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Interdisciplinary Team Addresses Cotton Leafroll Dwarf Virus in Alabama

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Abstract. A multi-state and interdisciplinary team was formed to address the Extension and research needs of CLRDV, an emerging cotton disease with high potential impact for U.S. cotton production. In 2017, CLRDV was identified in AL and Auburn University immediately formed an interdisciplinary working group composed of plant breeders, plant pathologists, entomologists, and agronomists. Since then, scientists from ten other states have joined the CLRDV group. Thus, allowing research to be coordinated efficiently and best deploy limited resources to attend the stakeholder's needs. The CLRDV group produces and shares new and relevant information with the scientific community and cotton producers alike.

INTRODUCTION

Cotton (*Gossypium hirsutum*) is one of the most economically important crops in the United States. During 2017, *Cotton leafroll dwarf virus* (CLRDV) (genus *Polevirus*, family *Luteoviridae*) was first identified in the United States in cotton on approximately 50,585 ha from Alabama (Avelar & Schrimsher et al., 2019). CLRDV is transmitted by the cotton aphid (*Aphis gossypii*). The virus has since been found across the cotton belt in North Carolina, South Carolina, Georgia, Tennessee, Florida, Mississippi, Louisiana, Texas, Arkansas, Oklahoma, and Kansas (Aboughanem-Sabanadzovic et al., 2019; Alabi et al., 2019; Ali & Mokhrari, 2020; Ali et al., 2020; Faske et al., 2020; Iriarte et al., 2020; Price et al., 2020; Tabassum et al., 2019; Thiessen et al., 2020; Wang et al., 2020). Symptoms of CLRDV consist of: stunting due to internodal shortening; leaf rolling; leaf cupping; leaf petiole and vein reddening; distorted new growth; rugosity; wilting of plants; reduced flower and boll size; accentuated verticality; and sterility. Symptoms can vary based on: plant age at time of infection, cotton variety, environmental conditions at or after infection, and nutritional status of the plant/field. In 2017, disease incidence based on visual symptoms (i.e., leaf crinkle) ranged from 3 to 30%, and yield loss was estimated at an average of 560 kg/ha which was valued at \$19 million dollars (Avelar, & Schrimsher, et al., 2019).

Whole genome sequences derived from symptomatic leaf samples collected during 2018 showed that the strain of CLRDV found in the United States is different from the “typical” and “atypical” strains previously found in South America. This confirmed that the CLRDV strain detected in in the United States is unique (Avelar, Sobrinho, et al., 2019). Whole genome sequences of CLRDV-AL isolates collected from other states across the cotton belt are similar, which suggests a single introduction of the virus into the United States (Aboughanem et al., 2021).

DEVELOPMENT OF CLRDV WORKING GROUP

The development of resistant cotton cultivars will be the best defense against CLRDV in the United States. Seed companies have germplasm with resistance to “typical” and “atypical” CLRDV strains, but these have proven susceptible to the CLRDV-AL found in the United States. In 2018, Alabama Extension Specialists and Auburn University research faculty from multiple disciplines (Plant Breeding, Agronomy, Entomology, and Plant Pathology) formed a CLRDV working group. The group has focused efforts on Extension outreach and research projects

to address this emerging disease. Initially, a statewide survey was conducted to determine the distribution of the pathogen in Alabama. At this time, CLRDV had been found in 43 of the state's 67 counties, including all major cotton production areas of Alabama. From 2018 to 2019, a weed survey was conducted to identify alternate hosts of the virus, and multiple species were identified as natural hosts (K. Conner, personal communication).

In 2019, a multi-state CLRDV Sentinel Plot Working Group was formed that included Extension Specialists and researchers from 11 cotton belt states (Alabama, Virginia, North Carolina, South Carolina, Georgia, Florida, Mississippi, Arkansas, Louisiana, Tennessee, and Texas). This multi-state group meets regularly to share updates on Extension and research efforts on CLRDV. The CLRDV sentinel plots, which included 15 sites across 10 states (with five regional sites in AL), were first established in 2019 to assess planting dates, environmental factors, varietal selection, and yield impacts of CLRDV. Leaf samples were collected twice per season by Auburn University personnel from all sentinel locations and tested for the presence of CLRDV at the Auburn University Plant Diagnostic Lab. Results from the sentinel plot system increased awareness of the disease to growers and agribusiness clientele and allowed the industry to clearly see the distribution of the disease in the United States.

Extension/research efforts at Auburn have included identifying the aphid vector and characterizing transmission efficiency (Heilnsnis et al., 2020). A robust breeding program at Auburn has allowed researchers to evaluate over 2,000 cotton breeding lines to screen for resistance to the disease. A leaf disc assay was also developed to improve the efficiency of germplasm screening (Heilnsnis et al., 2021). Members of the Auburn CLRDV working group have set up insecticide trials to determine the efficacy of insecticide treatments and found that intensive insecticide programs do not result in a reduction of virus spread (A. Jacobson, personal communication). The Auburn Plant Diagnostic Lab tested over 4,000 cotton samples in 2019, and 5,200 samples in 2020 for the presence of CLRDV.

CONCLUSION AND RECOMMENDATIONS

Traditional Extension methods were utilized to inform growers about CLRDV including presentations at county and regional production meetings (over 35 presentations from 2018 to 2020), farm visits and field days, pest alerts issued in news articles, blogs and the ACES website, and updates on CLRDV through Twitter and Facebook (Sikora et al., 2009). In-service trainings were conducted annually for Regional Extension Agents and members of the ACES Agronomic Crop Team to provide updates on CLRDV in Alabama. A CLRDV diagnostic field guide was developed for growers to assist in disease scouting and includes management recommendations for the disease (Conner et al., 2021). To date, the work from this interdisciplinary team of Extension and research personnel has led to 12 peer reviewed journal articles and over \$25 million in funding.

Current management recommendations for growers include: 1) Cotton in areas at high risk for infection should be planted early. Disease incidence and subsequent symptom severity is much greater in late-planted cotton. 2) Many weed species have been found to be natural hosts of CLRDV and may have a role in overwintering of the pathogen and likely act as a source of primary inoculum. An aggressive weed control program around field borders and nearby ditch banks prior to planting may be helpful in delaying virus movement from overwintering hosts into cotton fields. 3) Destroy cotton stalks following harvest as well as kill ratoon and volunteer cotton with herbicides or tillage equipment. They may serve as a bridge between an overwintering host and the newly planted cotton crop. 4) Long term establishment of resistant cotton cultivars will be the best defense against CLRDV.

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