USING GPS TO SCOUT COTTON FOR VARIABLE RATE PIX (MEPIQUAT CHLORIDE) APPLICATION

M. E. Thurman and R. W. Heiniger
North Carolina State University
Department of Crop Science
Vernon James Research and Extension Center
Plymouth, NC

Abstract

Availability of precision technology and GPS systems has prompted interest in variable rate Pix application to cotton. A 14 acre irrigated cotton field was grid and random sampled for 4 weeks during the bloom period. Variagram analysis indicated that a kriged map based on the spherical model and grid data adequately represents cotton growth in the field. Frequency analysis of percent of field area in a specific range for height, height to node ratio, and average length of top 5 internodes showed a large amount of varibiality in the field. At a uniform Pix rate, the spatial distribution of plant measurements increased over time. Plants in the tallest height range at time of application never adequately responded and were the tallest at final sampling date. Comparison of contour maps generated from the consultants randomly sampled points and the grid points indicated that random sampling did not adequately identify major plant growth zones in the field. Spatial analysis would improve decision process of Pix application. The large amount of variability justifies VRT practices and Pix application.

Introduction

Most cotton growers include Pix as a regular part of crop management. Because growers primarily apply Pix for vegetative growth control, factors considered in a Pix application often include: moisture status, height, height to node ratio (HNR), average length of top 5 internodes (ALT5), and internode length (Silvertooth, 1996; Edmisten, 1994). Consultants are hired to scout fields and generate recommendations on a field-to-field basis, a form growers can easily interpret. Technology advances, including equipment such as GPS systems, have made site specific crop management a reality. Georeferencing sample sites, whether soil or crop measurements, provides a convenient way to analyze plant growth patterns in the field and to deal with variability that may exist. The value of this technology is reliant on being able to improve profits to the producer.

Variability in crop growth occurs in most cotton fields. To maximize effectiveness, a Pix variable rate application must meet several criteria to be practical: (a)improve field profitability, (b)improve input efficiency, and (c)increase environmental stewardship. As stated by Sawyer (1994), VRT implementation requires that the factors that affect crop yield be spatially variable, that the variation affects crop yield, and that the variability can be identified, measured, and mapped. Although a variable rate application may be the ideal method for chemical application, it is not necessarily the most economically feasible choice for all situations.

Many studies have shown both positive and negative effects of Pix on cotton growth and yield. Pix decreases plant height by inhibiting cell elongation, subsequently affecting plant measures such as crop growth rate, HNR and ALT5. Although yield responses vary greatly, York (1983) found a yield positive response to Pix in North Carolina when environment conditions favored excessive vegetative growth. Additionally, Kerby (1985) observed a yield advantage with Mepiquat Chloride not only in a short season situation (less than optimal heat units received), but also on plants that reached a shorter or taller than normal final plant height. Maintaining a uniform cotton crop can be advantageous especially with insect management, crop termination (Cothren and Oosterhuis, 1993), and final harvest.

Objectives

1. Characterize the spatial and spatial-temporal variability in cotton growth and development. Properties monitored included height, HNR, and ALT5.
2. Compare scouting methods currently used by crop consultants and scouts to whole field variability; determine if their methods are sufficient to identify variability and could be used to develop a variable rate Pix (Mepiquat Chloride) application map.

Materials and Methods

Characterize Spatial-Temporal Variability

To characterize the variability in cotton growth, a 14 acre irrigated cotton field in Bertie County, North Carolina was selected. In 1997, the field was sampled beginning prior to first bloom and ending approximately at cutout (NAWF<5). Plant height, HNR, and ALT5 were taken as indicators of cotton growth. The field was mapped and then sampled once weekly using a backpack housing a differential global positioning system with a handheld computer to record location and plant information. In the 14 acre field, 30 samples were taken. Nineteen samples came from 0.75 acre grids and 11 from finer 0.25 acre grids. Each sample point consisted of five plants visually selected from within a 10 ft. diameter area to represent the whole grid. The average values calculated from these five plants were used to represent a single point in each field.

Variography analysis was conducted to examine spatial relationships in the data using GS+ (Gamma Design Software, Plainwell, MI). Variograms plot the variance

Reprinted from the *Proceedings of the Beltwide Cotton Conference*
Volume 2:1499-1502 (1998)
National Cotton Council, Memphis TN

between sample points as a function of the distance between samples (lag distance) (Rossi et al., 1992). A spherical model was fit to the variogram to determine the nugget (sampling error), range (maximum distance showing spatial continuity), and structural variance (sampling variance attributed to location differences) of the data. Using the variogram application in Surfer (Golden Software Inc., Golden, CO), the data for each sampling date were kriged to determine values for the unsampled areas of the field (Isaaks and Sirvistava, 1989). Plant height, HNR, and ALT5 data were separated into categories based on recommendations charts for Pix application rate and timing (Edmisten, 1997; Edmisten, personal communication; Landivar, Cothren and Livingston, 1996). Contour maps based on these categories were developed using MapInfo (MapInfo Corp., Troy, NY). A frequency analysis of the area of each field covered by the different categories of data was done for each sampling date. Comparisons of coverage areas were made across dates to determine the temporal variability in cotton growth parameters.

Compare Scouting Methods for Mapping Cotton Growth

During the period of sampling, both fields were also monitored weekly by a local crop consulting business (Roanoke-Chowan Agricultural Consulting, Jackson, NC) using a random sampling method. The consulting service marked their sampling sites which were then georeferenced using the backpack DGPS. Their measurements for each site were matched to the location and this data was kriged to produce contour maps using the procedures described above. The measurements taken from the grid sampling process were compared to the random sampling measurements to determine whether the consulting service data could by used to identify specific plant growth zones within the fields.

During the period of this study, two applications of Pix were made to the field, 12 oz/acre at early bloom and 6 oz/acre at late bloom. These applications were made based on the advice given by the consultants on the rate and timing of Pix for the field. In addition, aerial photographs were taken on the final sampling date. These were digitized and compared with the maps of cotton measurements to assist in identifying areas of the field which differed in growth and development.

Results and Discussion

Variogram Analysis

The variogram analysis of plant height, HNR, and ALT5 showed spatial relationships. Figure 1 shows the variograms for 31 July. The variograms for the other dates were similar to those shown. Spherical models fit to the variograms had correlation coefficients of 0.88 to 0.94 for plant height, 0.62 to 0.76 for HNR, and 0.53 to 0.67 for ALT5. Variograms of plant height showed a consistent relationship between lag distance and sample variance, while variograms for both HNR and ALT5 showed hole effects at approximately 200 ft. This roughly corresponds to the width of the field and may be related to changes in plant growth at the edges of the field. The structural variance (difference between the sill and nugget) accounted for 68 to 74% of the variance found in the plant height data, 62 to 83% of the variance in HNR, and 73 to 98% of the variance in ALT5. Nugget variance for all three crop growth measures was low indicating that the sampling procedures used were adequate for describing the values at the locations tested. The range (distance of maximum spatial continuity) of the spherical models differed according to the parameter being measured. The range for height was 306 ft. This would indicate that samples collected on 2 acre grids would be adequate for mapping plant height. However, the range for HNR was 212 ft and for ALT5 the range was only 121 ft. This indicates that these measures must be sampled at a finer scale (0.5 to 1 acre). The spatial relationships in the variogram analysis indicated that interpolated maps based on the spherical model and the grid data collected would adequately represent the cotton growth in the field.

Contour Map Comparisons

Visual analysis of the contour maps from all sampling dates reveals that specific field areas have common growth habits. Areas with tallest heights also have greatest ALT5 and HNR. The aerial photo clearly showed a lighter area, indicating crop stress (the center pivot irrigation stops at one point in the field). This area was detected in the contour maps for all dates, especially for height and HNR. The aerial photo also shows a region of darker green color in the upper right corner. The three contour maps for 7-31 show that this area has taller plants and has more vegetative growth than other regions of this field. Clearly this was an area to consider for additional Pix application. Grid sampling did detect an area in the lower right corner that was consistently lower in plant vigor measurements. Inspection of the aerial photo did not show a similar lack of vegetative cover.

Field Area Frequency Analysis

Area frequency analysis shows the growth trend of this cotton field through the bloom period (Fig. 2-4). Plant height increases as the crop continues to grow. However, the range in plant height increases over time. The increase in the number of contours on the maps clearly shows that spatial distribution of measurements increased with uniform Pix application. The plants in the lowest height range increased from 4% at July 11 to 15% at July 31 (Fig. 2). Because these plants received the 12 oz Pix rate, the height differential between these shorter plants and the more average sized plants was never recovered. At the opposite end, the area of the field with plants in the highest growth categories did not respond adequately to Pix as shown by the increasing height and ALT5. Five percent of the field area was in the tallest height range for all dates indicating that the growth for this vegetative cotton was never sufficiently slowed by the July 11 Pix application.

Random versus Grid Sampling

A comparison of the consultant's sample data with the grid sample data was completed for three of the four dates. The random sampling method did not detect the large region of crop stress on the left end of the field (in aerial photo). For July 23 (Fig. 5-6), the grid sample, as compared to the random sample, found a wider range of values for height and HNR and that a greater percentage of the field was in the two lowest vegetative growth indicator zones (height: 23% vs. 7%; HNR: 60% vs. 10%). Although random sample data were not available for July 31, the grid data indicate that 58% of the field area would have benefited or potentially responded to the final Pix application (Aug. 1) (Based on applying Pix at ALT5>1.55 and height>38").

Summary

1. Spatial continuity was found in all three properties measured, especially height and HNR. Less continuity was observed in ALT5.
2. Analysis of contour maps and aerial photograph showed relationships between growth factors and field locations.
3. Frequency analysis of growth factors height, ALT5, and HNR indicated a large amount of variability within the field.
4. Uniform application of Pix resulted in an increase in spatial variability in height and HNR.
5. Consultant's use of random sampling scouting method did not adequately identify plant growth zones in the field.
6. Analysis indicates that large variability exists in cotton growth in the field. The variability is wide enough to justify VRT practices and application of Pix. Spatial analysis would improve the decision process of Pix timing.

References

Cothren, J. T. and D. M. Oosterhuis. 1993. Physiological Impact of Plant Growth Regulators In Cotton. In D. J. Herber and D. A. Richter (Eds.) Proc. Beltwide Cotton Conf., New Orleans, LA., 10-14 Jan. 1993. pp. 128-132. Natl. Cotton Council of Am., Memphis, TN.

Edmisten, K. L. 1994. The use of plant monitoring techniques as an aid in determining mepiquat chloride rates in rain-fed cotton. In G. A. Constable and N. W. Forrester (Eds.) Proc. World Cotton Res. Conf-1., Brisbane, Australia, 14-17 Feb. 1994. pp. 25-28, CSIRO, Melbourne.

Edmisten, K. L. Personal communication, December 30, 1997.

Edmisten, K. L. 1997. Suggestions for Pix Use. In 1997 Cotton Information Book. North Carolina Cooperative Extension Service, North Carolina State University, Publication No. AG-417, pp.70-76.

Isaaks, E. K. and R. M. Sirvistava. 1989. Applied Geostatistics. Oxford Univ. Press, New York.

Kerby, T. A. 1985. Cotton Response to Mepiquat Chloride. Agron. J. 77:515-518.

Landivar, J. A., J. T. Cothren, and S. Livingston. 1996. Development and Evaluation of the Average Five Internode Length Technique to Determine Time of Mepiquat Chloride Application. In P. Dugger and D. A. Richter (Eds.) Proc. Beltwide Cotton Conf., Nashville, TN, 9-12 Jan. 1996. pp. 1153-1155. Natl. Cotton Council of Am., Memphis, TN.

Rossi, D. E., D. J. Mulla, A. G. Journel, and E. H. Franz. 1992. Geostatistical Tools for Modeling and Interpreting Ecological Spatial Dependence. Ecol. Monographs 62:277-394.

Sawyer, J. E. 1994. Concepts of Variable Rate Technology with Considerations for Fertilizer Application. J. Prod. Agric. 7:195-201.

Silvertooth, J. C., A. F. Wrona, D. S. Guthrie, K. Hake, T.A. Kerby, and J. A. Landivar. 1996. Vigor Indices for Cotton Management. In Cotton Physiology Today. National Cotton Council of Am., Memphis, TN. Vol. 7, No. 3.

York, A. C. 1983. Responses of Cotton to Mepiquat Chloride with Varying N Rates and Plant Populations. Agron. J. 75:667-672.

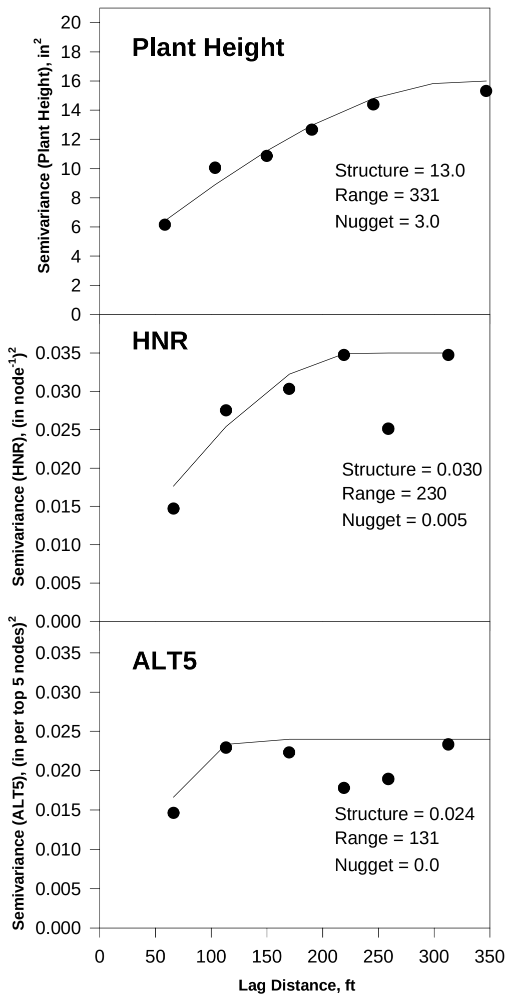

Figure 1. Variagram Analysis for July 31 indicate intensity of sampling required to adequately represent cotton growth in this field.

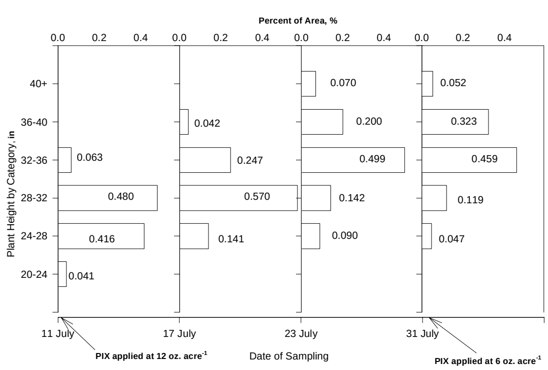

Figure 2. Area frequency analysis for height demonstrates that the distribution of plants in certain height ranges increases with time.

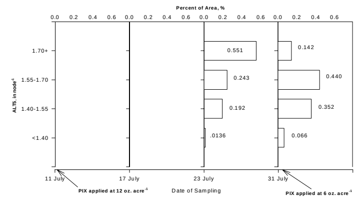

Figure 3. Area Frequency Analysis for Average Length of Top 5 Internodes.

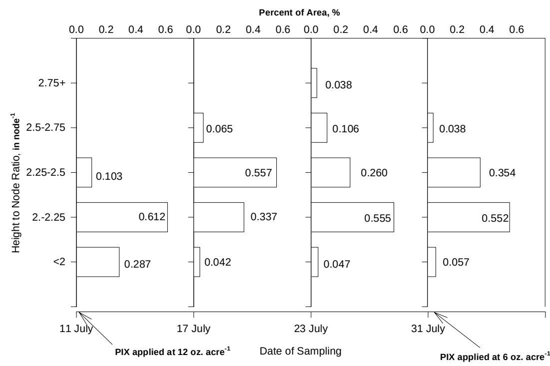

Figure 4. Frequency Area Analysis for HNR. Distribution of field areas increases over time.

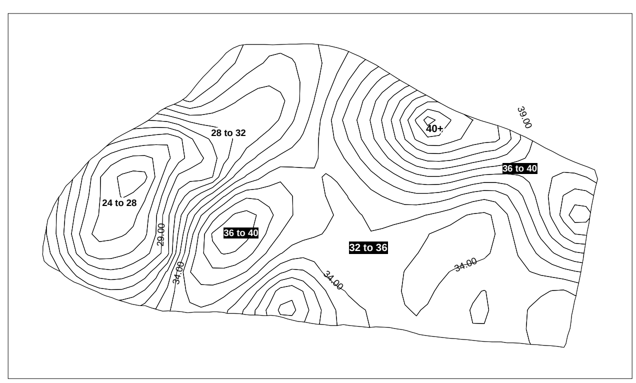

Figure 5. Contour map for grid data on 7-23. Darker colors are shorter plants and lighter colors are taller regions.

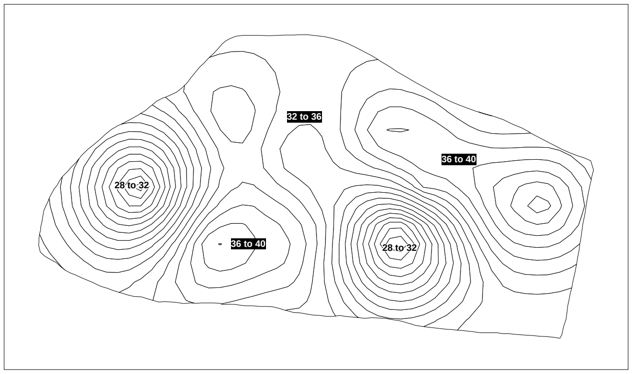

Figure 6. Contour Map for Random Sampled Data shows range of height values detected. Darkest regions are shorter plants whereas striped areas are tallest.