EXPLORING USES OF TRACTOR-MOUNTED PLANT HEALTH SENSORS TO EVALUATE COTTON GROWTH AND INSECT INJURY IN FIELD PLOTS

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Uses of a tractor-mounted plant health sensing system were evaluated in two experiments at the Texas A&M AgriLife Research and Extension Center, Corpus Christi, Texas in 2013. The studies were a Cotton Fleahopper/Water Stress experiment arranged in small plots (50 feet by 4 rows), and the other was a Conventional/Minimum Tillage experiment arranged in larger plots greater than 200 feet and 10 rows. The plant health sensing system used in these studies consists of an optical sensor, an ultrasonic sensor, a GPS receiver, and a data acquisition unit (Sui and Thomasson 2006). The optical sensor is able to measure crop canopy reflectance in four wavebands: blue band (400-500nm), green band (520-570nm), red band (610-710nm), and near infrared band (750-1100nm). The ultrasonic sensor measures plant height. The system was installed on a self-propelled four-wheel spray rig for field operation. As the equipment travelled across the field, plant canopy was automatically and continuously scanned, and measurements of the plant canopy reflectance and plant height were taken each second along with the spatial coordinates. Readings were stored in the data acquisition unit, downloaded onto a PC, and imported into an Excel spreadsheet for further data manipulation. The NDVI of the plots was calculated using the IR and NIR bands of the system's optical sensor.

Cotton Fleahopper/Water Stress. This study was arranged as small plots in a split-split-split plot design with five replications. The main plot was two water regimes. The 1st split was two planting dates, the 2nd split was two cotton cultivars, and the 3rd split was insecticide/no insecticide foliar sprays using Centric 40 WG to control cotton fleahopper (Brewer et al. 2014). There were a total of 80 small plots measuring 50 ft long by four rows. Results on direct observations on insect and plant measurements are reported in a separate article in this proceedings publication. Briefly, significant differences in insect counts and yield were detected across water regimes, cultivars, and insecticide treatment (Brewer et al. 2014). We focus here on capacity of the plant health sensing system to detect plant height and NDVI differences across these same treatments in these small plots. The system was used twice in this study during bloom, taking sensor readings on the inner two rows of each plot. Twenty to thirty readings in the middle of the plot were averaged and then used to calculate a single average value of plant height and NDVI for each plot. The average plot values were analyzed with ANOVA conforming to the experimental split-split-split plot design with five replications.

We observed differences in plant height and to a lesser extent NDVI across treatments. The greatest plant height differences detected were between the dryland and irrigated plots, with the taller plots in the irrigated plots successfully distinguished from the smaller plants in the dryland plots ($P = 0.002$). Sensitivity using the sonar sensor extended to the other treatments as well. Plant height measures from the ultrasonic sensor readings indicated differences between the two planting dates and the insecticide sprayed and unsprayed treatments, including detection of an interaction between these treatments ($P = 0.016$). NDVI calculated from the optical sensor readings showed differences between planting dates and cultivars, including detection of an interaction between these treatments ($P = 0.024$). But no difference between insecticide sprayed and unsprayed treatments were detected ($P > 0.20$), even though there were considerable differences in cotton fleahopper in sprayed and unsprayed plots (Brewer et al., 2014).

In summary, sensitivity was excellent to detect treatment differences in plant height using the ultrasonic sensor. Sensitivity using the optimal sensor to detect treatment differences in NDVI was overall good. The known challenges of using NDVI to detect plant stress likely explained the lack of sensitivity of detecting differences in the sprayed and unsprayed plots.

Conventional/Minimum Tillage. For this study, the sensors' readings were taken on multiple rows in the separate replications of the two treatments. The readings were aggregated by row and four locations in a row (subplots). Twenty to thirty readings in each subplot were used to calculate a single average value of plant height and NDVI. Differences in the plant height and NDVI were detected, associated with treatments and also were able to detect variation across subplots. The detected variation across subplots in these larger plots showed the potential of the plant health sensing system to calculate crop health indexes that have potential to detect intra-field stresses.

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