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REMOTE SENSING FOR PRECISION AGRICULTURE IN THE TEXAS HIGH PLAINS

Stephan Maas
Department of Plant & Soil Science
Texas Tech University
Lubbock, TX
Jerry Brighbill
Brightbill Farms
Plainview, TX
Jon Hooton
Hooton Crop Care, Inc.
Plainview, TX

Abstract

Procedures are described for using airborne remote sensing in the management of cotton, and for estimating yield prior to harvest.

Introduction

Airborne remote sensing is currently being used on farms in the Texas High Plains to assist crop management and estimate yields. We provide examples of its use for directing variable-rate application of growth regulator (Pix) and defoliant. We also describe how remote sensing and field scouting is used to estimate cotton lint yields from fields prior to harvest.

Examples

Growth Regulator and Defoliant Application

Multispectral imagery was shot for the field on August 28, 2003, using a Tetracam imaging system flown aboard a light aircraft. A Normalized Difference Vegetation Index (NDVI) image was formed using the red and near-infrared bands in the image. A false-color version of the NDVI image is shown in Figure 1. In this image, parts of the field with the more dense leaf canopy growth are colored green, while parts of the field with less dense leaf canopy growth are colored red. To develop a variable-rate Pix application for this field, the NDVI image was brought into SST Toolbox. The imaging tools in this software were used to divide the NDVI data for the field into three classes representing low, medium, and high values of leaf canopy density, which are colored red, green, and blue in Figure 2. Prior to the application date, the field was scouted to determine the appropriate Pix rate for each of the three classes. The field scout used an iPAQ handheld computer equipped with a GPS unit and loaded with a copy of the image to navigate to the various parts of the field representing the three classes. Based on the scouting, the following Pix application rates were determined: "red" zone, no Pix (60 acres within the field); "green" zone, 10 oz. (52.5 acres within the field); "blue" zone, 16 oz. (14.6 acres within the field). Pix was applied with a variable-rate spray rig on August 6. A similar procedure is used for the determination of variable-rate cotton defoliant application.

Cotton Yield Estimation

To estimate the lint yield of a field prior to harvest, again we start with an NDVI image. An example is shown in Figure 3, which was acquired on August 15, 2003, and shows two fields (Field 1 and Field 2). In the image, NDVI values have been divided up into three classes representing low, medium, and high levels of plant canopy growth (colored red, yellow, and green, respectively). Prior to harvest, a field scout using an iPAQ with a GPS unit navigated out into the field to make boll counts within the three classes. For each class, the total number of harvestable bolls within three 6-foot sections of rows were counted. For some fields, seed cotton was collected from the bolls, dried, and weighed to determine how many bolls were required to produce a pound of lint (see Figure 4). It was noticed that some cotton varieties produced more bolls per plant, but the bolls were typically smaller. The yield for each of the three classes was determined by dividing the number of bolls per foot by the number of bolls needed to make a pound of lint, and then converting this number to a per-acre basis. The per-acre yield for each class was then multiplied by the fraction of the field in that class, determined from the classified NDVI image, and summed to give the total field yield. Results for Fields 1 and 2 are shown in Table 1.

Summary

Airborne remote sensing is very effective in providing the spatial information on crop growth to develop site-specific, variable-rate growth regulator and defoliant applications. Along with field scouting, remote sensing imagery is also effective in estimating cotton lint yields for fields prior to harvest. Further refinement of these procedures is underway.

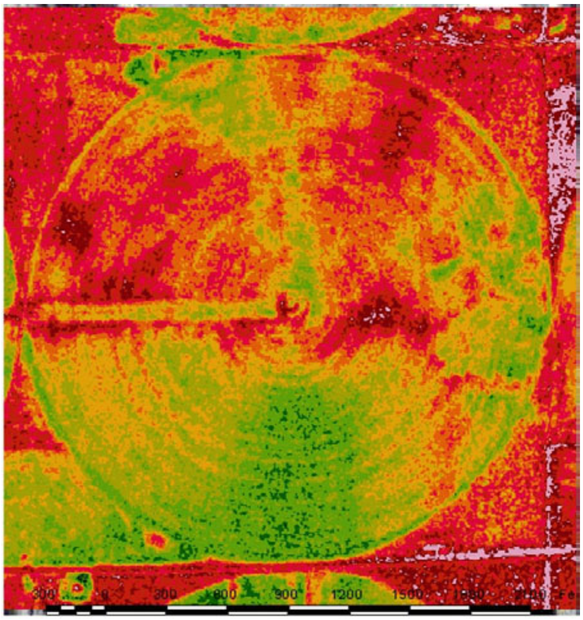

Figure 1. False-color image of the cotton field.

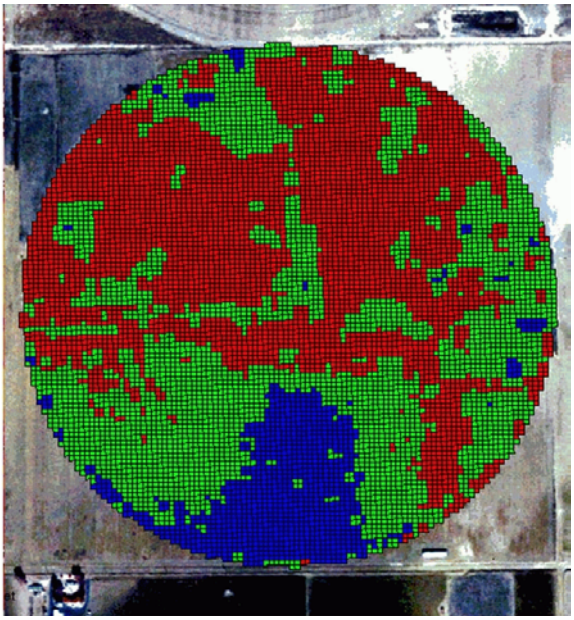

Figure 2. NDVI image of the field in Figure 1, divided up into 3 classes.

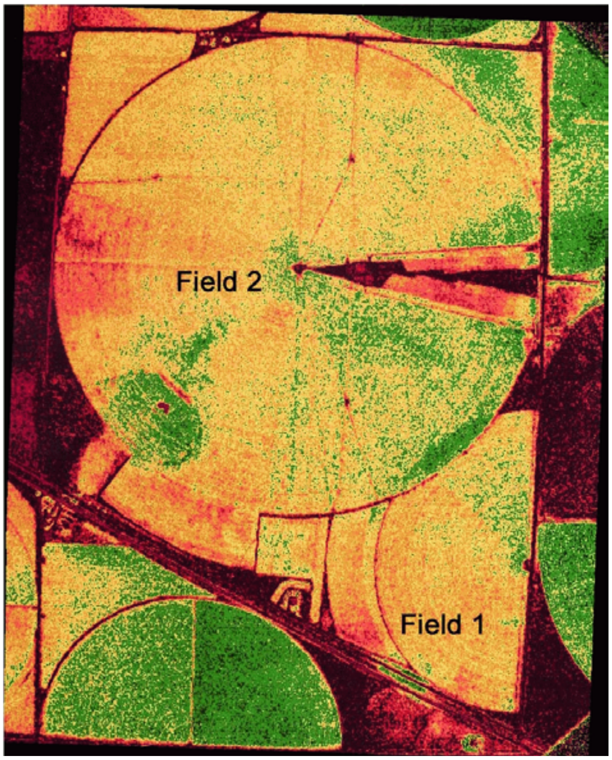

Figure 3. NDVI image of Fields 1 and 2, divided up into 3 classes.

Figure 4. Field scout collecting cotton sample for determining the number of bolls per pound of lint.

Table 1. Results of yield estimation for Fields 1 and 2 in Figure 3.

		Field 1	Field 2
Variety		Fibermax 958	Paymaster 2379
bolls/foot	red zone	12.5	16.1
	yellow zone	21.3	25.0
	green zone	22.5	30.0
bolls/lb. lint*	red zone	236	280
	yellow zone	250	294
	green zone	240	305
yield (lb./acre)	red zone	725	786
	yellow zone	1167	1164
	green zone	1285	1346
% field area	red zone	35	35
	yellow zone	45	50
	green zone	20	15
Estimated Field Yield (lb./acre)		1036	1059
Farmer-reported Yield (lb./acre)		962	1026
percent error		6.9	3.1

* assumes a 35% gin turnout