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Phosphorus and Potassium Placement for Corn and Soybeans Managed with No-till and Chisel-Plow Tillage

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Abstract
Extensive research on this research farm during the last three decades has provided valuable information about phosphorus (P) and potassium (K) fertilization for corn and soybeans managed with chisel-plow tillage. No-till management results in little or no incorporation of residues and fertilizers with soil. Broadcast fertilization could be inefficient with no-till because P and K accumulate near the soil surface. Banding fertilizers with the planter or deeper before planting could be more effective. A study was initiated in 1994 at this location and at other research farms to evaluate P and K fertilizer placement for 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. Corn and soybeans are grown in a rotation by alternating crops each year between adjacent areas of mainly Floyd and Clyde soils. The tillage and fertilization treatments are applied for both crops, which are planted with 30-inch 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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Phosphorus and Potassium Placement for Corn and Soybeans Managed with No-till and Chisel-Plow Tillage

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Introduction

Extensive research on this research farm during the last three decades has provided valuable information about phosphorus (P) and potassium (K) fertilization for corn and soybeans managed with chisel-plow tillage. No-till management results in little or no incorporation of residues and fertilizers with soil. Broadcast fertilization could be inefficient with no-till because P and K accumulate near the soil surface. Banding fertilizers with the planter or deeper before planting could be more effective. A study was initiated in 1994 at this location and at other research farms to evaluate P and K fertilizer placement for 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. Corn and soybeans are grown in a rotation by alternating crops each year between adjacent areas of mainly Floyd and Clyde soils. The tillage and fertilization treatments are applied for both crops, which are planted with 30-inch 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 inches apart and 5 to 7 inches deep, and crop rows are placed on top of the coulter-knife tracks. Side bands are applied about 2 inches below and 2 inches 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 apply the two-year maintenance P or K rates.

Summary Results

Corn yields for the 1999 and 2000 seasons were high and above long-term averages. Soil moisture was adequate or excessive in both years.

Soybean yields have been similar for chisel-plow and no-till management since the experiment began, and the last two years were no exception (Table 1). Corn yields have always been higher for the chisel-plow tillage. The advantage of the chisel-plow tillage has varied greatly over time, however, and the difference between the 1999 and 2000 seasons well represent that variation. Corn managed with chisel-plow tillage yielded about 11 bu/acre more than corn managed with no-till in 1999 but only about 3 bu/acre more in 2000. The 7-year average difference was 6 bu/acre.

No crop has shown a significant yield response to P fertilization (Table 1). Soil-test P (0 to 6 inches depth) was within the Very High interpretation class when the experiment began. By fall 1999, soil-test P of the check plots had decreased to the High class, and plots that received a 56 lb P_2O_5/acre/year had remained in the Very 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 did not influence corn and soybean yields until 1996. Very small responses began to be observed in 1997 and have become larger since 1999 for both crops and tillage systems (Table 1). This responsive trend (about 5 bu/acre in 1999 and 8 bu/acre in 2000 for corn, and about 2 bu/acre in 1999 and 4 bu/acre in 2000 for soybeans) is reasonable because soil-test K was High in 1994 and had decreased to the lower part of the Optimum class by fall 1999. Iowa State University recommends maintenance fertilization when soil K is in the Optimum class.

The fertilizer placement methods have differed significantly only for K and for no-till corn until 1998, when the deep-band K produced slightly larger yield increases. No differences were observed during the last two years, however, probably because soil moisture was adequate or excessive. The long-term average shows a very small advantage for the deep-band K placement of 2 bu/acre. This small deep-band effect includes zone tillage effects due to planting on top of the fall-applied coulter-knife track.

Conclusions

The tillage method seldom influenced soybean yield, but corn yields have been slightly lower for no-till than for the chisel-plow tillage. There has been no response to P fertilization or to the P placement method, probably because soil P has been within the High class. Large effects of banded P in early growth (especially in corn) did not translate into higher grain yield. Potassium fertilization began to produce small responses once soil-test K of the checks fell into the lower part of the Optimum class. Maximum yields were always achieved with the lowest K rate. The placement methods have not differed significantly, except for a small advantage of deep-band K for no-till corn.

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

		Phosphorus Experiment				Potassium Experiment			
			Placement Method				Placement Method		
Tillage	Year	Check	Broadcast	Deep-band	Planter-band	Check	Broadcast	Deep-band	Planter-band
		Corn yield (bu/acre)							
Chisel	1999	185	181	180	184	178	185	183	179
	2000	175	174	174	170	168	180	176	177
	7 years	163	160	162	160	156	161	160	161
No-till	1999	167	169	171	165	168	173	174	174
	2000	172	172	172	173	167	176	174	172
	7 years	152	155	155	154	152	154	156	154
		Soybean yield (bu/acre)							
Chisel	1999	53.6	53.7	53.6	54.6	51.3	53.8	53.6	54.3
	2000	56.5	57.6	58.2	58.9	55.2	57.0	58.6	58.1
	7 years	56.5	56.7	56.8	57.2	54.2	55.6	55.9	56.0
No-till	1999	55.1	52.9	53.0	53.6	52.3	53.1	53.5	53.9
	2000	56.9	58.3	56.4	57.9	52.7	57.0	59.0	57.2
	7 years	55.8	56.4	55.4	56.5	54.1	56.2	56.6	55.9