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Phosphorus and Potassium Fertilization of Corn and Soybeans Managed with No-till and Chisel-Plow Tillage

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Abstract
No-till management results in little or no incorporation of residues and fertilizers with soil. Broadcast fertilization could be inefficient with no-till because phosphorus (P) and potassium (K) accumulate near the soil surface. Banding fertilizers at shallow depths with the planter or deeper before planting could be more effective. A study was initiated in 1994 at this farm and at four other research farms to evaluate P and K fertilizer placement for corn and soybeans managed with no-till and chisel-plow tillage. The study consists of four separate trials: P for corn, P for soybeans, K for corn, and K for soybeans. Both crops are grown on Marshall soil in rotation by alternating crops each year between adjacent areas. The tillage and fertilization treatments are applied for both crops, which are planted with 30-in. row spacing. Cornstalks of plots managed with chisel-plow tillage are chisel plowed in the fall and field cultivated in spring, whereas soybean residues are only field cultivated in spring. The planter is equipped with row cleaners and dry fertilizer attachments.

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Introduction

No-till management results in little or no incorporation of residues and fertilizers with soil. Broadcast fertilization could be inefficient with no-till because phosphorus (P) and potassium (K) accumulate near the soil surface. Banding fertilizers at shallow depths with the planter or deeper before planting could be more effective. A study was initiated in 1994 at this farm and at four other research farms to evaluate P and K fertilizer placement for corn and soybeans managed with no-till and chisel-plow tillage. The study consists of four separate trials: P for corn, P for soybeans, K for corn, and K for soybeans. Both crops are grown on Marshall soil in rotation by alternating crops each year between adjacent areas. The tillage and fertilization treatments are applied for both crops, which are planted with 30-in. row spacing. Cornstalks of plots managed with chisel-plow tillage are chisel plowed in the fall and field cultivated in spring, whereas soybean residues are only field cultivated in spring. The planter is equipped with row cleaners and dry fertilizer attachments.

The fertilizer placement methods are broadcast, deep-band, or side-band with the planter. The broadcast and deep-band fertilizers are applied in the fall. Deep bands are applied 30 in. apart and 5 to 7 in. deep, and crop rows are placed on top of the coulter-knife tracks. Side bands are applied about 2 in. below and 2 in. to the side of the seeds. Fertilization rates are a check, an empty coulter-knife check, P and K rates slightly higher than one-half the maintenance needs (28 lb P_2O_5/acre or 35 lb K_2O/acre), and the P or K maintenance needs (56 lb P_2O_5/acre or 70 lb K_2O/acre). The coulter-knife check evaluates physical effects of the knives on crop yield and soil properties. Additional treatments use combinations of placements and one-time application of the two- year maintenance P or K rates.

Summary Results

Crop yields for the 2000 season were much lower than usual due to insufficient soil moisture. In 1999, corn matured prematurely due to a strong incidence of Southern leaf rust disease, and yields were very low.

Soybean yields have been similar for chisel-plow and no-till management with the notable exception of the dry 2000 season, when yields of no-till soybeans were 6 bu/acre higher on the average (Table 1). Corn yields have always been slightly higher for the chisel-plow tillage until 1998. In 1999, however, the average yield of no-till corn was 7 bu/acre higher than for corn managed with the chisel-plow tillage. Yields in 2000 followed the long-term trend, and yields were slightly lower with no-till. The higher yield of no-till corn in 1999 cannot be explained with certainty. The 1999 season was excessively wet, and corn managed with both tillage systems matured prematurely.

No crop has shown a significant yield response to P fertilization (Table 1). Soil-test P (0 to 6 in. depth) was in the upper Optimum interpretation class when the experiment began. By fall 1999, soil-test P of the check plots had decreased to the upper Low class, and plots that received a 56 lb P_2O_5/acre/year were in the High class. Although the P application method did not affect crop yield, banded P increased early growth and P uptake of both crops markedly (data not shown).

Potassium fertilization has increased corn and soybean yields inconsistently (Table 1). No response was expected because soil-test K has been Very High. Corn yield increases have ranged from zero to about 10 bu/acre and varied greatly across years, tillage systems, and placement methods. Soybean responded to K only in 1998 (about 2 bu/acre). The contrasting corn responses in the 1999 and 2000 seasons are good examples of the variation observed. The larger responses often corresponded to seasons with insufficient soil moisture, but this has not always been the case. Corn yield averages across all years show a very small advantage for the deep-band placement that is followed by the broadcast placement, mainly due to larger differences in two years. The deep-band effect includes any zone tillage effects due to planting onto the fall-applied coulter-knife track.

Conclusions

The tillage method seldom influenced soybean yield, but no-till was better in the 2000 season. Average corn yields have been only slightly lower for no-till. There has been little or no response to P fertilization or to the P placement method probably because soil-test P has been within the Optimum class. Large effects of banded P in early growth (especially in corn) did not translate into higher grain yield. Potassium fertilization has produced unexpected but highly variable responses (mainly of corn) in this high-testing soil. Maximum yields were always achieved with the lowest K rate when it was broadcast or deep banded. Larger responses to deep-band K have been observed at other locations. A new research project is investigating the reasons for responses to K fertilizer in some high-testing soils.

Table 1. Effects of tillage and phosphorus and potassium fertilization on corn and soybean yields.

		Phosphorus Experiment Placement Method				Potassium Experiment Placement Method			
Tillage	Year	Check	Broadcast	Deep-band	Planter-band	Check	Broadcast	Deep-band	Planter-band
		Corn yield (bu/acre)							
Chisel	1999	127	128	129	129	126	120	124	118
	2000	146	152	148	149	144	156	152	150
	7 years	161	165	163	163	156	161	162	158
No-till	1999	139	134	138	140	127	129	126	122
	2000	145	147	146	146	142	154	147	153
	7 years	161	160	161	159	152	157	158	154
		Soybean yield (bu/acre)							
Chisel	1999	62.1	64.5	62.7	63.1	62.2	61.4	62.6	62.1
	2000	39.6	40.2	40.9	39.8	41.4	41.4	41.3	44.7
	7 years	54.0	54.7	55.1	54.1	54.8	53.9	54.8	55.7
No-till	1999	62.3	61.6	61.2	62.2	62.3	63.4	62.8	62.7
	2000	43.8	44.2	43.1	45.1	50.5	48.9	49.2	51.2
	7 years	55.2	55.5	55	55.5	55.7	55.8	55.6	56.0