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INFLUENCE OF ANNUAL SOIL PARAMETERS ON COTTON AND CORN YIELDS AS DETERMINED BY GPS/GIS TECHNOLOGY

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Abstract

Producers in the Mississippi Delta as well as other areas of the country are being exposed to new technologies and the continued use of computers for daily operations on the farm. Site specific management in agriculture has been gaining in acceptance in some areas of the country and is being evaluated throughout the Cotton Belt. Global Positioning Systems (GPS) make it possible to geo-reference specific areas in a field and along with Geographic Information Systems (GIS) become the framework for multi-layered data that can be used to describe spatial variability in fields. The study being conducted in a 15-acre field on the Delta Research and Extension Center located at Stoneville, MS was initiated in 1998 to examine the spatial variability of yields from both corn and cotton in a rotational system. Corn was grown in 1998 and 2000 while cotton was grown in 1999 and 2001. The 496-plot field was geo-referenced in 1998 with plots (cells) maintained in the same area in subsequent years. Each cell consists of four 40-in rows 82 feet in length. Soil samples were taken after each crop was harvested. Samples were composited from six to eight soil cores from each plot. The samples were air-dried, ground, mixed, boxed, then shipped to Mississippi State University Extension Service for the laboratory analyses. All samples were analyzed for lime requirement, pH, phosphorus (P), potassium (K), exchangeable cations (H, K, Ca, Mg, and NA), cation exchange capacity (CEC), organic matter, sulfur (estimated), and zinc. The original objectives were to 1) build yield and soil characteristic maps in an effort to explain spatial variability in both cotton and corn; and to 2) examine the relationship between soil test parameters and yields of cotton and corn utilizing GPS/GIS technology. Several tools were used to accomplish the latter objective including, ArcView GIS, TableCurve 2D, Statistical Analysis Systems (SAS), graphics package to illustrate the results (Lotus Freelance Graphics), and a spreadsheet (Lotus 123) to handle the data. Results from soil samples taken after each annual harvest were correlated to yields measured during each growing season. The correlations included: 1998 corn yield correlated to 1998 soil data; 1999 cotton yield correlated to 1999 soil data and 1998 soil data; 2000 corn yield correlated to 2000 soil data, 1999 soil data, and 1998 soil data; and 2001 cotton yield correlated to 2001 soil data, 2000 soil data, and 1998 soil data. At the time of this writing, the 2001 soil analyses data were not available. In 1998, corn yields ranged from 132 to 186 bu/acre with an average yield of 156 bu/acre. Soil pH in the area averaged 6.4 with P at 114 lb/acre and K at 305 lb/acre. Organic matter ranged from 0.40% to 2.11% with an average of 0.97%. The CEC ranged from 8.18 to 22.30 meq/100g with an average of 13.81 meq/100g. Corn yields were most highly correlated to P with a correlation coefficient (r) of 0.496. The relationship was positive which meant that corn yields increased with increasing P rates. The next highest r (0.4893) was found with exchangeable Mg for which the response was negative indicating that corn yields decreased as exchangeable Mg increased. The area was rotated to corn again in 2000 (following cotton in 1999) with grain yields ranging from 153 to 210 bu/acre and the average yield established at 182 bu/acre. Corn yields were again correlated to soil P (r = 0. 267) for samples taken in 2000. However, yields in 2000 were more highly correlated to soil test P from 1999 (r = 0.305). The soil pH has become a significant correlation factor with respect to corn yield.

In 1999, the area was rotated to cotton (following corn in 1998) and had total lint yields that ranged from 949 to 1508 lb lint /acre. In examining maps from the different crops, it was obvious that the yield maps were different. When the yield was correlated to 1999 soil data, the highest correlations were to CEC (r = 0.330) and exchangeable acidity (r = 0.328). If correlated to 1998 soil data, the highest correlations were to exchangeable acidity (r = 0.289) and CEC (r = 0.264). However, the correlation to exchangeable acidity was positive rather than negative. This meant that, as acidity increased, yields increased rather than decreased as might be expected. There was a positive correlation to CEC which is also somewhat different than what would be expected. Generally, yields are lower as CEC increases, but within the ranges experienced in this study, the higher yields indicated a better water holding capacity for the heavier textured soils. The 2001 lint yields have not been completed, so only seedcotton yields could be correlated to soil test results from either 2000 or 1998. The 2001 seedcotton yield ranged from 880 to 3112 lb/acre with an average of 2403 lb/acre. The seedcotton yields were most correlated to 2000 CEC values and exchangeable Ca. If 1998 soil data were used, the highest correlations were related to Zn and K. Soil test levels of nutrients continue to decline with each subsequent crop and the changes are being monitored.

In summary, the best correlations for corn yields in 1998 were obtained with P (positively correlated) and exchangeable Mg (negatively correlated). In 2000, corn yields had higher correlations to P and pH. When two factors were considered at the same time, the highest correlations occurred with P+pH (r = 0.391) for 1999 soil samples. For cotton, the single-factor analysis showed the highest correlation values with soil acidity (r = 0.298) and CEC (r = 0.264) when compared to 1998 soils data and CEC

(0.330) when compared to 1999 soil data. The 2001 seedcotton yields were correlated to 1998 Zn ($r = 0.503$) and K ($r = 0.481$) while the correlation coefficients were higher CEC ($r = 0.576$) when using 2000 soil data.

In most cases, several factors are involved in spatial variability in fields. While there is a tendency to ascribe variations to soil differences, it may actually only explain a small portion of the inherent differences. The yield spatial variability is also not consistent from year to year.