Profitability of Corn Production by Improving Phosphorus and Potassium Fertilizer Recommendations

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Value to Growers:

1. They will benefit from information on the effect of phosphorus (P) and potassium (K) fertilizer application rates on corn under current Arkansas cropping practices. The results will be used to evaluate the current Arkansas corn P and K fertility recommendations.
2. The growers will benefit from information on the suitability of several plant tests for detecting in-season corn P or K deficiency. This will help them to increase the profit margin by avoiding under or over-fertilization.
3. The growers will benefit from information on P (and K) fertilizer use efficiency for high yielding corn. This information is essential to defend our P and K fertilizer recommendations when they are scrutinized by environmental community.
4. The growers will demonstrate to the environmental sector that Arkansas farmers are using fertilizers in accordance with the best available science to reduce the potential risks to the environment.

Study Objectives:

For corn production under cropping conditions in Arkansas evaluate:

1. The effect of phosphorus (P) and potassium (K) fertilizer application rates on corn grain yield,
2. The suitability of corn ear-leaf and young plants for predicting plant P status,
3. The suitability of corn ear-leaf and young plants for predicting plant K status,
4. Phosphorus and potassium fertilizer use efficiency.

Progress Report for 2011 (so far):

Four corn P fertility trials and four corn potassium fertility trials were conducted at the University of Arkansas research stations or commercial corn production sites. Experiments for each nutrient will be discussed separately.

Procedures for Phosphorus Fertility Experiments

Four replicated corn phosphorous fertility field experiments were conducted on commercial fields and University of Arkansas Research Stations in 2011. Before planting composite soil samples were collected from the 0- to 6-inch depth and composited by replication. Soil samples were dried, crushed, plant available P was extracted with Mehlich-3 solution. Soil pH was measured in a 1:2 (weight:volume) soil-water mixture. Soil particle size analysis was performed by the hydrometer method. Experimental plots were 25 to 40-ft long and 10 to 18.9-ft wide allowing for four or six rows of corn spaced 30 or 38-inch apart, depending on the location. Corn was grown on beds and furrow-irrigated at each site.

Phosphorus application rates ranged from 0 to 160 lb P_2O_5/acre in 40 lb/acre increments as triple superphosphate. Phosphorus treatments were applied to the soil surface in a single application either before planting or shortly after crop emergence. Blanket applications of muriate of potash (0-0-60), urea (46-0-0), and $ZnSO_4$ (18% S and 24% Zn) were made to supply 100 lb K_2O, 260 to 300 lb N/acre, 6.7 lb Zn, and 5 lb S/acre, respectively.

At three sites, five representative plants/plot were cut at two inches above the soil surface at the 6-8 leaf stage, dried in an oven at 70_C to a constant weight, and ground to pass through a 60-mesh sieve. Plant samples were digested with concentrated HNO_3 and 30% H_2O_2 and P concentrations were determined. When corn was at the early to mid-silk stage, 8 to 10 ear-leaves per plot were collected and processed as above. We also collected total above ground portion of corn plant samples when corn was at dent stage and sectioned them into leaves, ears, stems and measured dry weight and P concentration of

each plant component. We will use the whole plant nutrient uptake to calculate P fertilizer use efficiency. At the research farms, the middle two rows of each plot were harvested with a plot combine, at commercial sites one 12.5-ft segments in each one of the two center rows was hand harvested and ran through a combine later. The calculated grain yields were adjusted to a uniform moisture content of 15.5% for statistical analysis.

Results of the Phosphorus Fertility Experiments

Soil pH ranged from 6.3 to 7.4 and Mehlich-3 extractable P ranged from 20 to 51 ppm.. University of Arkansas fertilizer recommendations for corn classified the soil P availability as Low (15-25 ppm) at LEZ11, Medium (26-35ppm) at DEZ11 and PRZ11, Optimum (36-50 ppm) at CLZ11 and Above Optimum (>50 ppm) at CHZ13.

Phosphorus fertilization did increase corn grain yield at any site. It increased leaf P slightly and significantly at LEZ11 and DEZ11 only (Table 2). At all sites the ear leaf P was above the critical level of 0.25%. The lack of significant grain yield increases at CLZ11, DEZ11, CHZ11, and PRZ11 is not surprising since the soil test P was either Medium or Above Optimum at those sites. Although P is recommended for soils having a Medium soil test P level, only a nominal yield increase would be expected. We have just finished chemical analysis of whole plant samples collected early and at the dent stage. We will report that data when we submit our year-end report.

Procedures for Potassium Fertility Experiments

Four replicated field experiments were conducted on representative corn producing soils in 2011. Prior to K application soil samples were taken from the 0-to 6 and 6 to 12-inch depths and composited by replication. Procedures for chemical and physical analysis of soil samples for this potassium study were similar to the P experiments described above. Selected agronomically important information is listed in Table 3. Potassium application rates ranged from 0 to 200 lb K_2O/acre in 40 lb K_2O/acre increments as muriate of potash (KCl) and all of the K rates were surface applied in a single application. Triple superphosphate (0-46-0) was applied at a rate to supply 46 lb P_2O_5 and other nutrients were applied as described for P experiments. At each site, corn was planted on beds and furrow irrigated as needed. All experiments were randomized complete blocks. Young corn seedling and ear leaf samples were collected and processed similar to the corn P experiment. Corn grain harvest procedures for the potassium study were similar to the phosphorus experiment.

Results of the Potassium Fertility Experiments

Mehlich-3 extractable K in the 0-to 6-inch depth ranged from 83 to 120 ppm. According to the University of Arkansas soil test interpretation, soil test K was Medium (91-130 ppm) at CHZ14, DEZ12, PRZ12 and Low (61-90 ppm) at CLZ12. Soil test K in the 6-to 12-inch depth ranged from 38 to52 ppm, which was numerically lower than or comparable to the 0 to 6 inch depth.

Corn ear-leaf K concentration was significantly increased by K application at two sites CLZ12 and DEZ12 only. These are two of the sites with lower soil test K levels. Corn ear leaf concentrations <1.80% K indicate possible K deficiency. Corn grain yields were significantly increased by K fertilization at CLZ12 only the site with the lowest soil test K. Lack of yield response to K application at DEZ12 may be due to early season spray drift from adjacent sites. Corn ear-leaf K concentrations at tasseling appear to be a good indicator of the K nutritional status of corn and soil test K appears to be a good indicator of soil K availability. We have just finished chemical analysis of whole plant samples collected early and at the dent stage. We will report that data when we submit our year-end report.

ACKNOWLEDGMENTS

We appreciate the financial support of Arkansas Corn and Grain Sorghum Promotion Board .