus is aphid transmitted, intensive insecticide programs directed at controlling this insect pest will not result in a reduction of virus spread to fields when aphids initially colonize the crop because insecticides will not kill aphid vector before they can transmit the virus. A disease incited by the fungus Neozygites fresenii in early summer kills the majority of cotton aphids in cotton. When cotton aphid populations exceed the treatment threshold established by Alabama Extension, recommended insecticides should be applied as needed.

As was previously noted, disease incidence and subsequent symptom severity in 2018 was much greater in late-planted cotton. As a result, cotton in areas of Alabama at high risk for infection should be planted in early to mid-May. Early planting, which may increase the occurrence of boll rot and hardlock in South Alabama, has previously been recommended as a tool for managing CLRDV.

Long term, establishment of resistant cotton cultivars will be the best defense against poleroviruses like CLRDV and its relatives. Seed companies have germplasm with resistance to one or both CLRDV strains, which to date has not been deployed in the United States. So far, the few commercial cultivars exposed to US-CLRDV have shown no resistance. However, some regulated breeding lines being evaluated in the United States do carry CLRDV resistance markers, so adapted, virus-resistant commercial cultivars may soon be available. Currently, cotton cultivars marketed in Argentina and Brazil are resistant to the typical strain of CLRDV, while a few also have atypical strain resistance. However, the response of cotton germplasm with resistance to the CLRDV strains found in South America to isolates of the US-CLRDV has yet to be established.

Henbit (Lamium amplexicaule), a common winter weed, has been found to be a natural host of CLRDV and likely plays a role in the overwintering of the virus. It’s likely that other winter annual or perennial weeds will also be shown...
to be hosts of the virus over the next few months. These weed hosts are a likely overwintering site and source of primary inoculum of US-CLRDV. Several species in the Malvaceae family have been reported as hosts for CLRDV and under experimental conditions *Cicer arietinum*, *Hibiscus sabdariffa*, and *Sida acuta* have been reported as hosts. The cotton aphid is a polyphagous species and is also reported to feed on plants in the Malvaceae family, but there is limited information on host-use patterns in the southeast. While not all of the overwintering host(s) in the United States have been identified, an aggressive weed control program around field borders and nearby ditch banks may be helpful in delaying virus movement from overwintering hosts into cotton. In addition, producers are also advised to kill volunteer cotton, which may serve as a bridge between the overwintering host and newly planted cotton crop, with herbicides or tillage equipment.