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RELATION BETWEEN YIELD MAPS AND MID-SEASON REMOTE SENSING IMAGERY

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Abstract

Studies conducted in California in 1998 suggested that spatial patterns in cotton yield maps and mid-season remote sensing imagery were correlated. Preliminary results from new studies conducted in cotton fields in the Texas High Plains support this finding. Analysis procedures developed in this study represent a potential tool to guide farmers in the site-specific management of cotton fields.

Introduction

Researchers have observed spatial patterns in remote sensing imagery of agricultural fields and, more recently, in yield maps derived from yield monitor data. Research conducted in 1998 [1] at the USDA laboratory in Shafter, CA, demonstrated that spatial patterns in cotton yield maps and high-resolution remote sensing imagery were correlated. Figure 1 shows the value of the F-statistic for the correlation between cotton yield at harvest and remotely sensed near-infrared (NIR) reflectance observed at various times during the growing season for a 7-acre research field at Shafter. The strongest correlations appeared to occur for remote sensing imagery acquired at around the middle of the growing season (day 220-240). These correlations are positive, showing that relatively dense leaf canopy (indicated by high NIR reflectance) at mid-season was correlated with relatively high cotton yields at harvest. It was suggested that this correlation results from the ability of a dense leaf canopy to provide the photosynthates needed by the cotton plant to support the retention and growth of bolls formed at early fruiting sites that will contribute the most to harvested yield.

The studies conducted at Shafter indicated that irrigation amount and timing influenced the correlation between remote sensing imagery and yield. In the semi-arid Texas High Plains, cotton growth and yield is strongly influenced by water availability, either from irrigation or rainfall. For the past three growing seasons, we have collected yield mapping data and remote sensing imagery for a number of cotton fields in this region. The purpose of this presentation is to report preliminary findings of studies in the Texas High Plains that support the results of the studies conducted previously at Shafter, CA.

Materials and Methods

Data for this study were collected at Brightbill Farms, which contains around 3700 acres of deficit-irrigated cotton grown in center-pivot fields located near Plainview, TX. For most of these fields, yield maps were obtained in 2000, 2001, and 2002 using Agriplan yield monitors. Yield monitor data were assembled into yield maps using SST geographic information system (GIS) software. In 2001 and 2002, remote sensing imagery was acquired for many of these fields at several times during the growing season using a Tetracam airborne multispectral digital imaging system.

Multispectral imagery for a given field was analyzed for comparison with the corresponding yield map using Adobe Photoshop image processing software. For each pixel in the image, the digital count value for the red spectral band was subtracted from the corresponding digital count value for the NIR spectral band, resulting in a value of the Difference Vegetation Index (DVI). The resulting DVI image was scaled and rotated to match the size and orientation of the yield map. The DVI image was then "equalized" to increase the contrast of the image. For viewing spatial patterns in the yield maps, the yield values were classified into five classes using the SST GIS, and each class in the map was assigned a separate color. Similarly, the DVI values in the field image were separated into five brightness classes, and each class was assigned one of the colors used in the yield maps. The same color was used for the same relative magnitude of a class in either the yield map or the DVI image. For example, the same color was used for the class of lowest yield values in the yield map and the class of lowest DVI values in the DVI image. This convention facilitated visual comparison of the yield map and the DVI image for a given field.

Results

Results of this analysis are shown for two fields on Brightbill Farms. Figure 2 shows the yield map obtained for Field 35 in 2001 along with the corresponding DVI image developed from imagery acquired on August 1, 2001. It is readily apparent that the dark green portions of the yield map and DVI image are in the same relative positions, as are the red portions of the yield map and DVI image. In the yield map, dark green represents high yield, while in the DVI image, dark green is indicative of dense leaf canopy. Similarly, in the yield map, red represents low yield, while in the DVI image, red is indicative of sparse leaf canopy. Other colors represent intermediate classes of yield and canopy density. Figure 3 shows the yield map obtained for Field 38 in 2001 along with the corresponding DVI image developed from imagery acquired on August 24, 2001. Visual comparison of the results in this figure also suggest a coincidence between portions of the field with similar relative values of yield and leaf canopy density.

Summary and Conclusions

Preliminary results of the study on Brightbill Farms supports the earlier findings in California that suggest that spatial patterns in cotton yield maps are correlated with spatial patterns observed in mid-season remote sensing imagery. Such a finding is of practical importance to farmers because it suggests that, months prior to harvest, remote sensing imagery can be used to visualize the relative variation in yield across a cotton field in the manner of a yield map. The remote sensing imagery necessary for this analysis is relatively easy and inexpensive to acquire. Thus, this analysis represents a potential tool to guide farmers in the site-specific management of cotton fields in the Texas High Plains and California.

References

Maas, S.J., Fitzgerald, G.J., and DeTar, W.R. 1999. Spatial and temporal correlations between crop yield and remotely sensed plant canopy characteristics. Proc., 17th Biennial Workshop on Color Photography and Videography in Resource Assessment, ASPRS, May 5-7, 1999, Reno, NV. p. 106-110.

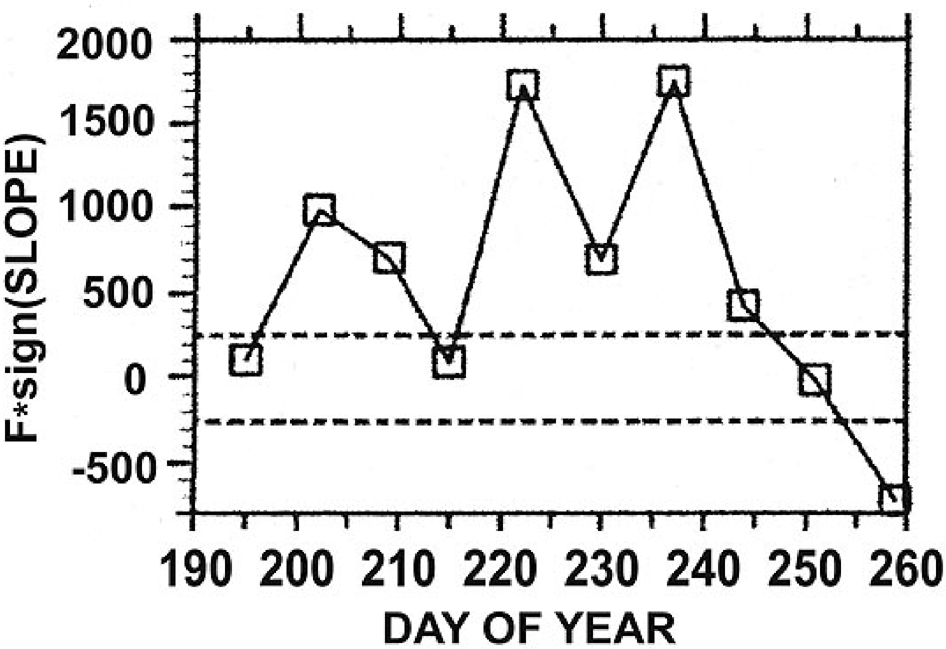

Figure 1. Value of the F-statistic times the sign of the slope for the correlation between yield and NIR reflectance for a 7-acre cotton research field at Shafter, CA. Values between the pair of horizontal dashed lines are not significantly different from zero at the 5 percent level. From [1].

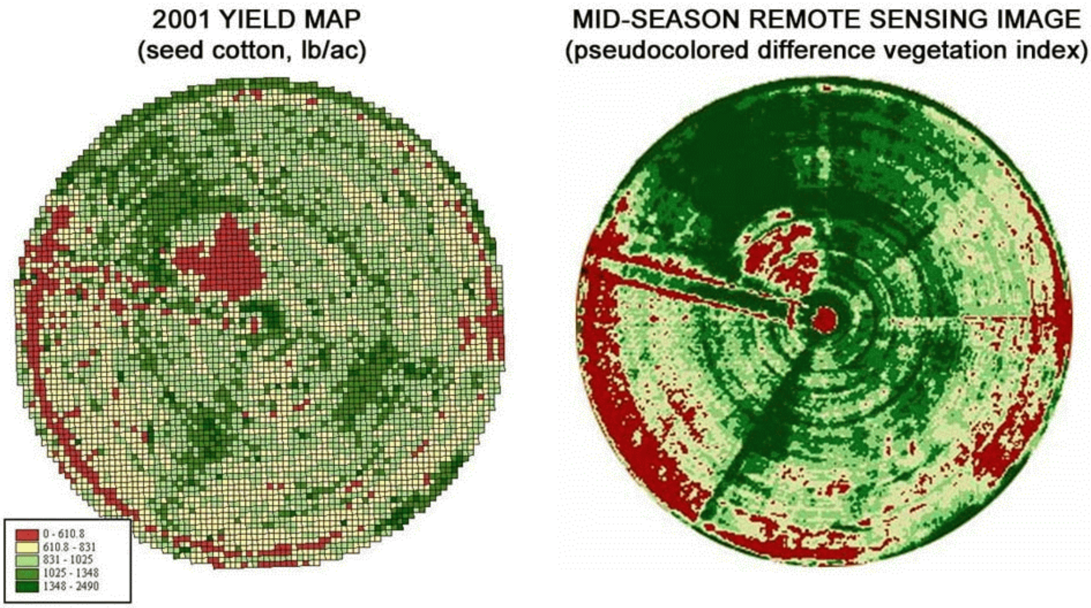

Figure 2. Yield map (left) and mid-season DVI image (right) for Field 35.

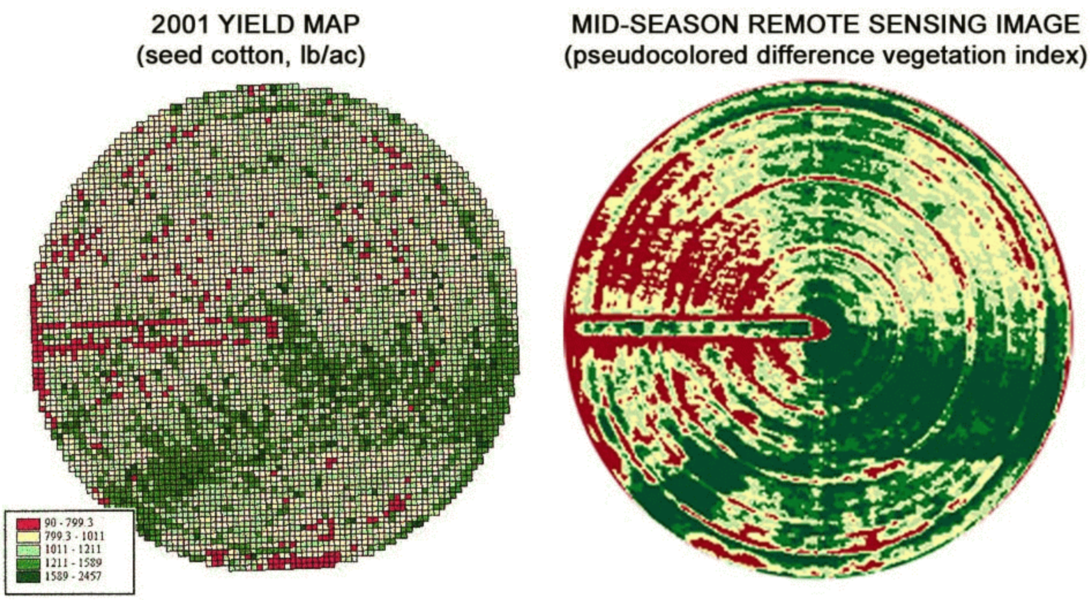

Figure 3. Yield map (left) and mid-season DVI image (right) for Field 38.