CHANGES IN SOIL TEST NUTRIENTS WITH LONG-TERM COTTON/CORN ROTATION

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Abstract

Long-term cotton/corn rotation studies were begun in 2000 at the Delta Research and Extension Center (DREC), Stoneville, MS on a Bosket very fine sandy loam (Mollic Hapludalfs) and at the Tribbett Satellite Farm (TSF), Tribbett, MS on a Forestdale/Dundee silty clay loam (Typic Endoaqualfs). The studies were intended to evaluate benefits and problems associated with crop rotations in the Mississippi Delta. The two sites had different soil types and included ‘poorly’ drained to ‘somewhat-poorly’ drained soils (Forestdale/Dundee) at Tribbett along with a well drained soil (Bosket) at Stoneville. The selected sites are characteristic of soils suited for good corn and cotton production, especially with irrigation. The objectives of the studies included, a) determining the effects of N and K nutrition on cotton lint yields and corn grain yields for different soil types; b) determining rotational effects of corn on cotton production and the implications of these rotations on whole farm economics; and c) evaluating the effects of nitrogen (N) and potassium (K) rates and rotational effects on nematode dynamics. Soil samples have been taken following harvest each year in order to monitor changes in soil test parameters across years. The changes that have occurred are of particular interest. Areas were defined at both locations that could be rotated over a 3-year period with corn followed by one or two years of cotton. Within each location (soil type), each section had a factorial arrangement of N and K treatments. The sections consisted of 4-row (40-in spacing) plots, 90 to 100 feet in length, with either four (TSF) or five (DREC) replications. Annual N rates were 60, 90, 120, 150, and 180 lb N/acre for cotton and 120, 160, 200, 240, and 280 lb N/acre for corn with the fertilizer N applied as urea-ammonium nitrate solution (32% N). Potassium rates for all rotations were 0, 40, 80, and 120 lb K/acre. Nitrogen was applied at a uniform rate (60 lb N/acre for cotton, 120 lb N/acre for corn) prior to or near planting with the different N rates established as a sidedress application at early square formation for cotton and at the 5- to 6-leaf stage of corn. Potassium applications were made after planting utilizing a 0-0-16 solution (1.3 lb K/gal) applied with the same equipment used for N applications. The K solution (muriate of potash, KCl) was chosen for ease of application with available equipment and does not imply that granular muriate of potash could not be used with incorporation. The crops were harvested with commercial harvesters modified for plot harvest with cotton grab-samples taken for ginning and corn samples taken at harvest for determination of harvest moisture, bushel test weight, and seed weight. Seedcotton samples taken at harvest were ginned through a 10-saw micro-gin for calculation of the lint percentage. End-of-season soil samples consisted of composited cores from 10-12 locations within each plot. The samples were placed in refrigerated storage until nematode analyses can be completed. The remaining sample was dried, ground, sieved, and mixed prior to analysis in the Soil Testing and Plant Analysis Laboratory at Mississippi State University. Nutrient uptake and removal has also been estimated based on published nutrient concentration information and summarized by location and rotation section.

After ten years, N applications total 840, 1180, 1520, 1860, and 2200 lb N/acre where corn has been grown four of six years. The applications total 780,1110,1440,1770, and 2100 lb N/acre when corn is growing in three of the ten years. Since K rates have been the same for both corn and cotton, total K applications were 0, 400, 800, and 1200 lk K/acre. On the sandy loam soil at DREC, corn yields have ranged from 167 to 244 bu/acre (excludes 2000 data due to herbicide injury in corn following many years of continuous cotton) when averaged across all N and K levels. The average corn yield at DREC was 204 bu/acre/yr. On the more poorly drained soils at TSF, corn yields have ranged from 141 to 221 bu/acre with an overall average of 182 bu/acre/yr (excludes 2000 data for comparison purposes). In evaluating K applications at DREC, no significant response to increasing K rates has been observed at either location in most years. Total K removal from the study areas range from 323 to 361 lb K/acre based on yields with no real difference in K removal as related to K application rates. Total K removal at TSF ranged from 342 to 373 lb K/acre over the 10-year duration of the study. With these levels of removal, in theory, one should expect to see lowering of soil test K levels where no K has been supplied and a build-up where application exceeds removal. This should be evident if plots continue in the same area and tillage does not shift plot locations or move the applied fertilizer material. For comparison purposes, soil results from 2008 were compared to the initial set of samples taken following the first growing season (2000). At present, soil samples following the 2009 growing season have not been analyzed. No samples were available

prior to the initiation of the studies at either location. At the DREC location, initial soil test K averaged less than 300 lb K/acre within the three sections. After the 2008 growing season, soil test K levels showed increases in soil test K at every K application rate including the 0 K/acre rate. Where no K had been applied, soil test K in 2008 was 50 to 100% higher than in the initial set of samples even though more than 300 lb K/acre had been removed. This provides strong indication that the plots have shifted or tillage has moved the applied fertilizer material and the O K plots have not remained in their original location. The data also suggests the possibility of some K release from clay minerals in the soil (release of fixed K). At the TSF location, the 0 lb K/acre plots have also increased in soil test K. Overall soil test K has not increased as much as that observed at the DREC location. These results again suggest movement across plots with tillage but also suggest some K supplying power in the soil. No K response has been observed in most years.

High N rates have been responsible for decreases in soil pH, however, irrigation has been thought to increase soil pH due to liming materials dissolved in the irrigation water. As indicated earlier, up to 2200 lb N/acre has been applied to the high N plots at each location. Crops removal estimates range from 890 to 1000 lb N/acre at DREC and 820 to 1050 lb N/acre at TSF with the highest removal at the higher N rates. In most cases, where N applications exceed N removal by the crop, much of the excess N is lost through biological processes such as denitrification and is removed from the soil N pool. Soil pH has decreased some with increasing N rates at both locations when averaged across K rates. At both locations, there has been little change in soil pH at the lower N rates.

Soil organic matter is the other factor that receives attention with respect to crop rotation. Adding corn to the crop mix is thought to increase soil organic matter or soil organic carbon. Increasing K rates and increasing N rates has not increased organic matter at either location. To date some slight changes have been observed when comparing the areas but no large changes have been observed. These research areas remain in conventional tillage systems that involve both subsoil and surface tillage. Further evaluations will continue for this area as rotations continue. Further analysis of the data is needed to really understand the year-to-year variation that occurs in the soil. Since the system is dynamic, changes are not always as expected.