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PROJECT TITLE: Detecting and monitoring physiological responses of peanuts to abiotic stress using high-resolution hyperspectral imaging

PROJECT NO: UGA-57-26/26 PROJECT LEADER: L. LACERDA

Project Report: Drought and heat are two important sources of abiotic stress affecting peanut production in the state of Georgia. A large proportion of the peanuts produced in the state are under rainfed conditions. Breeding research has focused on identifying specific traits related to drought tolerance. New technologies such as drone-based hyperspectral imaging can be a great aid in improving the efficiency of breeding efforts. Stressed-induced changes in crop physiological processes directly affect how the leaf and canopy reflect different light wavelengths. This project aims to use advanced drone technology to allow for large-scale and efficient detection and monitoring of peanut physiological responses to drought and heat stress through the analysis of peanut canopy light reflectance at different growth stages

The study was conducted during the 2025 growing season at the University of Georgia's Ponder Research Farm in Tift County, Georgia. Nine different peanut varieties were grown under both well-watered and drought conditions. Throughout the stress period and during recovery, physiological data and crop reflectance of visible and near-infrared light were collected. Preliminary results showed that exposing the peanut plants to drought conditions caused a reduction in stomatal conductance compared to irrigated plants, even during the recovery period at 109 DAP (Fig. 1). Differences in canopy light reflectance between drought-stressed and irrigated plants were also captured between the peanut genotypes and the stressed and non-stressed crop. These differences were evident in certain wavelengths, especially green (500 to 600 nm), red (600 to 700 nm), and near-infrared (750 to 1000 nm). Peanut canopy reflectance at the near-infrared range from 750 nm to 1000 nm showed the greatest differences between genotypes and irrigation treatments (Fig. 2).

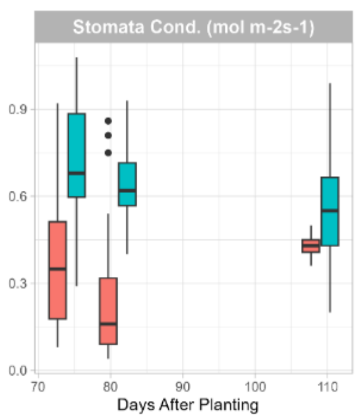

Fig. 1. Box plot results for stomatal conductance of irrigated and drought plots.

A machine learning model was used to identify specific light wavelengths most strongly associated with physiological parameters. The results showed that visible light was the most important for detecting changes in leaf pigments, such as chlorophyll and carotenoids, while red and near-infrared were more effective in detecting changes in stomatal conductance. Green and near-infrared wavelengths were identified as the most important for detecting changes in net photosynthesis. These results demonstrate the strong potential of this technology to identify crop-specific responses at a much larger scale than is possible with ground-based measurements. This work will be replicated in subsequent growing seasons to develop robust models that can help breeding programs identify very early signs of stress in peanuts more efficiently.

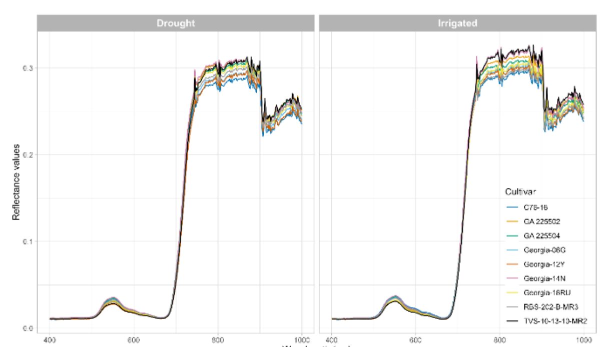

Fig. 2. Spectral response from 400 to 1000nm of peanut genotypes under the irrigation treatments.