SPATIAL VARIABILTIY OF YIELD IN IRRIGATED COTTON

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Abstract

Precision agriculture technologies are providing an opportunity to manage fields as separate units instead of one management unit. These technologies are valuable because soil and crop parameters often vary within a field. Relatively little spatial variability data are available for cotton. This experiment was conducted to study the variability of an irrigated cotton field. At 70 points within a field, cotton yield and quality parameters were determined. Yield and yield components were more variable than were quality components. The variability could be even greater in production scale fields. Precision agriculture could provide ways to reduce the amount of variability in production cotton fields while increasing the production efficiency.

Introduction

Commonly, entire fields have been treated as a single management unit with respect to application of nutrients, pesticides, and other crop production inputs(Wilkerson and Hart,1996). Currently, precision agriculture technologies are being developed that allow fields to be broken down into smaller management units. These technologies are designed to increase crop production efficiency because they can be used to vary inputs within a field. Varying inputs within a field is desirable because soil and crop parameters often vary within a field (Wilkerson and Hart,1996). Variability of cotton growth within a field has been demonstrated (Oosterhuis et al., 1991). However, with respect to grain crops, information is lacking on variability of soil and crop factors within fields used for cotton production.

Objectives

The objectives of this study were to evaluate variability of cotton parameters within an irrigated cotton field. Specifically, spatial variability in cotton yield, production of fruiting sites, fruit retention, length, strength, and micronaire were determined.

Material and Methods

This study was conducted at the Erskine Research Farm at Lubbock, TX. The field used for this study was a 13 acre circle. The soil at this site was Amarillo fine sandy loam. Irrigation was provided by using a center pivot LEPA system.

Cotton (HS-26) was planted (65,000 seeds/acre) on 22 May 1996. The field was fertilized with 80 pounds N/acre, 22 pounds P/acre, 0.5 pounds Zn/acre, and 0.25 pounds Cu/acre. During the growing season, the site received 14.3" of rainfall. An additional 8.6" of water was supplied via irrigation to provide a total of approximately 23" of water.

A grid system was established on 100 foot intervals. A total of 70 grid points were established; 57 of the points were located inside the irrigated portion of the field, and 13 of the points were located outside of the irrigated portion of the field(Figure 1). The actual grid points are located at the center of each grid cell (Figure 1). The center pivot irrigation system is denoted by the circular outline in Figure 1. Due to physical limitations, the top portion of the field was not irrigated.

Yield data were collected at each grid point by harvesting all bolls within an area of 52 inches by 3 rows; a harvested area was centered onto each grid point. The harvested bolls were ginned in a 20 saw plot gin. A sub-sample of lint from each yield sample was sent to the International Textile Center in Lubbock, TX for determination of length, strength, and micronaire.

Plants were collected immediately adjacent to the harvest area for determination of production of fruiting sites and fruit retention (Landivar and Benedict, 1996).

Statistical analysis was performed by using the appropriate procedure from SAS statistical package (SAS Institute, Inc., 1989). Spatial variability maps were developed by using bi-cubic spline interpolation to 10' pixel; this was accomplished with Spyglass Transform software (Fortner Research LLC, Sterling VA).

Results

Lint yield ranged from less than 600 pounds/acre to over 2000 pounds/acre (Figure 2). Yield was highly variable as indicated by a relatively high coefficient of variation (CV) of 21%. The spatial variability of lint yield is shown in Figure 2. The grid system used provided sufficient resolution to detect low yielding areas in dry land portions of the field(Figure 2). The low yields located near the left side of the sampling area may be explained by the fact that a roadway was located there 3 years ago.

The production of fruiting sites ranged from less than less than 16 to 38 sites per plant (Figure 4). The production of fruiting sites was highly variable as indicated by a high CV (21%). The spatial variability of fruiting sites is shown in Figure 5. Areas of low production of fruiting sites were located near the left side of the irrigated area and outside the irrigated area.

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The percentage retention of fruit ranged from below 14% to over 47% (Figure 6). The percentage retention of fruit was highly variable as indicated by a high CV (19%). The spatial variability of percentage fruit retention is shown in Figure 7.

The fiber length ranged from 0.94” to 1.20” and had a low CV of 4.2% (Figure 8). The spatial variability of fiber length is shown in Figure 9. The areas of shorter length were located near the area where a road was located 3 years ago (Figure 9).

Fiber strength ranged from 28 grams/tex. to 34 grams/tex. and had low variability with a CV of 4.6 (Figure 10). The spatial variability of fiber strength is shown in Figure 11.

Micronaire ranged from 3.9 to 6.1(Figure 12). The variability was moderate with a CV of 10.4. The spatial variability map of micronaire showed areas of higher micronaire on the left side of the sampling area, non-irrigated areas with higher micronaire and areas of lower micronaire on the right side of the sampling area (Figure 13).

Conclusions

The cotton parameters measured in this study varied within the 13 acre field. The highest spatial variability occurred with yield, production of fruiting sites, and fruit retention. Micronaire had moderate spatial variability. The lowest spatial variability occurred with length and strength. The high spatial variability in the area sampled suggests that precision agriculture technologies may have application for cotton production in production-scale fields where even greater variability may exist.

Further studies are being conducted to determine relationships between soil properties and cotton parameters.

References

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Oosterhuis, D.M., E.M. Rutledge, C.A. Stutte, S.D. Wullschleger, R.E.Hampton and C.R. Bell. 1991. In-field growth variability. Arkansas Farm Research 40(4):9-10.

SAS Institute. 1989. SAS/SAT user’s guide. Version 6.03 SAS Inst., Cary, NC.

Wilkerson, J.B. and W.E. Hart. 1996. Yield sensing technology in cotton harvest applications- Beltwide Cotton Production Research Conferences. 1996. Pp.184-186.

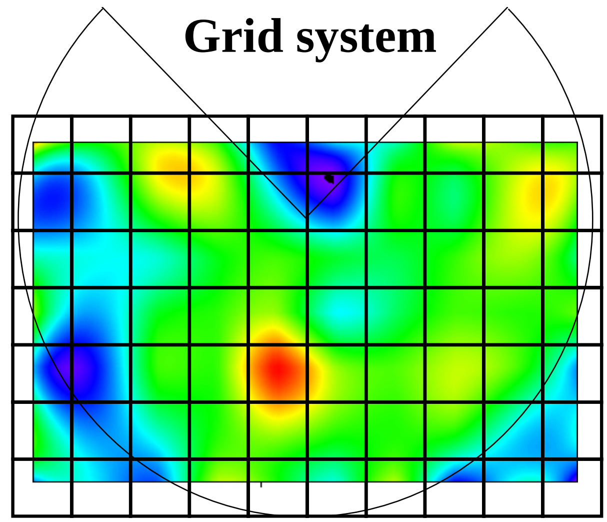

Figure 1. Map of field site showing grid system and outline of irrigation system

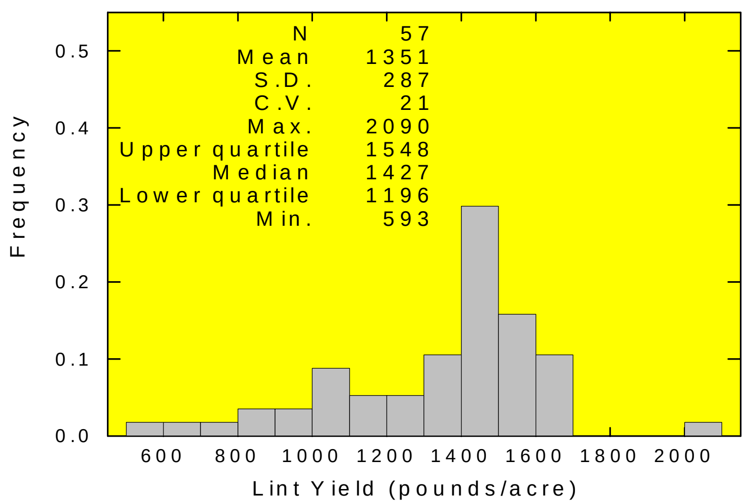

Figure 2. Normalized histogram and summary statistics for yield data obtained at 57 grid points within an irrigated cotton field.

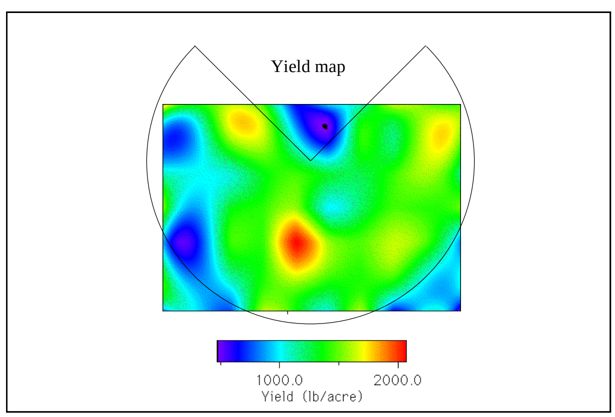

Figure 3. Spatial variability map for yield obtained at 70 grid points within a cotton field.

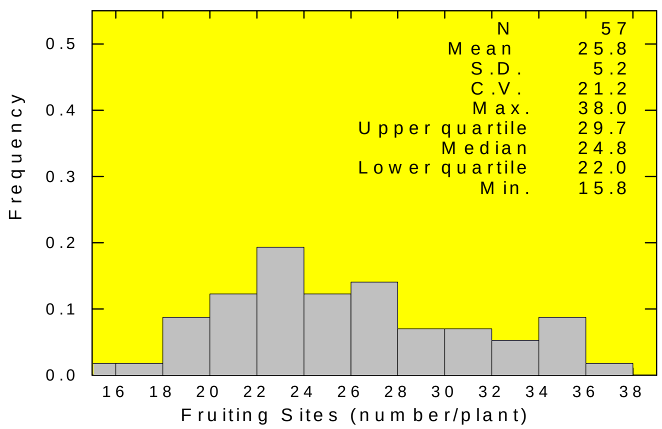

Figure 4. Normalized histogram and summary statistics for number of fruiting sites obtained at 57 grid points within an irrigated cotton field.

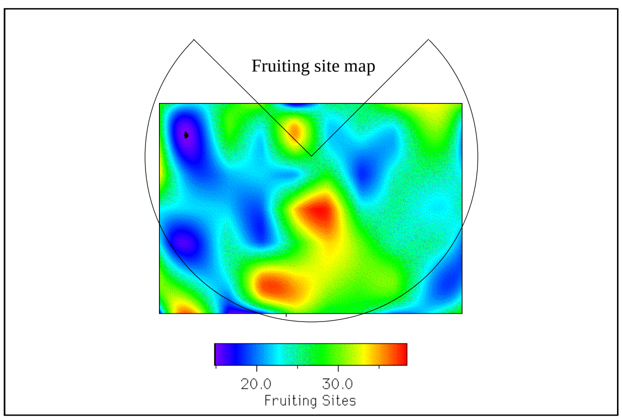

Figure 5. Spatial variability map for fruiting sites obtained at 70 grid points within a cotton field.

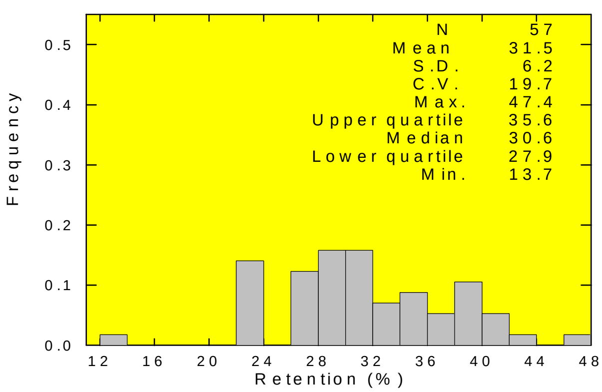

Figure 6. Normalized histogram and summary statistics for % fruit retention obtained at 57 grid points within an irrigated cotton field.

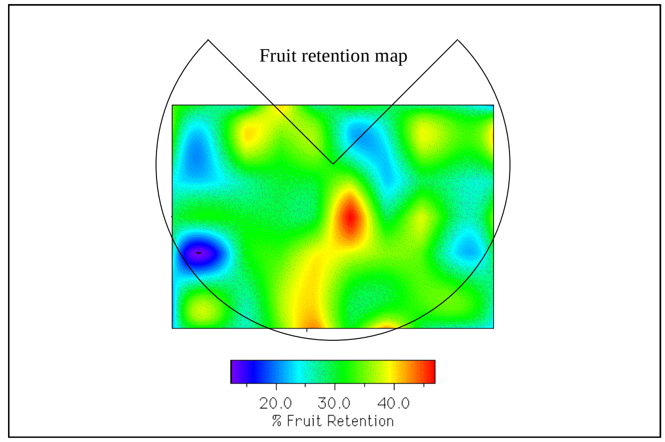

Figure 7. Spatial variability map for % fruit retention obtained at 70 grid points within a cotton field.

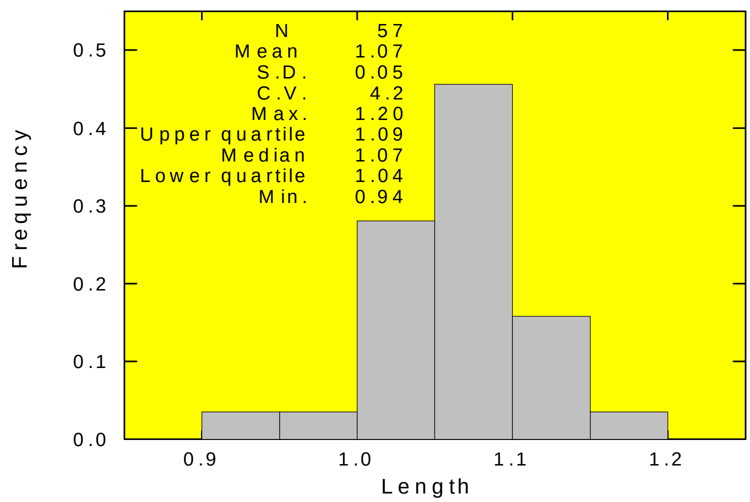

Figure 8. Normalized histogram and summary statistics for fiber length obtained at 57 grid points within an irrigated cotton field.

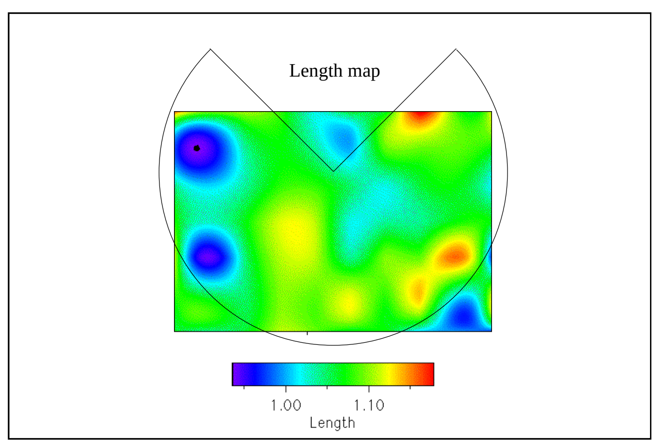

Figure 9. Spatial variability map for fiber length obtained at 70 grid points within a cotton field.

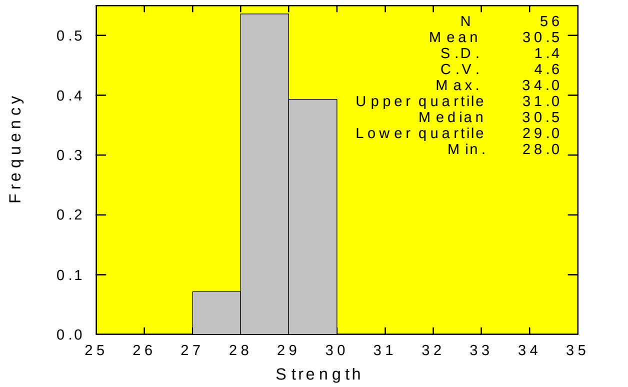

Figure 10. Normalized histogram and summary statistics for fiber strength obtained at 57 grid points within an irrigated cotton field.

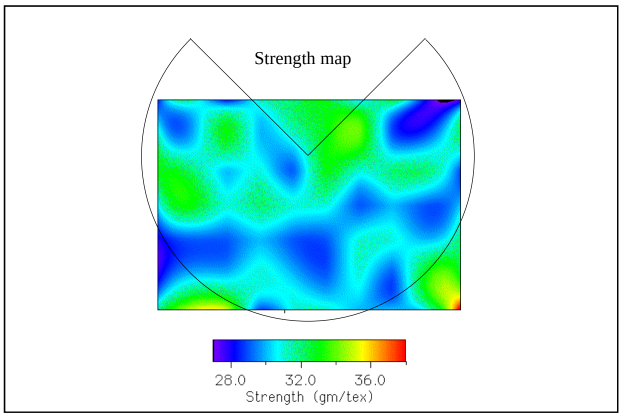

Figure 11. Spatial variability map for fiber strength obtained at 70 grid points within a cotton field.

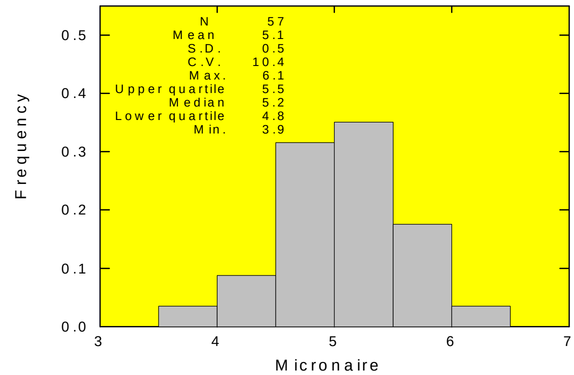

Figure 12. Normalized histogram and summary statistics for micronaire obtained at 57 grid points within an irrigated cotton field.

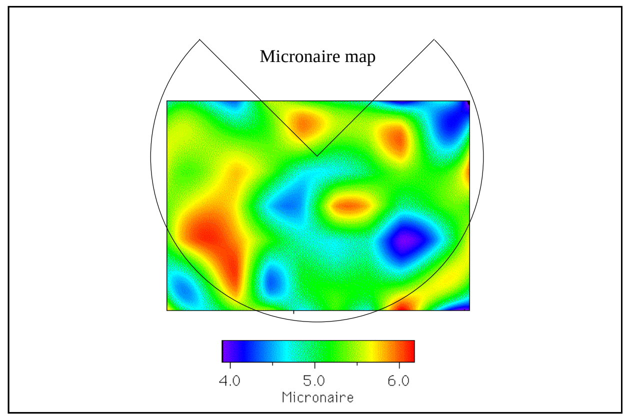

Figure13. Spatial variability map for micronaire obtained at 70 grid points within a cotton field.