2005 PROJECT SUMMARY

Title: Remote Sensing to Improve the Development of High-Yielding Drought Resistant Varieties of Peanut

Principal Investigators:

Dana Sullivan	Soil Scientist	USDA-ARS Southeast Watershed Research Laboratory
Corley Holbrook	Research Geneticist	USDA-ARS Crop Genetics and Breeding
Craig Kvien	Crop and Soil Scientist	UGA- NESPAL

Study Location: Tifton Georgia

Objective:
Our primary objective was to develop a quantitative index to assist selection and maximize breeding progress of drought resistant peanut genotypes.

Methods Overview:
In 2004 and 2005, several small research plots were established at the University of Georgia, Gibbs Farm in Tifton, GA. The experiment consisted of five different peanut genotypes encompassing a range of known drought tolerance and yield characteristics. Two different planting environments were investigated (early planting and late planting). At midbloom, all treatments were inoculated with A. parasiticus and A. flavus and subjected to drought-induced conditions using rainout shelters. The plots remained under the shelters through harvest. Data collection under drought-induced conditions consisted of twice weekly spectral response measurements, visual ratings using a 1-5 scale, and soil water content (0-7.5 and 7.5-15 cm). At harvest samples were collected for yield and aflatoxin determinations. Our primary objective was to develop a quantitative index to maximize selection and breeding progress of drought resistant peanut genotypes.

Results Summary:
Plant spectra were positively related to changes in soil water content over time. Plants have a distinct spectral signature, peaking slightly in the green with the largest peak in reflectance in the near-infrared (NIR)(Figure 1). As drought conditions progressed, peaks in the NIR and green decreased as much as 10-20 % depending on the level of drought tolerance. These results were best expressed during 2004. In 2005, tomato spotted wilt virus (TSWV) caused early stress that was not attributable to drought conditions.

Because of inherent differences in the pigmentation of each genotype, a difference index was calculated to quantify changes in genotype response to drought over time (Figure 2). The difference indices used in this study were based on two common vegetation indices: 1) the greenness normalized difference vegetation index and 2) the normalized difference vegetation index. Difference indices were determined by comparing a pre-drought benchmark vegetation index to vegetation indices calculated under drought conditions. Thus, difference indices measured the magnitude of change in crop response to drought over time. Difference indices more accurately quantified drought response compared to the standard visual rating technique. Despite TSWV during the 2005 growing season difference indices outperformed the standard visual rating. Difference indices were also highly correlated ($r = -0.60$- -0.74, $\alpha < 0.05$) with yield throughout the study. During 2004, a high correlation between spectral response (drought tolerance) and aflatoxin was observed during the second planting date only ($r=0.48$-0.53, $\alpha < 0.05$). Data are currently being analyzed for the 2005 planting environment.

Our data indicate remote sensing can be used to more rapidly and accurately quantify small changes in drought tolerance among new peanut breeding lines. Remote sensing shows promise as a tool to determine the onset of drought stress, detect small changes in response to stress, and potentially serve as an indicator of aflatoxin resistance. Future research will capitalize on these successes and extend research to validate vegetation indices in untested breeding populations. .

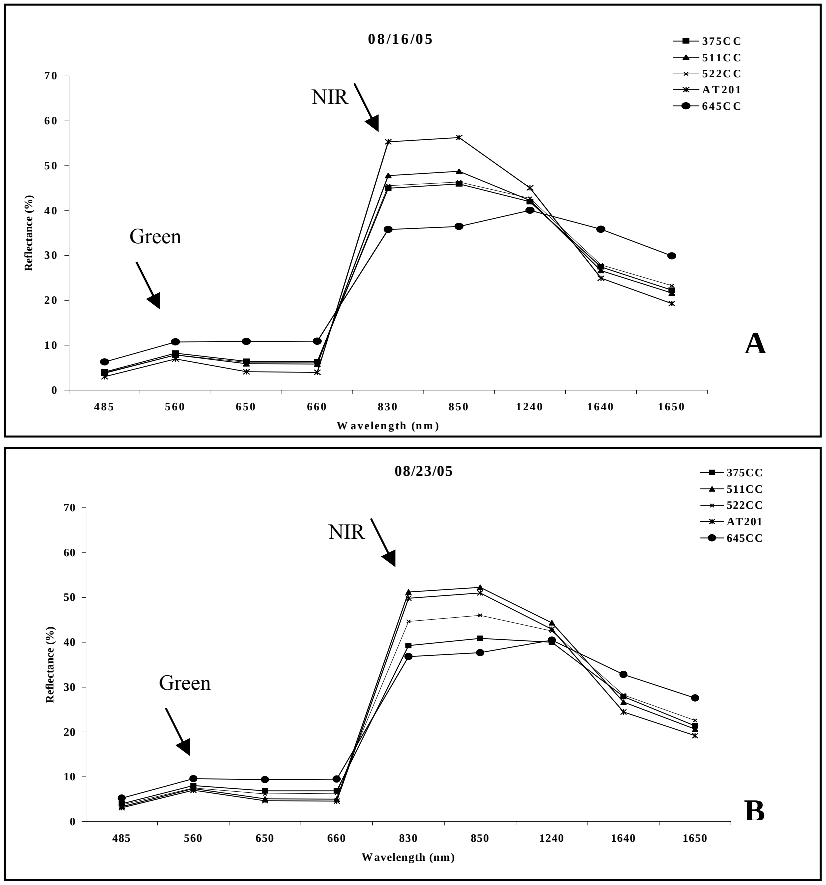

Figure 1. Data represent plant spectral response curves for five different peanut genotypes. Each graph shows reflectance along the y-axis and wavelength along the x-axis. Graph A represents plant spectra just prior to drought induced conditions. Graph B represents plant spectra 3-weeks after the onset of drought induced conditions. Peaks in the green and near infrared (NIR) are noted by arrows. In 2005, early signs of stress were associated with tomato spotted wilt virus.

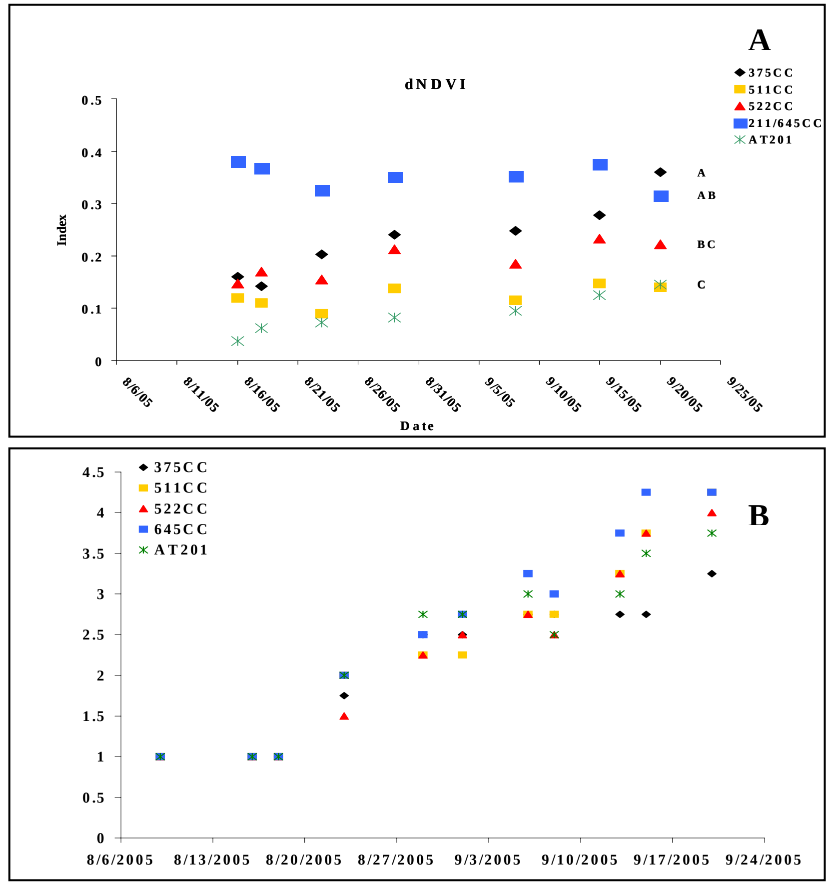

Figure 2. Data represent two indices used to select peanut genotypes most resistant to drought conditions. Data are represented by date. Graph A shows a change in the normalized difference vegetation index (NDVI) over time. Significant differences were observed between resistant, moderately resistant, and susceptible genotypes. Graph B shows change in the visual index over time for each genotype. A visual index of one indicates a healthy plant; an index of five indicates a severely stressed plant. No significant differences between genotypes were observed.

Return to GPC Research Reports on 2005 projects