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

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Abstract
Iowa research has provided much information about P and K management for corn and soybeans, but it has been mostly based on broadcast fertilization for tilled soils. No-till management results in little or no incorporation of residues and fertilizers with soil. Subsurface banding of phosphorus (P) and potassium (K) fertilizers with planter attachments or before planting could be more effective because both nutrients accumulate at or near the soil surface. A long-term study was initiated in 1994 at this farm and at other farms to evaluate P and K fertilizer placement for corn and soybeans managed with no-till and chisel-plow tillage.

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Introduction

Iowa research has provided much information about P and K management for corn and soybeans, but it has been mostly based on broadcast fertilization for tilled soils. No-till management results in little or no incorporation of residues and fertilizers with soil. Subsurface banding of phosphorus (P) and potassium (K) fertilizers with planter attachments or before planting could be more effective because both nutrients accumulate at or near the soil surface. A long-term study was initiated in 1994 at this farm and at other farms to evaluate P and K fertilizer placement for corn and soybeans managed with no-till and chisel-plow tillage.

Procedures

The study consists of four separate trials: P for corn, P for soybeans, K for corn, and K for soybeans. The experimental area is on Galva and Primghar soils that had a 2-year no-till management history. 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 the spring, whereas soybean residues are field-cultivated in the spring. The planter is equipped with row cleaners and dry fertilizer attachments. The fertilizer placement methods are broadcast, deep-band, or banded with the planter. The broadcast and deep-band fertilizers are applied in the fall. Deep bands are applied 30 inches apart and 5–7 inches deep, and crop rows are placed on top of the coulter-knife tracks. The deep-band treatment was discontinued after the 2002 season. Planter bands are applied about 2 inches below and 2 inches beside the seeds. Fertilizer rate treatments include a check, a coulter-knife check, and rates of P and K supplying about one-half the annual maintenance needs (28 lb P_2O_5/acre or 35 lb K_2O/acre) and full maintenance needs (56 lb P_2O_5/acre or 70 lb K_2O/acre). Other treatments are combinations of placements and one-time application of the 2-year maintenance rates.

Summary Results

Deficient soil moisture in recent years reduced yields of corn and soybeans on this farm, mainly in 2001 and 2002. Soybean yields have been similar for the two tillage systems over the years. In contrast, corn yields have been higher for chisel-disk tillage. Yields of no-till corn have been 6–7 bushels/acre lower.

Phosphorus fertilization has increased corn and soybean yields markedly (Table 1), and yield increases have been proportionally similar for no-till and chisel-disk tillage. The large yield responses to P fertilization are not surprising because soil-test P of the experimental area was low in 1994, and soil P of the control plots had decreased to the Very Low range by fall 1997. The P placement method has not affected grain yield of any crop, and this lack of difference was similar for all P rates used. However, banded P greatly increased early growth of both crops (data not shown).

Although in the early years of the study soil-test P was low, there were no statistical

differences between P rates applied until 2000. Since 2001, however, the high annual rate (56 lb P_2O_5/acre, or twice this amount every other year) has increased yield further than the lower rate (28 lb P_2O_5/acre). This result is reasonable because the low rate could not maintain soil P levels. The 56-lb rate increased soil P to the Optimum class by the late 1990s and to the High class by fall 2002.

Potassium fertilization has not influenced soybean yield, and has resulted in small and infrequent corn yield increases (Table 1). Small responses were expected because soil-test K was High in 1994. By fall 2002, soil K of the check plots had decreased to values within the Optimum class (146 ppm on average, ammonium acetate test) whereas soil K of plots that received 56 lb P_2O_5/acre/year remained in the High class. Corn yield responses to K have ranged from zero to about 8 bushels/acre across years, and varied greatly across tillage systems and placement methods. No-till corn responses to deep-band K have been slightly greater than for the other placement methods, even in recent years of low, drought-affected yield levels. The deep-band effect includes any zone tillage effect due to planting onto the fall-applied coulter-knife track.

Conclusions

Soybean yields have been similar for no-till and chisel-disk tillage systems. However, no-till management has resulted in lower yields than chisel-disk tillage over the years. Banding of P or K fertilizer has not consistently reduced this yield difference.

Phosphorus fertilization has produced large crop yield increases in this low-testing soil. An annual rate of 28 P_2O_5/acre was sufficient to maximize yield during the early years, but the 56-lb rate (or twice this amount applied every other year) produced higher yields. Large effects of banded P on early crop growth (especially in corn) did not translate into higher grain yields. Potassium fertilization has produced small and highly variable yield increases. Deep-banded K has been slightly better than broadcast or planter-band K, particularly for no-till corn.

Table 1. Effects of tillage, fertilizer placement method, and annual phosphorus and potassium rates on corn and soybean grain yields during a 9-year period.

		Phosphorus placement and rate (lb P_2O_5/acre)							Potassium placement and rate (lb K_2O/acre)						
			Broadcast		Deep band[†]		Planter band			Broadcast		Deep band		Planter band	
Period	Tillage	Check	28	56	28	56	28	56	Check	35	70	35	70	35	70
		Soybean grain yield (bu/acre)													
1994-2000	Chisel	35.0	41.3	41.9	41.3	42.1	41.3	42.7	40.1	40.7	39.7	40.7	41.4	40.3	40.3
	No-till	35.5	40.9	43.2	41.4	42.4	41.9	43.1	40.6	41.2	40.7	41.5	41.9	41.0	41.5
2001-2002	Chisel	35.4	44.1	46.4	44.3	45.2	44.5	47.4	39.3	38.5	38.3	38.7	39.8	38.4	38.5
	No-till	31.8	42.1	44.8	41.5	44.6	42.4	43.5	38.9	39.5	38.8	39.2	39.8	38.7	39.9
		Corn grain yield (bu/acre)													
1994-2000	Chisel	119	138	143	137	143	140	146	136	139	140	143	139	140	140
	No-till	102	133	139	131	138	135	139	132	133	133	131	135	132	133
2001-2002	Chisel	111	129	142	134	136	135	140	126	130	128	131	132	129	129
	No-till	92	128	133	131	129	129	133	116	125	122	126	124	115	120

[†] The deep-band treatment was discontinued in fall 2001, and residual effects were evaluated in 2002.