INFLUENCE OF SOIL SPATIAL VARIABILITY ON COTTON FIBER QUALITY

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For maximum profitability, a cotton producer must attempt to control the quality of the crop while minimizing costs and maximizing yield. One strategy that may help to accomplish this difficult task is adoption site-specific management practices. Site-specific management allows a producer to apply crop inputs on an individual-needs basis, as opposed to a single-field average rate. This is accomplished by dividing the field into management zones, which receive prescribed levels of crop inputs. The first step in defining management zones is determination of the inherent soil and crop spatial variability present in the field. The objective of this research was measurement of the natural variability present in cotton fiber yield and quality parameters in relation to the underlying soil spatial variability.

A field experiment was conducted in a producer's field in Winnsboro, LA, to investigate the influence of soil spatial variability on the variability of cotton [*Gossypium hirsutum*, genotype Deltapine 33B] fiber yield and quality. Soil (0-15 cm) and fiber (1-m row) were collected from a staggered grid (250 x 250 m, 23-m interval). The grid location was chosen to transverse a ridgeline to assure a significant range in soil and fiber variability. Soil properties determined included organic matter [%], pH, Ca, Mg, K, P, Na, B, As, Cu, Fe, Mn, Ni, Pb and Zn [all ions, mg kg^{-1} soil] and cation exchange capacity [CEC, meq 100 g^{-1} soil]. Cotton fiber samples were collected, by hand, from ~ 1 m of row centered on the grid points on September, 27, 1998. Fiber was saw-ginned and weighed to determine yield [218-kg bales]. Fiber quality was determined by using the Zellweger Advanced Fiber Information System (AFIS, A-2). Fiber properties determined by the AFIS system included, fiber length by number and weight, short fiber content [% distribution of fibers < 12.5 mm] by weight and number, diameter by number, circularity [theta], immature fiber fraction [% distribution of theta < 0.25], cross-sectional area by number, fine fiber fraction [% distribution of fiber with cross-section < 60 mm^2], micronAFIS [micronaire analog] and perimeter. All fiber and soils data were analyzed by both conventional univariate statistics [SAS PROC UNIVARIATE] and variogram analysis [GS+]. Simple correlation analysis was performed between soil and fiber properties with SAS PROC CORR. Finally, spatial maps were constructed by kriging [Surfer] utilizing the previously determined variograms.

All soil properties, with the exception of organic matter, exhibited a non-normal distribution, as determined from the Shapiro-Wilkes statistic. The majority of these properties also exhibited a positive skew with the mean greater than the median (except soil K). Soil K exhibited a slight, but measurable negative skew. These combined observations further support the non-normality of the 1998 soils data. The coefficient of variation for the properties measured ranged from 21 % for soil organic matter to almost 201% for soil sodium. The large CV values for soil sodium, arsenic and lead are partly due to several extreme values in the data set. These extremes are also reflected in the large kurtosis values for these properties. The validity of these values is being investigated to ascertain their validity. The observed variability in soil properties suggests that there exists a sufficient range in the soil properties measured for a site-specific management strategy to be beneficial.

All soil properties were also spatially correlated, with the exception of soil lead levels. The semivariogram model for soil P was exponential with a range of 83 m (273 ft). The model for sodium was Gaussian with a range of 158 m (521 ft) and soil organic matter was best described by a spherical model with a range of 134 m (440 ft). The semivariograms for soil K, Ca, Mg, pH and CEC were all linear. Note that because the range determined from the linear model is arbitrary, it is not possible to directly compare these values to other models. Soil boron, arsenic, manganese and zinc all exhibited spherical semivariograms and copper and nickel were fit to the exponential model. Soil iron was described by a linear model. The ranges of spatial correlation for these soil micronutrients varied from 80 m (263 ft) for soil zinc to 274 m (900 ft) for soil arsenic.

The yield data were non-normally distributed, but the mean was in good agreement with the median. The yield data did exhibit a positive skew and a slight negative kurtosis. The CV was significant (33%), reflecting the large range (2.0 bales) in the data. The distribution of fiber properties was variable, with L(n), L(w), SFC(n), SFC(w), IFF, and FFF all exhibiting non-normal distributions. The data for L(n), L(w), Theta, A(n), MicronAFIS and perimeter were negatively skewed; while SFC(w), SFC(n), D(n), IFF and FFF all had positive skews. The coefficients of variation for the fiber properties measured ranged from 1.0% for perimeter to 17% for IFF. The properties with the highest variability were IFF, FFF, SFC(w), SFC(n) and MicronAFIS.

Cotton yield was also spatially correlated, exhibiting an exponential semivariogram with a range of 237 m (780 ft). All fiber properties were spatially correlated, with the exception of SFC(n) and SFC(w). Exponential variograms were fit to fiber L(n), L(w), Theta, Micronafis and

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perimeter. Fiber IFF and FFF exhibited spherical variograms and D(n) and A(n) were linear. The range of spatial correlation for fiber properties was smaller than that observed for soil properties. The majority had spatial correlation ranges of 10-20 m. The notable exceptions were FFF and IFF, which had ranges of 32 and 43 m, respectively.

Fiber yield was positively correlated to soil organic matter, B, Cu, Fe, Mn and Zn. Negative correlations were observed with soil potassium and arsenic. The best predictor of fiber length and SFC appears to be soil Mn, but boron and iron also exhibited significant correlations. Diameter was best described by soil Na and Mg. Theta, IFF, A(n), and micronAFIS are all related to fiber maturity and exhibited similar responses to soil variation. The best predictors for these properties appears to be soil Mg, followed by soil K, Cu and As. Although significant correlations between soil and fiber properties were observed the strength of these correlations were marginal at best. A much clearer picture of the relation between soil and fiber variation is illustrated in the spatial maps.

The ridgeline present in the center of the experimental site is clearly illustrated in the maps of soil boron, OM, P and Mn. It is evident that soil erosion (run-off) processes have modified the distribution of soil nutrients in this field. Cotton yield and fiber quality also appear to have been influenced by landscape position and soil nutrient distribution. The areas of the field that had the lowest yield appeared to produce the most mature fiber, as evidenced by the lower fiber IFF and elevated levels of micronAFIS and theta. The plants in the low-yield part of the field were also smaller and had fewer bolls. Additional fiber and soil maps could be used to study further the spatial relation between fiber quality and soil variability and, possibly in the future, to direct variable application systems.