Title: Detection and Site-Specific Control of Weeds Through Remote Sensing

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Progress Report

Executive Summary:

The only viable mechanism for addressing the problem of over-application of herbicides, even using the computer-generated recommendations, is through effective field scouting and variable-rate applications. Current field scouting techniques are time-consuming and simply have not proven cost-effective. Remotely sensed images provide the opportunity to rapidly develop these population maps. In order to achieve this goal the spectral characteristics of weeds and crops must be quantified. Additionally, the impact of interspecific competition, fertility, and environmental factors on these spectral responses need to be understood to ensure accurate species classification. Analysis of spectral data using the cross-validation technique resulted in 91, 63, 63, 100, 46, and 33% correct classification of velvetleaf, redroot pigweed, broadleaf signalgrass, cotton, johnsongrass, and corn, respectively. Generally, broadleaf species are more easily differentiated from each other than grass species. Based upon airborne images populations generally at or above threshold densities could be correctly classified 2/3 of the time. Soil and rye cover crop residue were differentiated accurately 100% of the times tested. Spring tillage improved detection capability of grassy weeds, regardless of presence of cover crop residue. Small grasses were detected accurately 97 to 100% of the time in tilled treatments, compared to 86 to 94% in no-till treatments. Moisture stress changes the reflectance pattern for some species like sicklepod. Preliminary data also shows that classification accuracy decreases as moisture stress increases. These data are crucial for the development of databases to enable accurate classification under a variety of growing conditions. The NDVIg and the SAVI correctly classified the weed populations 75% when used alone. The SAVI and NDVIg were similar in their weed classification capabilities. The SAVI may be a better tool when used earlier in the growing season due to its correction for the soil interference. NDVIg could be the index of choice from the middle to end of the growing season, assuming canopy closure is good.

An estimate of the value of site-specific management can be developed by comparing the projected net returns for each field. In 1998, North Field data results estimated $184.39/ha increase in net returns with site-specific applications over broadcast applications and a $67.86/ha increase in net returns with site-specific management in the South Field.

Objectives:

Determine reflectivity patterns for specific weed species under a variety of growth stages and environmental conditions through both aerial and ground-based sensors.

Quantify the weed populations and/or weed ground cover necessary for detection and accurate identification through remote sensing.

Determine the impact of soil cover/plant residues on weed detection and quantification.

Conduct basic physiological studies on the most troublesome weeds in Mississippi to determine the impact of stress factors (nutrients, moisture, herbicide injury) on weed reflectance characteristics.

Develop capabilities to generate weed population and distribution maps in soybean and cotton through remote sensing and correlate these distribution patterns with yield and soil maps.

Detect stress areas in soybean and cotton fields through remote sensing and scout for causal agents of this stress by ground truthing.

Progress Toward Completion &
Success Arising from Project:

Objective one and two are ongoing objectives that will need continuance for quite sometime in order to develop libraries of information for the diverse weed spectra found in MS crops. Initial multispectral data analysis have shown a fair to good accuracy for discerning between weed species (Figures 1& 2). These separations are based on training sets generated from a limited number of weed species. More ASD and hyper-spectral data are needed to accurately assess the ability to differentiate among weed species. Currently, these data are being analyzed by more sophisticated techniques by collaborators in Computer and Electrical Engineering.

Experiments were conducted in 2000 at the Plant Science Research Center, Starkville, MS, to evaluate the use of spectral data in classifying different crop and weed species. The experiment was designed as a randomized complete block with 4 replications. Velvetleaf (*Abutilon theophrasti)* , redroot pigweed (*Amaranthus retroflexus*), johnsongrass (*Sorghum halepense*), broadleaf signalgrass (*Brachiaria platyphylla*), cotton (*Gossypium hirsutum*), and corn (*Zea mays*) were planted in 12 ft^2 plots. Each species was maintained free of other species and hyperspectral data were taken with a handheld spectroradiometer on two week intervals. Although spectral data were taken from 350-2500 nanometers (nm) discrete bandwiths were selected to correspond with available airborne sensors. The discrete bands selected were: Green 545-555 nm; Red 670-680 nm; and Near Infrared 835-845 nm. The following commonly used vegetation indices were computed using the selected bands: Normalized difference vegetation index (NDVI); Green normalized difference vegetation index (NDVIg); Global Environmental Monitoring Index; Near Infrared (NIR); Red vegetation Index (RVI); and Difference vegetation index (DVI). The computed indices and band widths were evaluated with PROC DISCRIM in SAS. This is a linear discriminant analysis technique where the dependent variable is categorized. Both the