UTILIZATION OF SPECTRAL IMAGING TO DETECT N AND K DEFICIENCIES IN COTTON

Jac J. Varco, Mike Seal, Horacio Buscaglia and John M. Thompson
Dept. of Plant and Soil Sciences
Mississippi State University
Mississippi State, MS

Abstract

Nitrogen and K as well as other plant nutrients influence the spectral properties of individual crop leaves and canopies. Technology is currently available that can determine reflectance at spectral resolutions of less than 2 nm. Thus, the identification of specific changes in spectral reflectance relative to plant nutrient concentration is a possibility. The objective of this study was to determine the sensitivity of spectral reflectance to variable N and K nutrition of cotton. An ongoing field study evaluating fertilizer N and K requirements of no-tillage cotton was utilized for this research. The site is located at the Plant Science Research Center at Mississippi State. The soil at this site is a Leeper silty clay loam that formed from clayey alluvium in the Blackland Prairie Land Resource Area. Cotton variety Suregrow 125 was no-till planted on 12 May 1997 at a rate of 4.5 seed/ft. Nitrogen plots received 0, 60, 120, and 180 lb N/acre as ammonium nitrate. Fertilizer N was broadcast applied 50% at planting and 50% at early square. Potassium plots received 0, 30, 60, and 90 lb K/acre from muriate of potash (KCl). Fertilizer K was broadcast applied prior to planting. Prior to fertilization, soil test K levels ranged from 250 lb/acre to 300 lb/acre for the no fertilizer K check to the 90 lb K/acre rate. The experimental design was a randomized complete block with four replications. Leaf samples were obtained at various specified stages of cotton growth to evaluate the N and K status and relate these concentrations to spectral images and reflectance measurements. Aerial images were obtained the second week of bloom from a fixed wing aircraft flown at 3500 ft. using four digital cameras with narrow band pass filters. Bands used were green at 540 nm, red at 695 nm, and near infrared at 790 nm and 840 nm. Spatial resolution was approximately 2.1 ft. Leaf and canopy reflectance were measured with a spectroradiometer that scanned from 350 nm to 1050 nm with a spectral resolution of 1.6 nm. Readings were obtained at various stages of growth and corresponded with leaf samplings. Post-processing of aerial images included calculation of a normalized difference vegetation index (NDVI = (NIR - red)/(NIR + red)) and a histogram stretch to accentuate crop health both good and bad. A curvilinear lint yield response to both fertilizer N and K occurred, while leaf N and K concentrations responded in a linear fashion. Aerial imaging was useful in identifying N and K stress anomalies. Crop 'health' varied with N and K nutritional status suggesting that aerial imaging would be a useful tool in directing producers or consultants to problem areas. Correlations were found between leaf N and K concentrations and spectral reflectance at certain specific wavelengths and sampling periods. This suggests that remote sensing with a high degree of spectral resolution may be able to assist in the identification of specific nutritional stresses and the mapping of field scale variability in plant nutritional status. These results are rather preliminary and further research endeavors are necessary to identify variations in spectral reflectance relative to such factors as crop growth stage, variety, and environmental conditions.

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