KANSAS

# Nitrogen and Phosphorus Management for Corn and Soybeans Grown in Rotation

By W.B. Gordon

This 42-year Kansas study demonstrates the benefit of starter phosphorus (P) fertilization, even on soils high in available P. Addition of starter P fertilizer increased yields, improved nitrogen (N) use efficiency, lowered N requirement, and hastened maturity of the corn crop.

Nitrogen and P management are critical in crop production for both economic and environmental reasons. Application of N and P has significant economic benefits, but can create unwanted water quality problems. Phosphorus fertilization is essential for optimum production of irrigated corn in central Kansas. Phosphorus is vital to plant growth and plays a key role in many plant physiological processes such as energy transfer, photosynthesis, breakdown of sugar and starches, and nutrient transport within the plant. Phosphorus is also known to enhance maturity of crops. Adequate P fertilization can help maximize corn grain yield and increase N use efficiency. A study was initiated in 1960 to assess the effects of applied N with or without P on corn and soybeans grown in annual rotation.

This 42-year experiment was conducted at the North Central Kansas Experiment Field, located near Scandia, on a Crete silt loam soil. The experimental area was ridge-tilled and furrow-irrigated. The treatments applied to corn consisted of five N rates (40, 80, 120, 160, and 200 lb/A) with or without 30 lb $P_2O_5$/A. An unfertilized check plot and a P only plot were also included. The experimental design was a two factor randomized complete block, replicated four times. The test area was arranged so that 12 corn rows were rotated with 12 adjacent soybean rows every year, thus each crop appears every year. The soybean crop received no fertilizer. Individual plots consist of 6 rows, 30 in. wide and 40 ft. long. Initial Bray P-1 in the top 6 in. of soil (1959) was high...80 parts per million (ppm). Anhydrous ammonia was

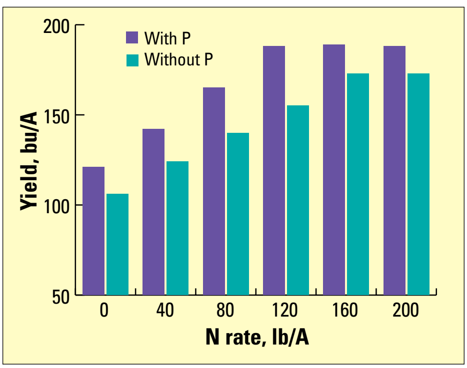


**Figure 1.** Corn grain yield as affected by N and P rate, 1960-2002.

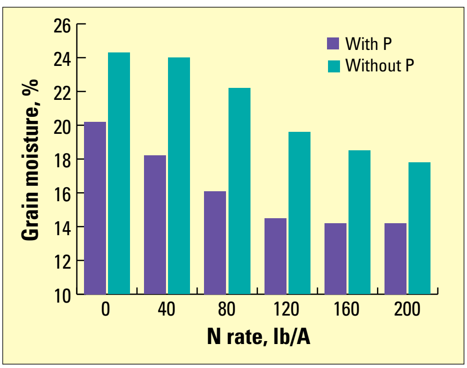


**Figure 2.** Grain moisture content at harvest as affected by N and P rate, 1960-2002.

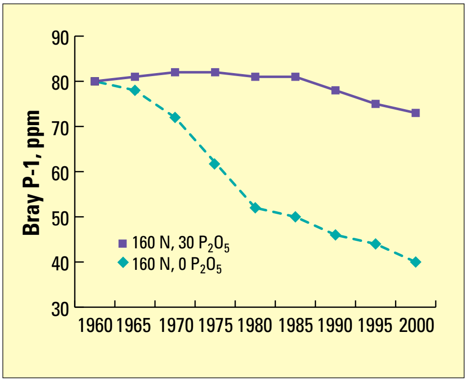


**Figure 3.** Soil test P changes over time at the 160 lb N/A rate with and without 30 lb $P_2O_5$/A.

**TABLE 1.** Nitrogen and P rate effect on number of thermal units from emergence to mid-silk, 1995-2002.

| N rate, lb/A | Without P | With P | Difference |
|---|---|---|---|
| | Thermal units to mid-silk | | |
| 0 | 1,386 | 1,290 | 96 |
| 40 | 1,362 | 1,280 | 82 |
| 80 | 1,320 | 1,210 | 110 |
| 120 | 1,318 | 1,208 | 110 |
| 160 | 1,318 | 1,210 | 108 |
| 200 | 1,316 | 1,210 | 106 |
| **Average** | **1,337** | **1,235** | **102** |

used as the N source and was applied 7 to 14 days before planting each year. Granular triple superphosphate (0-46-0) was used as the P source and was applied as a starter, 2 in. to the side and 2 in. below the seed at planting.

When averaged over the 42 years of this experiment, plots that received starter P yielded greater than the no P plots at all levels of N (**Figure 1**). Addition of P increased N fertilizer use efficiency. Maximum yield in the plots that received P was achieved with 120 lb N/A, while in the no-P plot yields continued to increase with increasing N rate up to 160 lb N/A.

Phosphorus plays an important role in seed development and can hasten crop maturity. **Figure 2** shows that application of starter P significantly reduced grain moisture at harvest. At the 120 lb N/A rate, grain moisture was reduced from nearly 20% without P to less than 15% with P. Maturity differences that were established early in the growing season persisted up to harvest. Phosphorus fertilizer reduced the number of thermal units needed to go from emergence to mid-silk at all levels of N (**Table 1**).

**A long-term study** in Kansas found favorable results with starter P in a corn-soybean rotation.

Applied P also improved the yield of soybeans grown in rotation with corn. When averaged over N rates and years, yield of soybeans with P was 61 bu/A and only 51 bu/A without P. Soybean yield was not affected by N applied to the previous year's corn crop.

Annual application of 30 lb $P_2O_5$/A maintained soil test P at near the initial level until about 1985 (**Figure 3**). Since then, soil P levels have declined. Corn grain yields were 11% greater for the period 1985-2002 than for 1960-1984. This indicates that the 30 lb $P_2O_5$ rate may not be keeping pace with the higher removal rate. Soil test P has declined to half of the original value in the no P plots. BC

*Dr. Gordon (e-mail: bgordon@oznet.ksu.edu) is with the Department of Agronomy, Kansas State University, Courtland, KS 66939.*