Researchers See Promise in Multi-Spectral Imaging for Latent Detection of Anthracnose Disease on Strawberry Crop

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Anthracnose fruit rot (AFR) can cause severe yield losses of up to 80% under favorable conditions. Plants are susceptible to AFR both in the field and after harvest. Further, AFR exhibits a latent period during which the strawberry plugs are infected without exhibiting visible symptoms, making it a suitable candidate for assessing the scalability of disease detection using spectral imaging techniques. Early detection plays a pivotal role in selecting the most suitable disease management techniques and in curbing the transmission of infections among healthy plants. The purpose of this research was to evaluate a novel approach that involves the integration of small unmanned aerial systems (UAS) equipped with multispectral imaging (MSI) sensors to accurately identify the most appropriate vegetation indices (VI) for early detection of AFR on strawberries (Photo 1).

Virginia Tech researchers conducted a field study at the Tidewater AREC located in Suffolk, VA, in the 2022–2023 strawberry growing season. The treatments in the study consisted of three groups: i) plants that were inoculated with *Colletotrichum nymphaea*, ii) plants that were inoculated with *Colletotrichum fioriniae*, and iii) non-inoculated control plants that were treated with Switch 62.5WG before being transplanted into the field. Both, *Colletotrichum nymphaeae* and *C. fioriniae* are dominant species within the *C. acutatum* species complex.

Multispectral imagery data was gathered on 31 November 2022, 15 days after the transplanting process. Subsequently, data collection was carried out every month throughout the season until the end of harvest on 15 June 2023. Collected snapshot images for all multispectral bands were stitched and radiometrically calibrated through a sequence of image stitching procedures executed within a photogrammetry and mapping software platform called Pix4D Mapper, developed by Pix4D, Inc., based in Lausanne, Switzerland. This provided seamless imagery maps of the trial site. Next, these images from different imaging days were registered. Regions of interest were drawn around all the plants and mean feature values were extracted for each vegetation index (VI).

This study investigated 22 VIs as markers for detecting AFR on strawberries. The photosynthesis process in healthy plants involves the reflection of green light and the absorption of blue and red light to create chlorophyll. A plant containing more chlorophyll will reflect near-infrared (NIR) energy. By analyzing the reflectance of the NIR wavelength and the absorption of blue and red wavelengths, one can determine the plant's overall health.

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Aerial imagery was collected by Baker Aljawasim (Ph.D. graduate student) using a DJI Phantom 4Multispectral quadcopter drone (SZ DJI Technology Co., Shenzhen, China) at the Tidewater Agricultural Research and Extension Center, Suffolk.

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Results showed that all VIs were significantly lower for infected leaves with *C. nymphaeae* and *C. fioriniae* than healthy leaves, except for green leaf index (GLI) and infrared percentage vegetative index (IPVI). This suggests stress on infected leaves may decrease chlorophyll content. The highest contrast and significant differences were observed in VIs of infected and healthy strawberry plants throughout the season. Five spectral VIs - chlorophyll index (CI), difference vegetation index (DVI), enhanced vegetation index (EVI), green optimized soil adjusted vegetation index (GOSAVI), and non-linear index (NLI) - were highly effective in detecting and identifying AFR on strawberries with a high degree of accuracy (Fig. 1-2). This method can be of great assistance to growers as it enables them to monitor the severity of disease infestations using field maps and drones to apply appropriate management techniques. We are currently repeating this study for a second growing season.

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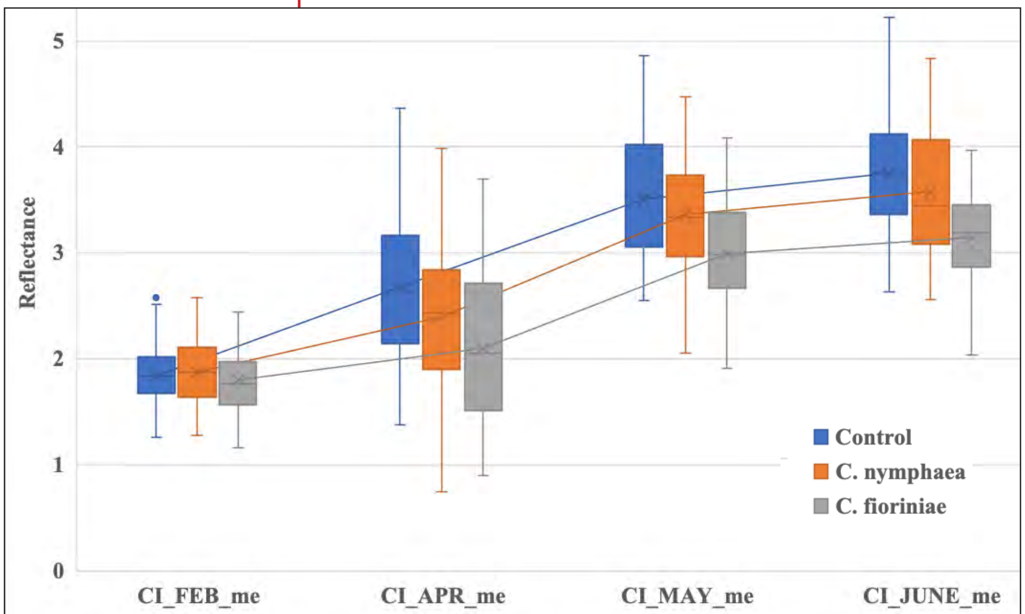

Fig. 1: **Chlorophyll indices** (CI) of plants inoculated with i) *C. nymphaea* ii) *C. fioriniae* and iii) untreated control. These imaging data were collected during February, April, May, and June 2023.

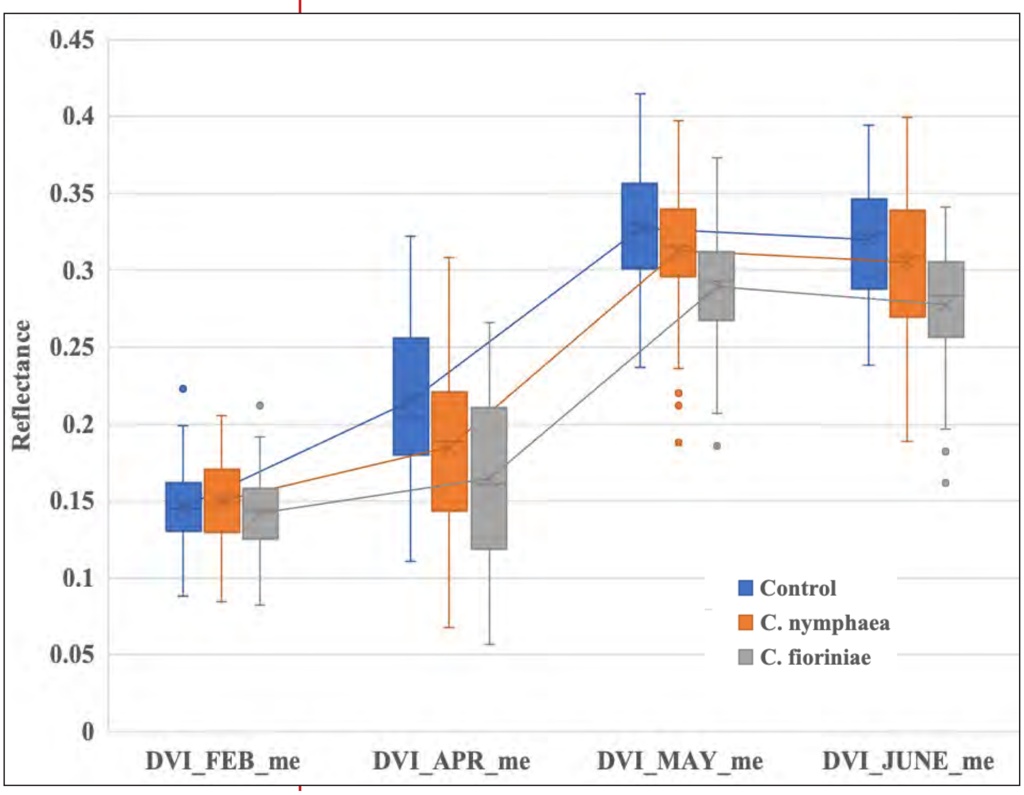

Fig. 2: **Difference vegetation index** (DVI) of plants inoculated with i) *C. nymphaea* ii) *C. fioriniae* and iii) untreated control. These imaging data were collected during February, April, May, and June 2023.