AERIAL REMOTE SENSING SURVEYS OF FUSARIUM WILT OF COTTON NEAR EL PASO, TEXAS

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Abstract

Fusarium wilt of cotton is a widespread cotton disease that occurs in nearly all cotton production areas of the world. This disease is caused by the fungus *Fusarium oxysporum* f. sp. *vasinfectum* (FOV), which has many races or genotypes. The highly virulent FOV race 4 (FOV4) was found in the San Joaquin Valley of California in early 2001 and in the Texas-New Mexico border area near El Paso, Texas in 2017. A remote sensing aerial survey was performed in 2017 and a second one was conducted on September 19, 2018, about one year apart from the first survey. The intent of the surveys was to map the distribution and severity of this introduced disease in the area and to assess the progression of the disease across years. An aircraft equipped with multispectral and hyperspectral imaging systems was flown at approximately 5000 ft above ground level over three suspected areas: a 3800-acre area to the northwest of El Paso, Texas and a large 39,000-acre area and a small area of 2500 acres to the southeast of El Paso. Over 600 pairs of normal color and near-infrared images were acquired from the three areas, and the multispectral images for each of the areas were mosaicked to create orthomosaics. Images from portions of FOV4-infested fields were used to illustrate the spatial and spectral characteristics of FOV4-infested areas as compared to root-knot nematode infestations and soil variability. Plants infected early in the season were dead as evidenced by bare soil exposure. The images are being visually examined to identify probable FOV4-infested fields for ground confirmation. These aerial surveys provide useful information for faster and more effective identification of FOV4 infestations in the Texas-New Mexico border area. Multiple aerial surveys should be conducted during the growing season to monitor the progression of the disease in conjunction with ground truthing. Meanwhile, more research is needed to evaluate multispectral and hyperspectral imagery for identifying FOV4 from other coexisting races and stresses.

Introduction

Fusarium wilt of cotton, caused by the fungus *Fusarium oxysporum* f. sp. *vasinfectum* (FOV), is an important cotton disease. Many races of FOV have been identified affecting cotton (Armstrong and Armstrong, 1958; Cianchetta et al., 2015), and FOV race 4 (FOV4) is a particularly virulent race that was detected in California in 2001 (Kim et al., 2005) and in the New Mexico-Texas border area near El Paso, Texas (Halpern et al., 2018; Isakeit and Morgan, 2018). As concerns grow regarding the spread of this race and other virulent FOVs in the U.S., Cotton Incorporated and its cooperators have initiated research on surveying, management, and breeding to prevent further losses to FOVs. As part of the research effort, two aerial remote sensing surveys were conducted to map the distribution and severity of Fusarium wilt of cotton, particularly FOV4, near El Paso, Texas using airborne imaging systems. The preliminary results from the 2017 survey was reported at the 2018 Beltwide Conferences (Yang et al., 2018). This paper briefly reports on additional observations and comparisons of images on portions of some infested fields in both years.

Materials and Methods

This study was conducted in the New Mexico-Texas border area near El Paso, Texas. Three areas apparently infested with FOV4 were selected: a 3,800-ac area to the northwest of El Paso, Texas and a 39,000-ac area and a 2,500-ac area to the southeast of El Paso. A Cessna 206 aircraft equipped with three imaging systems (multispectral, hyperspectral and thermal) was used for image acquisition. Images were acquired at approximately 5000 ft above ground level along multiple flight lines on September 20, 2017 and September 19, 2018. Pix4DMapper (Pix4D SA, Lausanne, Switzerland) was used to mosaic the images for each of the three areas and Erdas Imagine (Intergraph

Corporation, Madison, AL) was used for image analysis. Details on the imaging systems, image acquisition, and image processing and analysis can be found in the Beltwide proceedings paper (Yang et al., 2018).

Results and Discussion

Figure 1 shows the normal color and color-infrared (CIR) images for a FOV4-infested area within a cotton field. FOV4-infested areas can be easily distinguished by the light color on both types of images. Non-infected plants had a dark green color on the normal color image and a reddish tone on the CIR image. As plants infected early in the season were dead at the time of image acquisition, the infested areas had mainly soil exposure. Grass and weeds were growing in some of the affected areas as shown by the lime green tone on the normal color image and the pinkish color on the CIR image. Figure 2 presents a classification map showing areas with high-vigor plants (green), FOV4-infested areas (red), and areas with varying levels of plant vigor and other stresses for the portion of the cotton field in Figure 1.

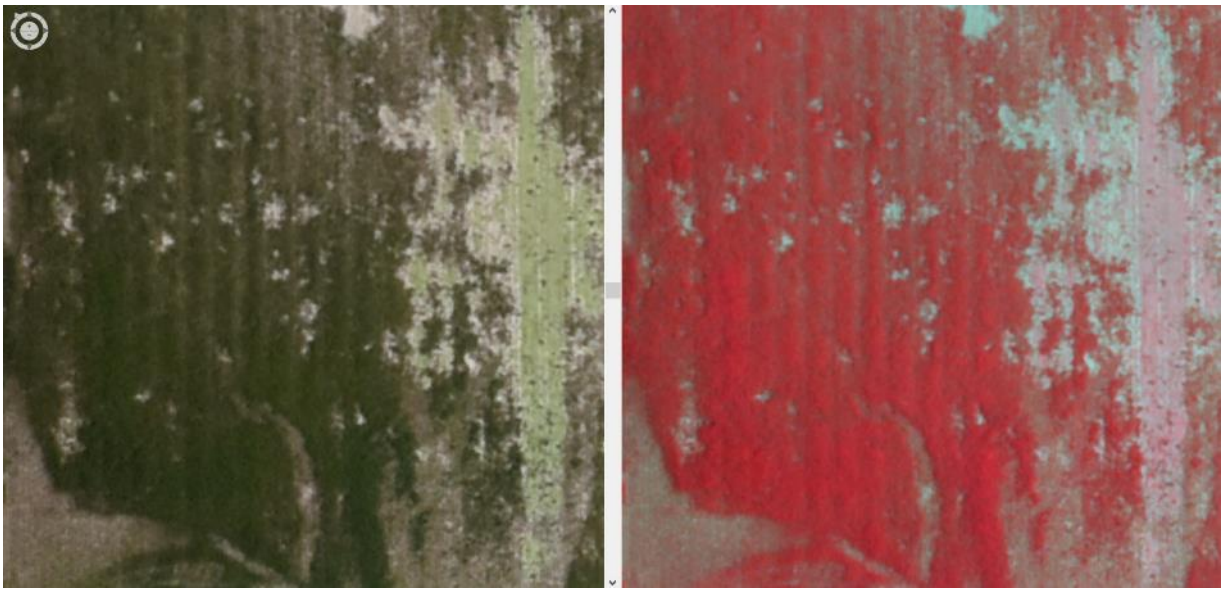

Figure 1. Sample normal color (left) and color-infrared (CIR) images showing a FOV4-infested area in a cotton field near El Paso, Texas.

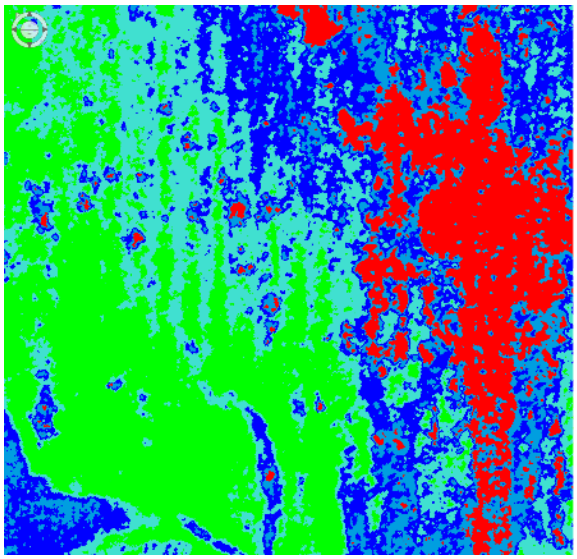

Figure 2. A classification map showing FOV4-infested areas (red) and areas with varying levels of plant vigor and other stresses for the portion of the cotton field in Figure 1.

Figure 3 shows the normal color images in 2017 (top) and 2018 (bottom) for a portion of a second cotton field affected by multiple stresses possibly from FOV4, other FOV races, nematode infestation, and variation in soils. It appears that different treatments may have been made to the filed over the two years.

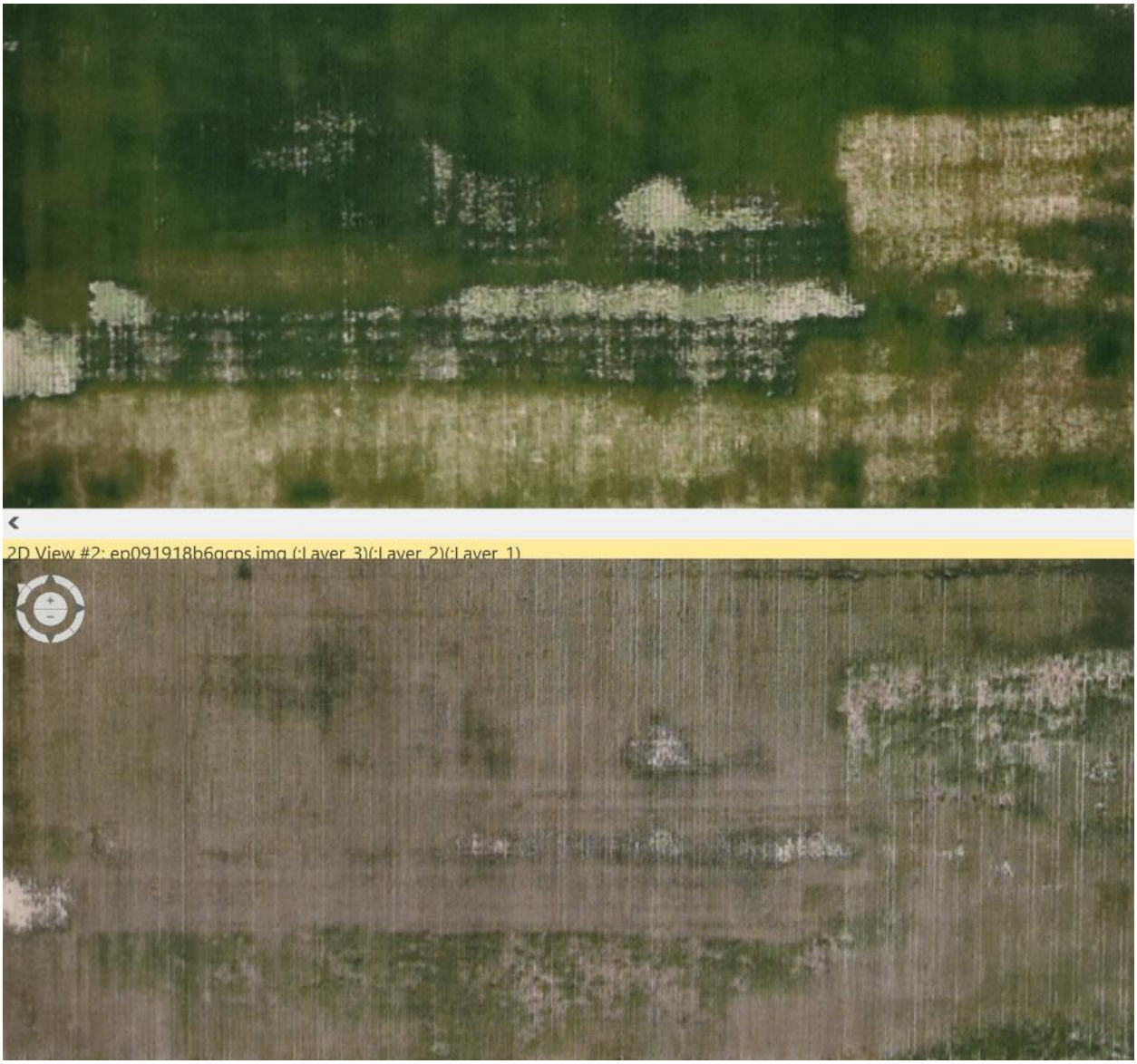

Figure 3. Aerial images showing multiple stresses for a portion of a cotton field in 2017 (top) and 2018 (bottom).

Summary

Two years of aerial surveys have provided useful information on the distribution of probable FOV4-infested fields in the New Mexico-Texas border area near El Paso. FOV4-infested fields can generally be detected from aerial imagery by examining the spatial patterns and bare soil exposure caused by plant death, though ground truthing is needed to confirm remote sensing observations. Additional research is needed to evaluate airborne imagery for monitoring the progression of FOV4 over the season and across different seasons and for distinguishing it from other races and stresses. Unless this information can be released and shared with growers, county agents, and researchers, it will be difficult to effectively manage this destructive disease.

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