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# VARIABILITY OF COTTON FIBER QUALITY IN WEST TEXAS

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## Abstract

The objective of this study was to evaluate the spatial variability in measures of cotton fiber quality. This study was conducted in a 98-acre field near Plainview, Texas in 2001 and 2002. Seed cotton samples were collected from the field (with GPS locations), ginned, and analyzed for micronaire, length, strength, and uniformity using HVI. Commercial HVI classing results from the bales produced in the same field were compared to the field sample testing results. Both types of results showed that micronaire and short fiber index exhibited the greatest variability, while Uniformity Index showed the lowest variability. Results of fiber quality testing from the samples collected in the field and from the commercial bales were nearly identical, showing that our sampling methodology effectively represented the field. Nevertheless, results from our sampling method also provided information about the fiber quality spatial distribution in the field, which potentially provides opportunities to improve the fiber qualities using site-specific crop management techniques.

## Introduction

To date, a few studies have documented spatial variability of cotton fiber qualities within a field. Hequet and Ethridge (2002) evaluated within field, within bale, within sample, and within instrument variability in cotton harvested in West Texas, and found that fiber micronaire, strength, length, and Uniformity Index exhibited variability within field, micronaire having the largest variability, followed by strength, then UHML and finally Uniformity Index. Elms et al. (2001) reported highest variability in micronaire, followed by length, and strength within a 5.3-ha experimental field. Similar fiber quality variability was reported in a study conducted in a 0.5-ha experimental field in South Carolina (Johnson et al., 2002).

The USDA fiber quality classing results provide information about the variability of cotton fiber qualities, but the information about the spatial variability of the fiber quality is lost because cotton from various parts of a field is mixed when harvested and ginned. As a result, the distribution of fiber qualities in a field is impossible to determine by just using the classing results. To better understand the spatial distribution of fiber qualities, field locations associated with fiber qualities are required. The objective of this study was to evaluate the spatial variability of fiber qualities within a field based on sample location as opposed to the USDA classing results.

## Materials and Methods

This study was conducted in a 98-acre field near Plainview, Texas in 2001 and 2002. Upland cotton (*Gossypium hirsutum* L.) varieties PM 2379 and PM 2326 were planted in 2001 and 2002, respectively, with approximately 1-m row spacing. Cotton was deficit-irrigated using a center pivot irrigation system.

Seed cotton samples (214 samples in 2001, and 185 samples in 2002) were collected randomly with three commercial harvesters. The geographical locations of samples were recorded with GPS units attached to the harvesters. The samples were ginned with a laboratory saw gin at the Texas Agricultural Experiment Station in Lubbock, Texas, and the fiber samples were analyzed at the International Textile Center, Lubbock, Texas. Fiber samples were tested on a Zellweger Uster HVI 900A with 4 micronaire, 10 Upper Half Mean Length (length), strength, and Uniformity Index readings.

Commercial quality classing results of the individual bales (233 bales in 2001, and 203 bales in 2002) were obtained from the farm owner. Short fiber index was calculated using the USDA-AMS formula for both sample testing qualities and the commercial classing qualities.

Yield data were obtained with AgriPlan yield monitors while harvesting seed cotton. Soil electrical conductivity was measured with the Veris EC equipment (Veris Technologies, Salina, KS). Elevation of the field was measured with a differential global positioning system.

Landscape positions, soil electrical conductivity, cotton lint yield, and fiber qualities were interpolated to 16 m × 16 m grids within the sampling zone for both years using kriging method with SSToolbox, a GIS software package (Site-Specific Technologies, Stillwater, OK). The sum of premium or discount for fiber length, micronaire, strength, and Uniformity Index were calculated for each grid based on the USDA-AMS cotton fiber premium-discount tables.

## Results and Discussion

Results of the study are presented in Table 1. Micronaire values were quite variable in both field and bale samples. They ranged from 4.0 to 5.3 with a CV of 5.64% in field samples, and from 4.2 to 5.2 with a CV of 3.22% in bale samples in 2001. In 2002, micronaire ranged from 3.1 to 5.0 with a CV of 7.64% in the field samples, and from 3.6 to 4.6 with a CV of 4.12% in bale samples. However, the mean micronaire for field samples was very close to that of the bale samples in both years -- 4.78 and 4.76 for field and bale samples respectively in 2001, and 4.21 and 4.25 for field and bale samples respectively in 2002 (see Figure 1). The higher micronaire in 2001 was probably variety related. Strength also exhibited a large degree of variability. It ranged from 27.1 to 31.3 g/tex with a CV of 3.15% in field samples, and from 25.7 to 31.7 g/tex with a CV of 3.08% in bale samples in 2001. In 2002, strength ranged from 27.0 to 31.5 g/tex with a CV of 3.38% in field samples, and from 25.8 to 32.4 with a CV of 3.94% in bale samples. Average strength for the field samples is close to that for the bale samples with a mean of 28.89 g/tex for the field samples and 28.24 g/tex for bale samples in 2001. In 2002 the values were 29.49 g/tex for field samples and 29.27 g/tex for bale samples (see Figure 2). Length variability was lower than micronaire or strength variability. The CV was 1.81% for field samples, and 1.60% for bale samples in 2001. The variability in length in 2002 was slightly larger, with a CV of 2.16% for both field and bale samples. Nevertheless, length ranged from 25.4 mm to 28.2 mm in the field samples, and from 24.6 mm to 27.8 mm in the bale samples in 2001; in 2002, it ranged from 25.4 mm to 28.7 mm in field samples, and from 25.4 mm to 27.8 mm in bale samples. The greatest range was 4/32$^{nd}$ of an inch, which had a considerable impact on estimated bale value calculated from the premium or discount schedule. Mean UHML of field samples reflected the mean UHML length of the bale samples (see Figure 3). Uniformity Index had the lowest variation (0.68% in 2001 and 0.74% in 2002 for field samples, 0.88% in 2001 and 1.04% in 2002 for bale samples). Uniformity Index of the samples was close to that of the bale samples (see Figure 4). With CVs of 5.75% for field samples, and 7.22% for bale samples in 2001, and 6.03% for field samples and 8.62% for bale samples in 2002. Short fiber index showed the largest variability among all the fiber quality properties. Like the other fiber quality properties, mean short fiber index of field samples were close to that of the bale samples (see Figure 5).

In both years, mean length was slightly better for the field samples than for the bale samples probably due to the use of ginning equipment (small experimental saw gin used for the field samples, as opposed to a commercial gin for the bale samples). The effect of module mixing was obvious for micronaire-- variability (CV) was reduced 42% and 46% in 2001 and 2002, respectively.

From these results, one can conclude that the field sample results represented the bale sample results relatively well in average quality properties and their variability. From the bale samples, we can understand the basic statistics like mean, maximum, minimum, median, standard deviation as well as the distribution of the fiber quality properties (see Figure 12). However, with the commercial classing results, it is not possible to understand the spatial distribution of fiber quality within a field. As a result, there is no opportunity to manage the fiber properties of the crop within that field based on these data. With the sampling method described in this study, we know the specific locations for each sample in the field. Using interpolation methods, a spatial distribution for each fiber quality characteristic can be mapped. These distributions can be compared to corresponding distributions of other field characteristics, such as elevation, soil EC, and yield.

An example is the micronaire distribution in relation to elevation, soil EC, and lint yield distribution in the field in 2001. Elevation ranged from 3534 to 3559 feet, with high elevation in the northwest and lower elevation in the southeast part of the field (see Figure 6). Soil EC ranged from 22.6 ds/m to 69.3 ds/m, with a mean of 35.8 ds/m (see Figure 7). Yield ranged from 205 lb/ac to 2262 lb/ac, with a mean yield of 895 lb/ac. High yields were mainly associated with high elevation (see Figure 8). Micronaire was negatively correlated with elevation, soil EC, and lint yield (see Figures 6-9). That is, high micronaire values occurred mainly in the areas with low elevation, low EC, and low yield.

Micronaire also showed similar distribution pattern in 2002 (see Figure 10). The premium-discount distribution was also associated with elevation, with discount values in the low elevation area and premium values in the high elevation area. This premium and discount distribution was mainly due to variations in micronaire, which had the largest contribution to the premium-discount (see Figure 11).

There was only one cotton variety in the field each year, so variations in environmental growing conditions were the main factors contributing to the variability of fiber quality properties across the field. Additional information is needed to conclusively determine if field elevation or soil electrical conductivity were the factors that caused the spatial variability in fiber quality properties. Further data collection and analysis will be done to investigate the influence of environmental factors on fiber quality.

## Conclusions

The results from the GPS-directed sampling method used in this study adequately described the variability of fiber quality characteristics in the field. The advantage of using the GPS-directed field sampling method in this study over the commercial classing results is that spatial distribution of fiber quality properties such as length, micronaire, strength, Uniformity Index, and short fiber index can be determined, which provides a basis for possible site-specific crop management to improve fiber quality and overall profitability.

## References

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Hequet, E., and D. Ethridge. 2002. Cotton fiber quality evaluation for cotton breeders and biotechnologists. p. 95-112. *In* Proc. 15th Annual EFS System Conf., 10-12 June 2002, Memphis, TN. Cotton Incorporated, Memphis, TN.

Johnson, R.M., R.G. Downer, J.M. Bradow, P.J. Bauer, and E. J. Sadler. 2002. Variability in cotton fiber yield, fiber quality, and soil properties in a Southeastern Coastal Plain. Agronomy Journal. 94:1305-1316.

Table 1. Univariate statistics for fiber quality from samples and commercial classing for 2001 and 2002 cotton field, Plainview, Texas.

| Sample | Quality | N | Max | Min | Mean | Median | STD | CV |
|---|---|---|---|---|---|---|---|---|
| | UHML (mm) | 214 | 28.2 | 25.4 | 26.77 | 26.7 | 0.48 | 1.81 |
| | Micronaire | 214 | 5.3 | 4.0 | 4.78 | 4.8 | 0.27 | 5.64 |
| Field | Strength (g/tex) | 214 | 31.3 | 27.1 | 28.89 | 28.9 | 0.91 | 3.15 |
| | UI (%) | 214 | 83.7 | 80.7 | 82.28 | 82.3 | 0.57 | 0.69 |
| | SFI (%) | 214 | 11.6 | 8.3 | 9.71 | 9.7 | 0.56 | 5.75 |
| | UHML (mm) | 233 | 27.8 | 24.6 | 26.68 | 27.0 | 0.43 | 1.60 |
| | Micronaire | 233 | 5.2 | 4.2 | 4.76 | 4.8 | 0.15 | 3.22 |
| Bale | Strength (g/tex) | 233 | 31.7 | 25.7 | 28.24 | 28.3 | 0.87 | 3.08 |
| | UI (%) | 233 | 83 | 79 | 81.55 | 82.0 | 0.72 | 0.88 |
| | SFI (%) | 233 | 12.9 | 9.0 | 10.43 | 10.1 | 0.75 | 7.22 |
| | UHML (mm) | 185 | 28.7 | 25.4 | 27.01 | 26.9 | 0.58 | 2.16 |
| | Micronaire | 185 | 5.0 | 3.1 | 4.21 | 4.3 | 0.32 | 7.64 |
| Field | Strength (g/tex) | 185 | 31.5 | 27.0 | 29.49 | 29.6 | 1.00 | 3.38 |
| | UI (%) | 185 | 84.4 | 81.0 | 83.09 | 83.2 | 0.63 | 0.76 |
| | SFI (%) | 185 | 11.8 | 8.7 | 9.58 | 9.5 | 0.58 | 6.03 |
| | UHML (mm) | 203 | 27.8 | 25.4 | 26.74 | 27.0 | 0.58 | 2.16 |
| | Micronaire | 203 | 4.6 | 3.6 | 4.25 | 4.3 | 0.18 | 4.12 |
| Bale | Strength (g/tex) | 203 | 32.4 | 25.8 | 29.27 | 29.2 | 1.15 | 3.94 |
| | UI (%) | 203 | 84.0 | 79.0 | 81.44 | 81.0 | 0.84 | 1.04 |
| | SFI (%) | 203 | 14.0 | 8.9 | 11.07 | 11.0 | 0.95 | 8.62 |

UHML: Upper Half Mean Length
STD: Standard Deviation
SFI: Short Fiber Index
CV: Coefficient of Variation

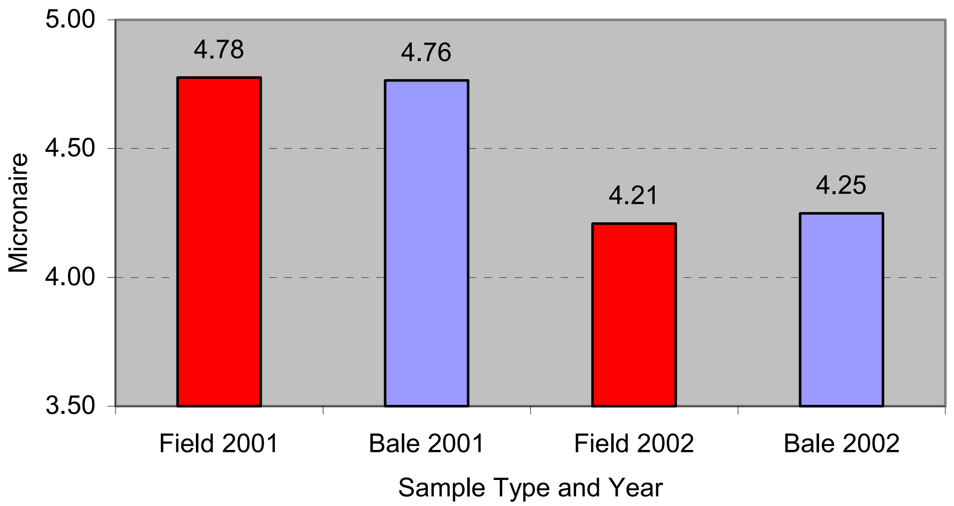


Figure 1. Micronaire -- comparison between field and bale samples.

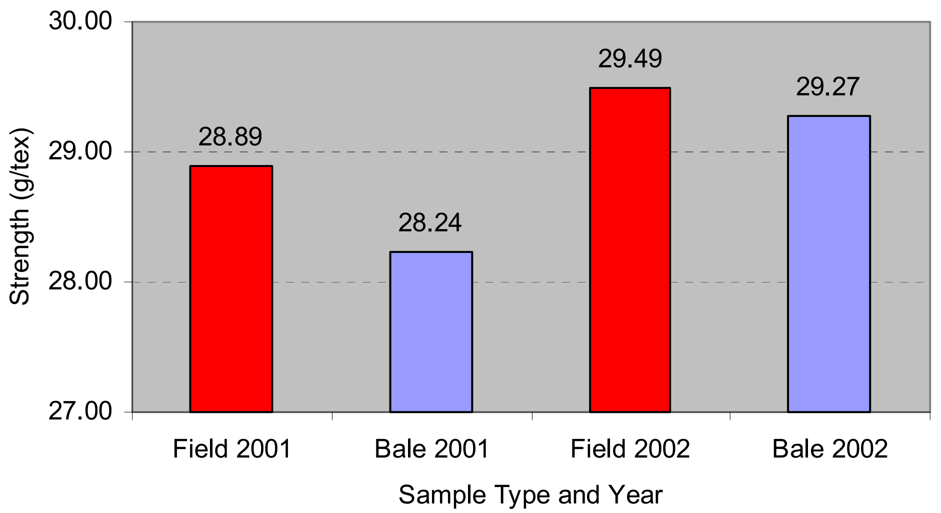


Figure 2. Strength -- comparison between field and bale samples.

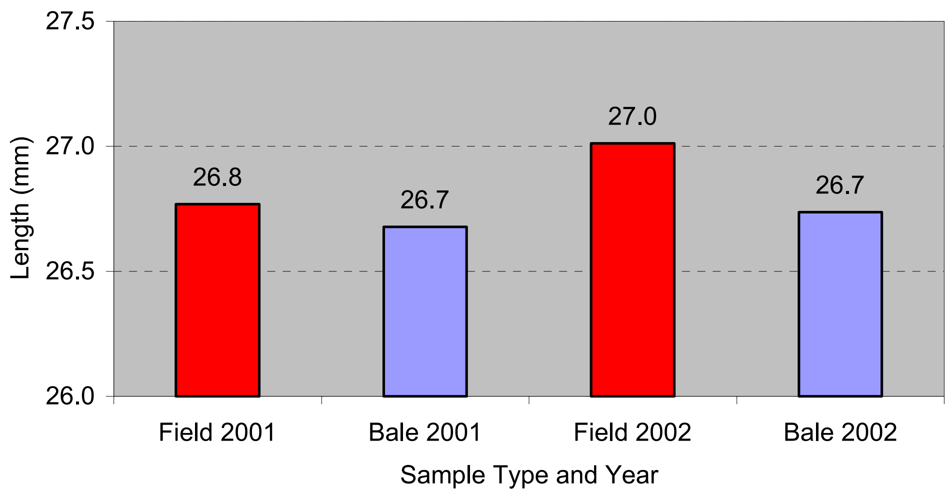


Figure 3. Length -- comparison between field and bale samples.

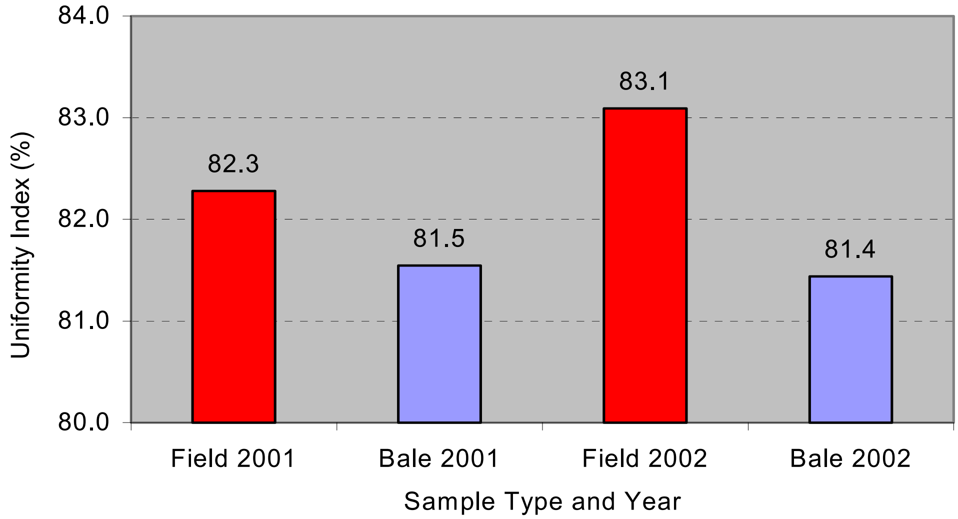


Figure 4. Uniformity Index -- comparison between field and bale samples.

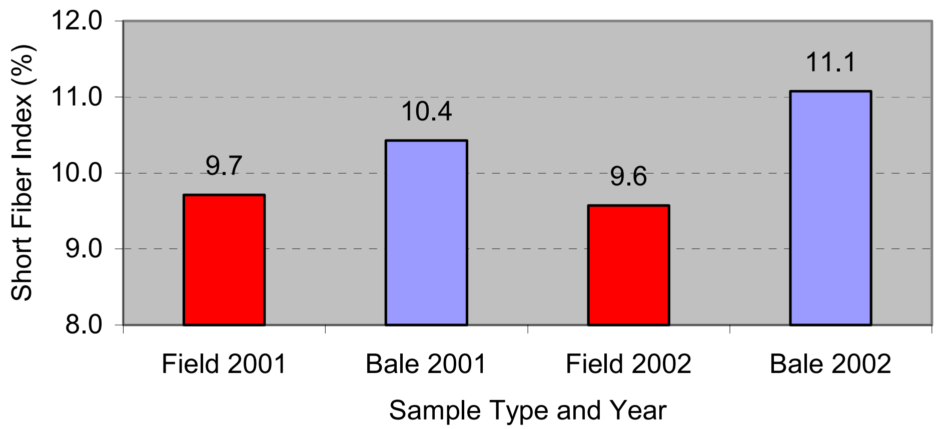


Figure 5. Short Fiber Index -- comparison between field and bale samples.

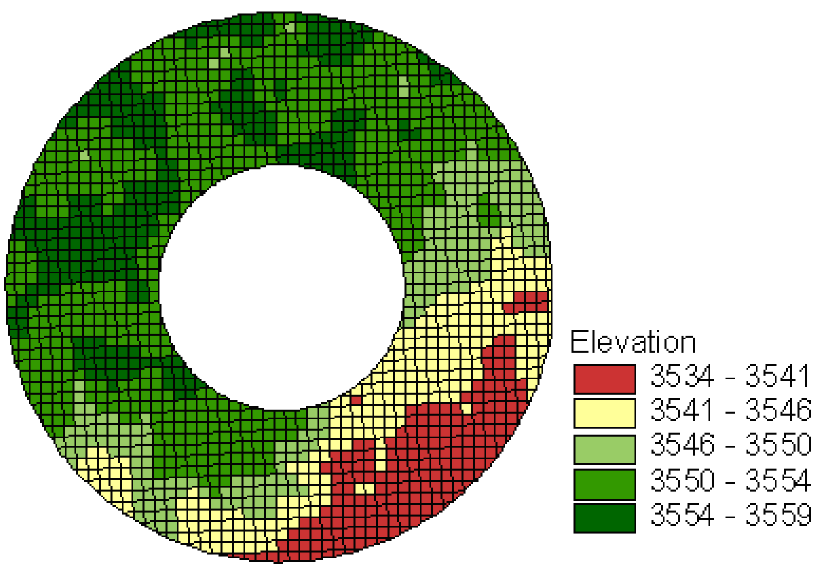


Figure 6. Elevation (ft) distribution within the field.

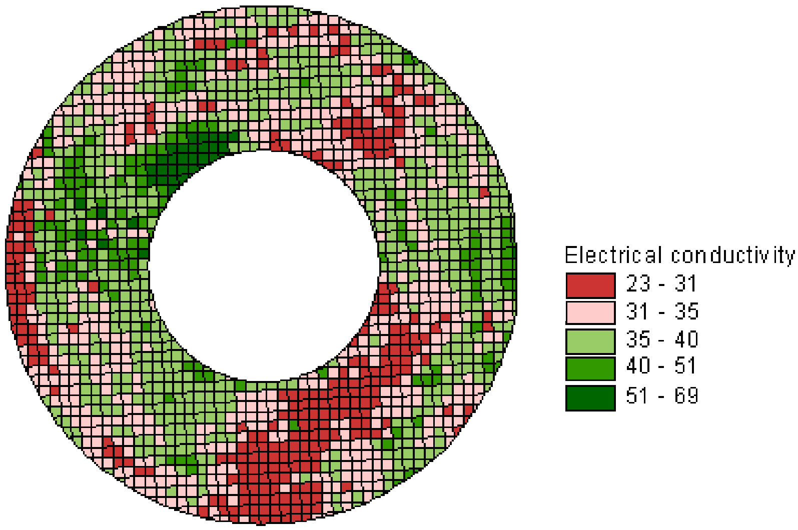


Figure 7. Soil electrical conductivity (ds/m) distribution in the field.

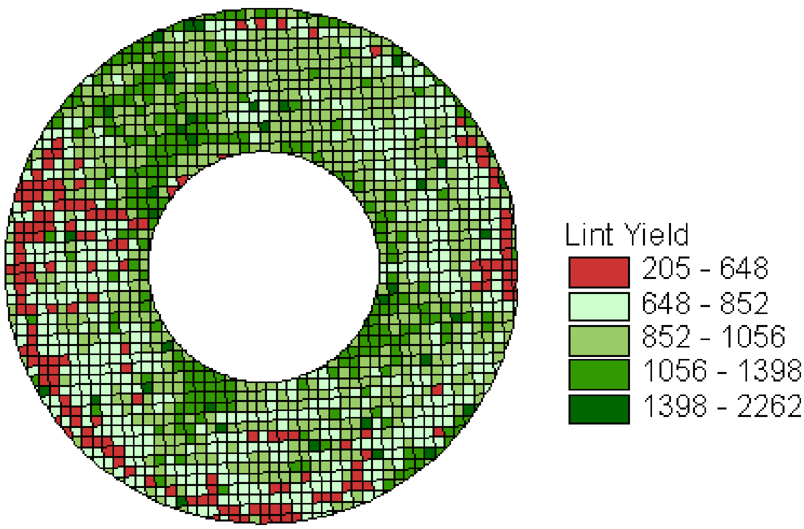


Figure 8. Lint yield (lb/ac) distribution in the field in 2001.

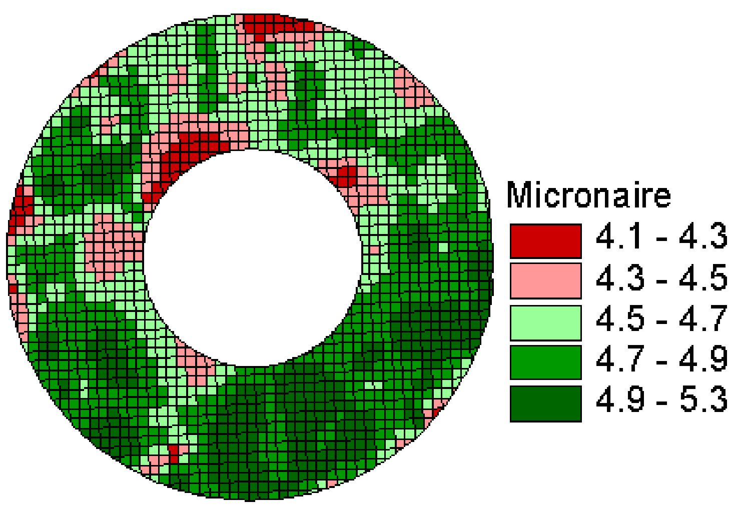


Figure 9. Micronaire variability with the field in 2001.

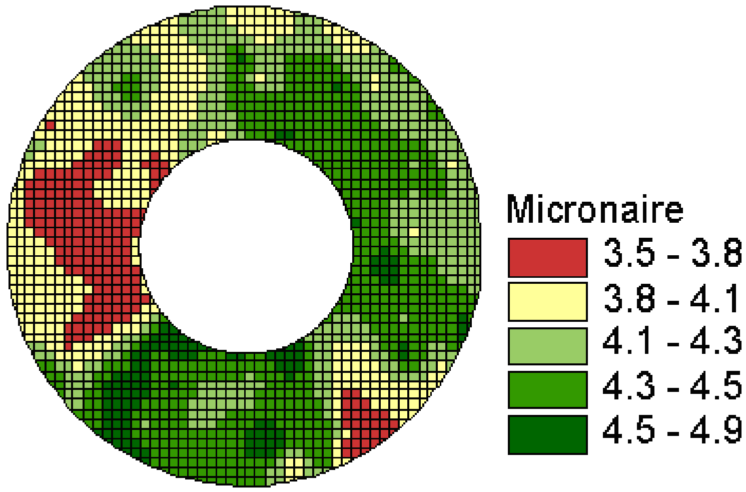


Figure 10. Micronaire variability within the field in Plainview, Texas in 2002.

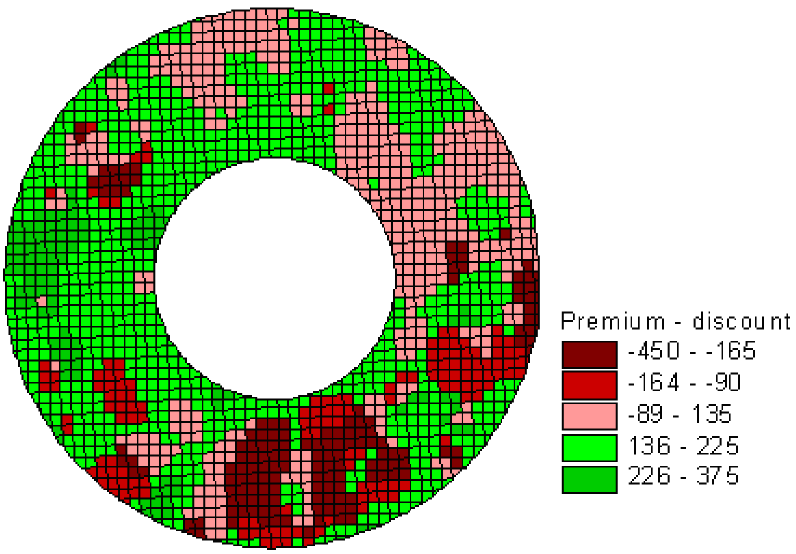


Figure 11. Premium-discount distribution in 2001.

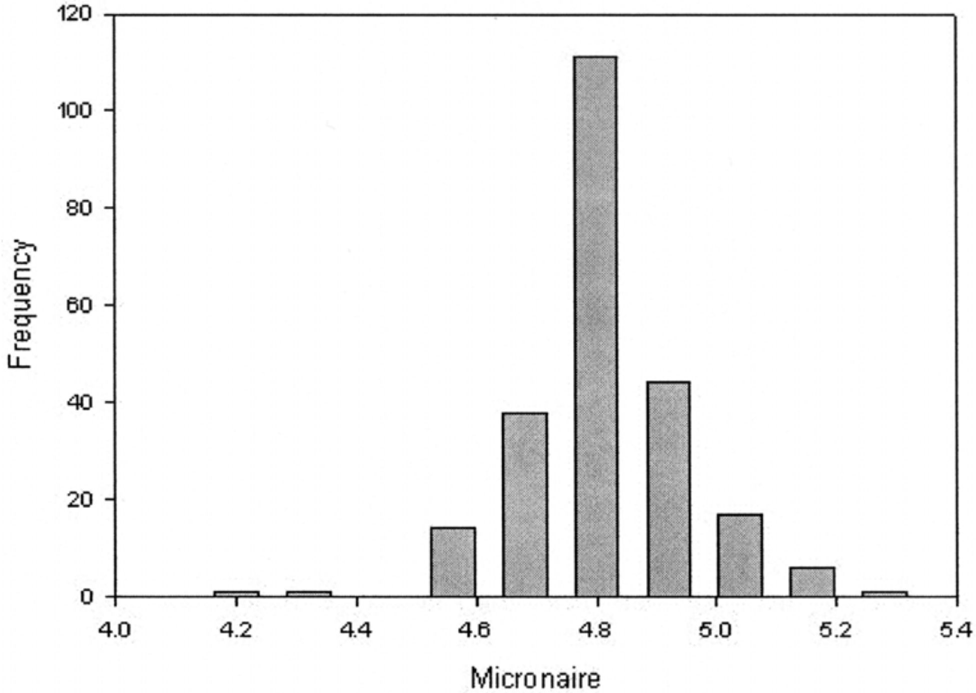


Figure 12. Micronaire distribution in bale samples in 2001.