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Long-term Phosphorus Fertilization for Corn-Soybean Rotations

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Abstract
A study was conducted from 1976 to 2002 to evaluate the effect of annual phosphorus (P) fertilization on soil P and yields of corn and soybeans. Both crops were grown each year in a rotation by alternating them between two halves of the area. Cornstalks were chisel-plowed in the fall and disked in the spring. Soybean residue was disked in spring. The Webster soil predominated, and there were small areas of Canisteo. Soil pH varied from 6.0 to 8.2. Less than 15% of the area had a pH of 7.3 or higher (calcareous).

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Disciplines
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Long-term Phosphorus Fertilization for Corn-Soybean Rotations

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Introduction

A study was conducted from 1976 to 2002 to evaluate the effect of annual phosphorus (P) fertilization on soil P and yields of corn and soybeans. Both crops were grown each year in a rotation by alternating them between two halves of the area. Cornstalks were chisel-plowed in the fall and disked in the spring. Soybean residue was disked in spring. The Webster soil predominated, and there were small areas of Canisteo. Soil pH varied from 6.0 to 8.2. Less than 15% of the area had a pH of 7.3 or higher (calcareous).

In spring 1975, P fertilizer was broadcast and incorporated into the soil to establish three contrasting soil-test P levels (STP1, STP2, and STP3). In spring 1976, soil-test P (Bray-1 test) was 17 (Optimum class), 43, and 75 ppm (both in the Very High class). Annual rates of 0, 23, 46, and 69 lb P_2O_5/acre (0-46-0) were applied from 1976 to 1996. Only the highest rate was applied form 1997 to 2002. All treatments were replicated four times.

Summary Results

Partial yield results have been presented in previous reports. This report focuses on trends of grain yield and soil-test P responses over time. Because yield levels varied over time, relative yields were calculated as the yield of each treatment expressed as the percentage of the maximum yield for each year. Maximum yield was defined as the average of the highest-yielding treatments according to statistical analyses.

Figures 1 and 2 show crop responses for years when all annual treatments were applied (until 1996). No crop responded to P during the first two years because soil-test P was Optimum or higher. Crops of the STP1 treatment began to show responses in the third year. Yield increases became larger over time as soil P of the checks decreased. Crops of the STP2 and STP3 treatments began to show responses after eight and 15 years of cropping.

Yield of plots that initially tested 17 ppm in P (STP1) were maximized with the 23-lb rate in early years and with the 46-lb rate in recent years (not shown). The 46-lb rate is near the rate recommended to maintain soil-test P for these yield levels. In plots that tested 43 ppm in P (STP3), the 46-lb rate was needed to maximize yield after 16 years. The 23-lb rate maximized yield in the few recent years when P fertilizer was needed for plots initially testing 75 ppm (STP3).

Figure 3 shows that the 46-lb annual fertilization rate maintained an Optimum level (STP1) but did not maintain a Very High level (STP2), although yield levels were similar. The Very High soil-test level of the STP2 treatment (43 ppm) decreased into the Low class after eight years of cropping without fertilization.

Conclusions

Phosphorus fertilization is profitable when used to increase soil-test P to the Optimum class (16-20 ppm) and maintain it in this class. Producers with high-testing fields can increase profits and reduce the risk of water quality impairment by withholding P fertilization or reducing rates until soil-test P decreases to levels that are profitable to maintain.

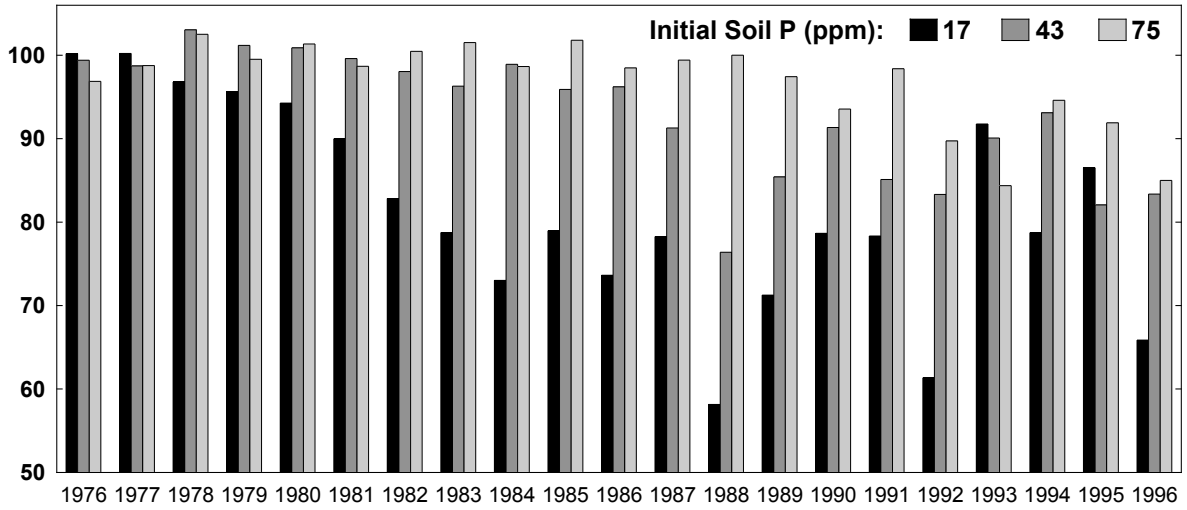

Fig. 1. Corn grain yield response to annual P fertilization during 21 years of cropping in rotation with soybeans for three field areas with contrasting soil-test P values (Bray-1 test).

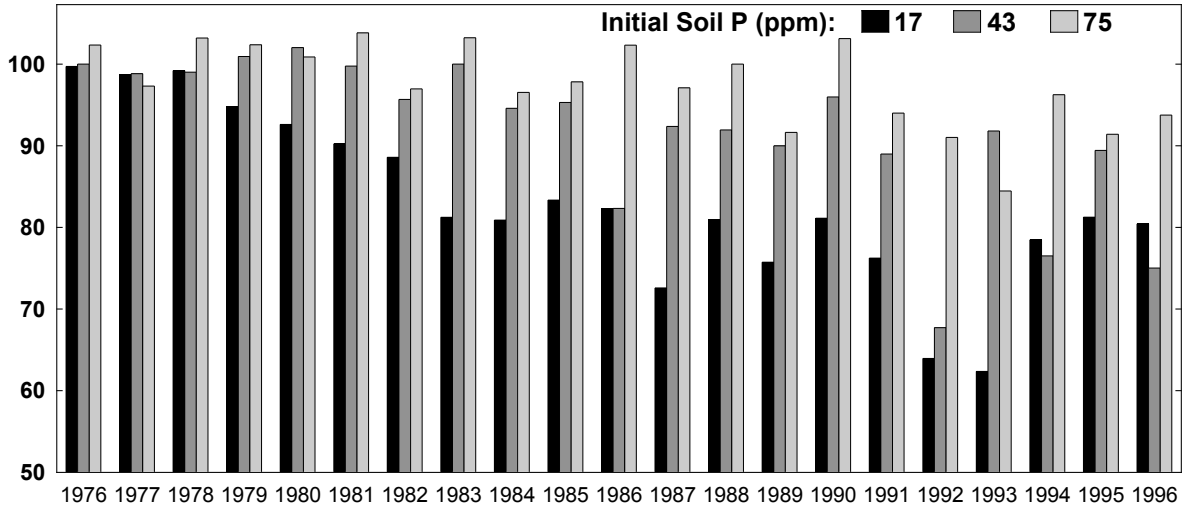

Fig. 2. Soybean grain yield response to annual P fertilization during 21 years of cropping in rotation with corn for three field areas with contrasting soil-test P values (Bray-1 test).

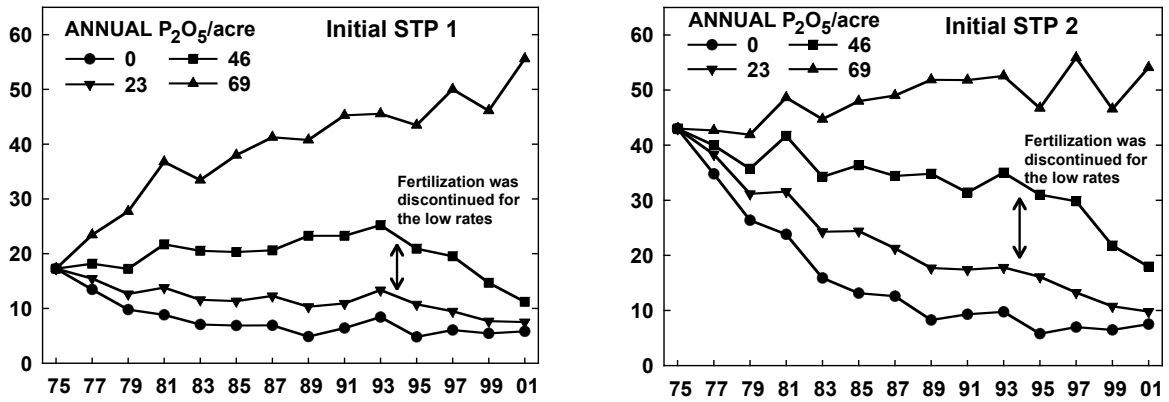

Fig. 3. Soil-test P trends over time for four annual P fertilizer rates for corn-soybean rotations on field areas with two initial values.