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Grain Yield, Phosphorus Removal, and Soil Phosphorus Long-Term Trends as Affected by Fertilization and Placement Methods in Corn-Soybean Rotations

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Abstract
An experiment was initiated in 1994 to study phosphorus (P) fertilization rates and placement methods for corn and soybean managed with no-till or chisel-plow tillage. We measured grain yields from all plots, soil-test values for selected plots, and until 2005 nutrient removal with harvested grain for selected no-till plots. In this report we summarize long-term trends (1994 until 2005) for grain yield, P removal, and soil test P for plots managed with no-tillage.

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Introduction

An experiment was initiated in 1994 to study phosphorus (P) fertilization rates and placement methods for corn and soybean managed with no-till or chisel-plow tillage. We measured grain yields from all plots, soil-test values for selected plots, and until 2005 nutrient removal with harvested grain for selected no-till plots. In this report we summarize long-term trends (1994 until 2005) for grain yield, P removal, and soil-test P for plots managed with no-tillage.

Corn and soybean were grown each year by alternating crops between identical adjacent trials. The predominant soil was Webster, and tested Low in P (11, 9, and 10 ppm Bray-1 P in the 0–3, 3–6, and 0–6 in. depths, respectively). Crops were planted 30 in. apart, and the no-till planter had Yetter fertilizer attachments. Grain yield and P removal were measured from three of several P-rate treatments broadcast in the fall or planter-banded in spring (2 in. below and 2 in. beside the seeds). The selected P rates were a zero (control), 28, and 56 lb P_2O_5/acre/year (0-46-0 fertilizer). Soil was sampled from plots of the control and the 56-lb broadcast rate and was analyzed with Bray-1, Olsen, and Mehlich-3 methods. We show Bray-1 averages for the 0–6 in. depth because, although soil P was stratified in recent years, long-term trends were similar for the three methods and both sampling depths.

Summary Results

Long-term soil P trends. Figure 1 shows that soil P of non-fertilized plots decreased slowly over time by about 0.5 ppm/year on average. Soil P for the 56-lb rate varied greatly from year to year but on average was increased by 2.2 ppm/year. This is reasonable because this rate was greater than the measured P removal with harvest (45 lb P_2O_5/acre/year on average).

Long-term trends of grain yield and P removal. Grain yield, P concentration, and P removal trends over time are shown in Figure 2 for corn and Figure 3 for soybean. Small yield differences in the first five years were not statistically significant. Responses to P became larger thereafter as soil P of control plots decreased slowly into the Very Low class. The high P rate increased yield (statistically) over the low rate in two recent years. The placement methods differed only for soybean in one year, when the high band P rate increased yield over the high broadcast rate by 1.5 bushels/acre. However, smaller differences in favor of one or the other method in other years determined no average placement differences over time. The average responses to P over the control were 10 and 13 bushels/acre of soybeans and 36 and 47 bushels/acre of corn for the low and high rates, respectively.

Results in figures 2 and 3 show that the increasing grain P removal response over time was larger than for grain yield or P concentration. This was because it reflected smaller effects on these two measurements. There was a strong linear correlation between grain P removal and yield level for both crops but no relationship between grain P concentration and yield level (not shown). The large impact of yield level on P removal was due to the stronger effects of yield level variation than grain P concentration variation. The average grain P concentrations observed for well-fertilized corn and soybean (0.33 and 0.73 lb P_2O_5/bu, respectively) were slightly lower than average values assumed in Iowa (0.375 and 0.8 lb P_2O_5/bu, respectively, ISU extension publication Pm-1688). However, the assumed average values were within the observed range of values for both crops.

Conclusions

The results confirmed previous Iowa research results in showing that crop response to P fertilization is probable in low-testing soils and that the P placement method usually does not affect corn and soybean yield response to P fertilizer. The results also showed that good measures of yield are very important for estimating P removal over time.

Acknowledgements

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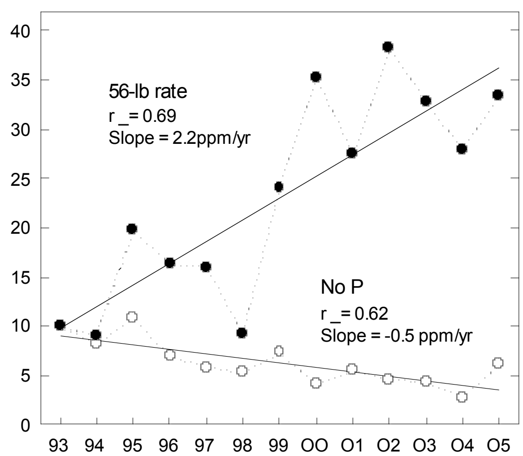

Figure 1. Soil-test P trends over time for rates of 0 and 56 lb P_2O_5/acre/year.

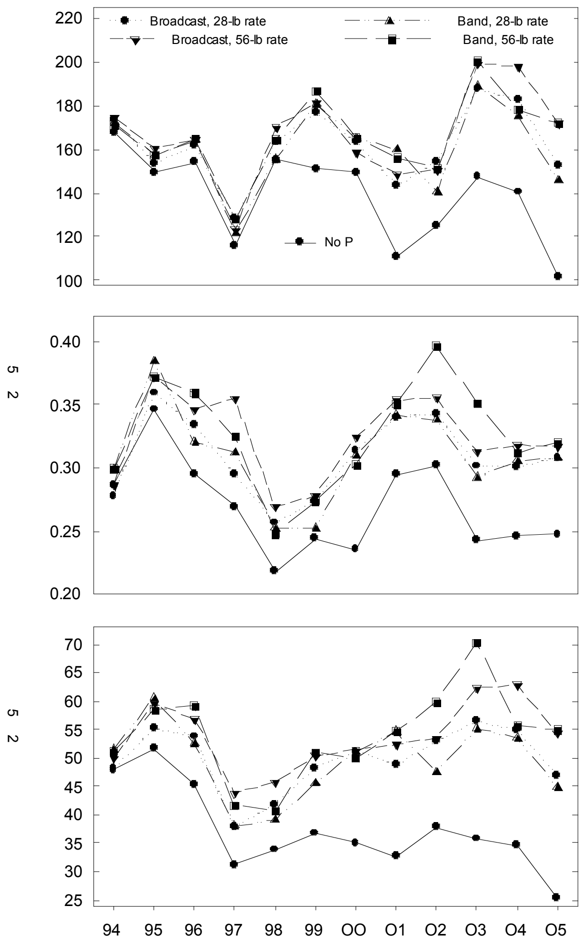

Figure 2. Trends over time for corn grain yield, grain P concentration, and P removal as affected by P rates and placement methods.

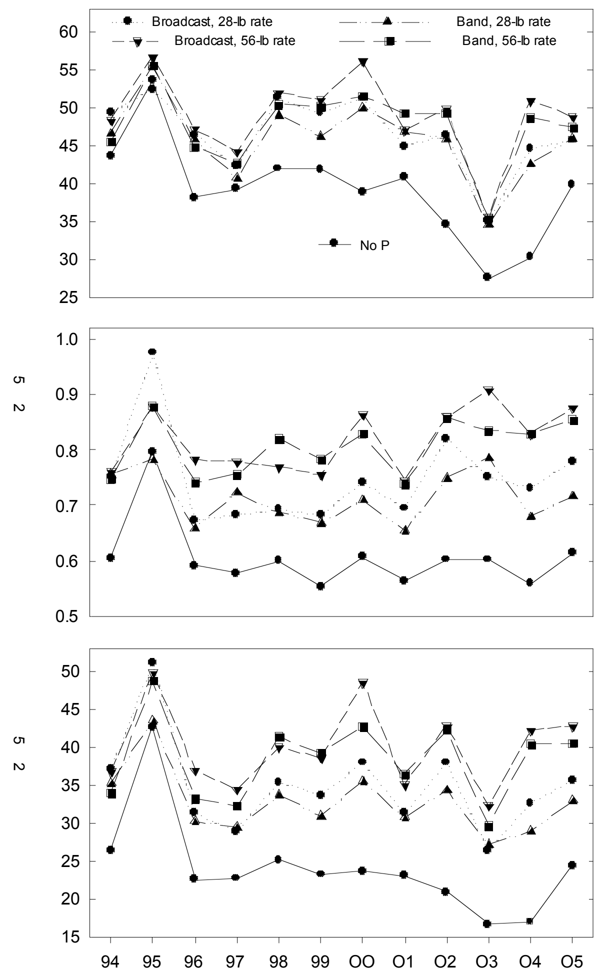

Figure 3. Trends over time for soybean grain yield, grain P concentration, and P removal as affected by P rates and placement methods.