INCREASING P EFFICIENCY-RESIDUAL P

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ABSTRACT

Two cropping systems were studied to determine the effect of different methods of phosphorus (P) fertilizer application on residual P value. In eastern Nebraska on a Pawnee clay loam, grain sorghum yields were significantly higher following P fertilizer that was knifed (dual placed) compared to where fertilizer was either seed applied or broadcast on a previous wheat crop. The knife method of application resulted in a residual value of between 30 and 50% of a new application depending on rate of application. The increased residual value of the knife method of application was probably the result of placement below the tillage depth where limited soil-fertilizer mixing occurred. However, in a wheat-fallow experiment in western Nebraska on a Keith silt loam, method of P application did not affect the residual value of previous fertilizer P applications on wheat even though rate of application did significantly increase wheat yields in the wheat crop following fallow. The increased time from application in the first crop through fallow to the next wheat crop was apparently too long. Knifed bands apparently reached an equilibrium with the surrounding soil and lost the advantage observed from knifed P in the wheat-sorghum system.

OBJECTIVES

The objective of this study was to compare the residual phosphorus (P) effectiveness of different methods of P application in two different cropping systems.

METHODS

Two cropping systems were studied to evaluate how methods of P application affect residual or carryover P. The systems were a wheat-sorghum system and a wheat-fallow system. In the wheat-sorghum system, four levels of P (11, 22, 34 kg P/ha with check) were applied with the wheat seed, broadcast, and knifed as a dual application in 1982. Wheat was harvested and yields determined in 1983. In the spring of 1984, sorghum was planted in the 2.4 m x 9 m plots and P was applied in the row at planting and knifed in prior to planting on plots that received no P in the previous wheat crop. P was applied at rates of 11, 22, 34 kg P/ha. All broadcast P was incorporated by disking and field cultivating prior to planting. Both wheat and sorghum was harvested on an area of 1.86 m^2. Study was located on a Pawnee clay loam in Saunders County Nebraska. Soil had a Bray and Kurtz No. 1 (B&K) P soil test of 4 mg/kg.

The wheat-fallow study was located in Perkins County Nebraska on a Keith silt loam with a B&K soil test of 8 mg/kg. This wheat study was established in 1982. Treatments included broadcast (spring and fall) seed, and knifed (spring and fall) applications of P with three rates of application (11, 22, 34 kg P/ha with check). The plot area was fallowed in 1983-84 and seeded to wheat in the fall of 1984 to determine residual P value of different methods of P application.

The residual P effect from the knife treatment was equivalent to about 15 to 17 kg P/ha when applied at the 34 kg P/ha rate (Figure 1). This resulted in a total fertilizer efficiency for both the wheat and sorghum crops of 33% or a 4% increase due to residual. Total fertilizer P efficiency was not increased by growing sorghum where P was seed or broadcast applied since there was no residual effect with these methods of application.

While wheat fertilizer efficiencies averaged about 30% in 1983 with either seed or knife applications, grain sorghum averaged only about 10% when row or knife applied in 1984. While wheat was much superior to sorghum in terms of P fertilizer uptake, sorghum produced 2.5 times more grain for each kg of P uptake.

While no soil samples were taken, it is believed that the knife method of P application resulted in more residual P because the band application was placed below the tillage depth. The seed bands and broadcast methods of application resulted in complete mixing with the soil and loss of P availability.

Wheat-Fallow-Wheat Experiment

Wheat grain yields in 1983 were significantly affected by methods of application. Seed and knife methods of application significantly increased grain yield compared to broadcast. Wheat was again planted in 1984 to test the residual P affect of previous treatments. While wheat grain yields were significantly increased in 1985 as the original P application rates increased, method of P application did not affect the residual value of applied P. While no significant effect of method of application was found, contrast comparisons showed that the knife (spring) application had greater residual value at the high rate of application (34 kg P/ha). This indicates that time was probably a critical factor in why knifed P did not affect residual value. It is not likely that tillage during fallow was deep enough to disturb the knifed P bands which were applied at a depth of 15 cm.

NEBRASKA SOIL FERTILITY PROJECTS

Chemical Aspects of Phosphorus Movement and Availability to Plants in Sandy Soils - R. C. Sorensen.

Studies concerning the factors which affect the extent of movement of phosphorus containing constituents in sandy soils, including soil particle size, soil pH, associated chemical components and organic matter content.

Potassium Chemistry of Micaceous and Feldspathic Soils in Nebraska - Dennis L. McCallister.

To identify the chemical and mineralogical fractions in a group of Nebraska soils which control their potassium supplying capability.

Increasing Fertilizer Nitrogen Use Efficiency in West Central Nebraska - G. W. Hergert.

Build a data base on nitrogen mineralization and evaluate residual nitrates to improve current nitrogen recommendations and to determine the extent of temporal and spatial variation of nitrate in farmers fields.

Fertilizer Utilization Efficiency in Central Nebraska - Richard Ferguson.

Project includes nitrogen efficiency and loss mechanisms such as ammonia volat lization, nitrate leaching, immobilization and denitfification in conventional and conservation tillage systems.

RESULTS AND DISCUSSION

It has been known for some time that P fertilizer effectiveness can be increased substantially by banding methods of application. In Nebraska, research has shown that applying P with the seed of wheat is up to four times more effective than broadcasting and that this ratio of effectiveness is related to the amount of available P in the soil. Dual placement or knifed P has been found to be equally as effective as seed application. Since farmers generally prefer not to apply fertilizer P at planting time, knifed P has been increasing in popularity. Since knifed P bands are not disturbed by normal tillage one might expect their residual value to be greater than broadcast P or shallow applied bands that are mixed with the soil by tillage.

Wheat-Sorghum Experiment

Wheat grain yields in 1983 were significantly increased by applied P in Saunders County by nearly 2 Mg/ha. The knife and seed methods of application resulted in equal grain yields while both methods produced significantly higher yields than obtained by broadcasting P. Broadcasting P on this low P soil was not effective. Only at the highest rate of 34 kg P/ha were yields increased above check yields. The result was that P fertilizer uptake efficiencies were very low averaging only 5% (across rates) when broadcast compared to an average of 33% for seed application and 29% for the knife application.

Although wheat fertilizer P uptake was high for the knife and seed methods of application, grain sorghum (planted in the spring of 1984) yields were significantly increased from the residual only when P was knifed applied (Figure 1). There was no residual effect of the 1982 P treatments for either the seed or broadcast treatments. While not significant, seed application at the low rate seemed to have a negative residual effect. At the 11 kg/ha application rate, wheat removed 46% of the applied fertilizer P when seed applied. This may account for the trend for decreased grain yield at the 11 kg/ha seed rate since this treatment yielded 1.2 Mg/ha more wheat than the check.

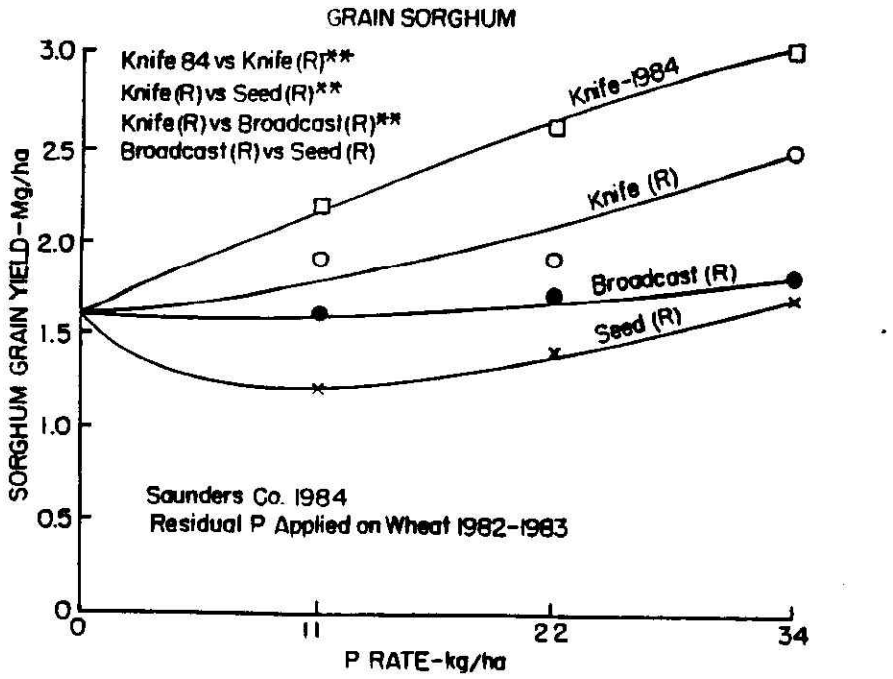

Figure 1. Effect of different methods of P application on residual P as determined by grain sorghum following fertilized wheat. Saunders County, NE. 1984.

Increasing the efficiency of P fertilization - D. H. Sander

This project includes various field and greenhouse studies designed to increase the efficiency of P fertilizers by studying the effect of method of application, timing of application, soil test correlation and calibration, source effectiveness, and variety and hybrid interactions.

Soil nutrient cycling as influenced by crop rotation and residue management - Daniel Walters, R. A. Olson, C. Shapiro.

To evaluate the influence of residue type, quality and placement on nutrient cycling in both monoculture, and rotated cropping systems. Emphasis is placed on N and P cycling.

Cultural and Nutrient Investigations for Crops in Western Nebraska - Frank Anderson.

Project involves the determination of N, P, K and micronutrient needs of western Nebraska crops on both dryland and irrigated soils.

Improving Fertilizer Efficiency in Northeast Nebraska - Charles Shapiro.

Studies involve various aspects of increasing fertilizer efficiency such as the value of starter fertilizers, methods of nitrogen and phosphorus application in both conventional and conservation tillage systems, and an evaluation of both nitrogen and phosphorus sources.

Evaluating the Cause of and Correcting Chlorosis - E. J. Penas and R. A. Wiese.

Investigations primarily involve the factors affecting chlorosis in soybeans as affected by varieties, soil characteristics and different material and application methods for correcting chlorosis.

Evaluating Plant Nutrient Needs and Product Quality - Delno Knudsen.

Objectives include providing chemical, physical and biological analyses of soil, plant and water samples for various ARD projects; improve soil testing correlations and calibrations for Nebraska conditions; adapt analytical techniques, procedures and instrumentation as appropriate.