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Broadcast and Band Phosphorus and Potassium Placement for Corn and Soybean Managed with Till or No Till

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Abstract
No-till minimizes the incorporation of crop residue and fertilizer with soil; resulting in wetter, colder soils and the accumulation of organic matter, phosphorus (P), and potassium (K) near the soil surface. Banding of P and Kcould be more effective than broadcast fertilization by counteracting stratification, applying nutrients in the root zone (starter effect), and minimizing reactions with the soil that may reduce their availability to plants. Therefore, a long-term study was established in 1994 to evaluate P and K fertilizer rates and placement methods for grain yield of corn and soybean managed with no-till and chiselplow/disk tillage.

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Introduction

No-till minimizes the incorporation of crop residue and fertilizer with soil; resulting in wetter, colder soils and the accumulation of organic matter, phosphorus (P), and potassium (K) near the soil surface. Banding of P and K could be more effective than broadcast fertilization by counteracting stratification, applying nutrients in the root zone (starter effect), and minimizing reactions with the soil that may reduce their availability to plants. Therefore, a long-term study was established in 1994 to evaluate P and K fertilizer rates and placement methods for grain yield of corn and soybean managed with no-till and chisel-plow/disk tillage.

Materials and Methods

The study consists of separate P and K trials on areas with Marshall soil at the ISU Armstrong Research Farm, Lewis, Iowa. Corn and soybean were planted using a 30-in. row spacing on adjacent areas with identical design. A complete rotation included alternating corn and soybean each year. The tillage consists of chisel-plowing cornstalks in the fall and disking for both crop residues in the spring. The fertilizer placement methods were broadcast, deep-band, and band with the planter until 2001, when deep-banding was discontinued. Broadcast fertilizers were applied in the fall, and planter-bands were applied 2 in. below and beside the seeds. The fertilizer rates were zero (P control), 28 or 56 lb P_2O_5 per acre/year, and zero (K control), 35 or 70 lb K_2O/acre/year. Additional treatments included applying twice the high fertilization rate that was broadcast in the fall every other year before corn or soybean, combining planter-band and broadcast methods using the low rate for each method, and annual broadcast rates of 112 lb P_2O_5/acre or 140 lb K_2O/acre.

Summary Results

Tillage Effects. Soybean grain yield seldom has been affected by tillage. Corn grain yield often has been higher with tillage than with no-till in normal or wet years, but has been higher with no-till in very dry years. Therefore, long-term yield averages show little or no difference between tillage systems. Calculations for corn plots fertilized with the high P and K rates (Tables 1 and 2) showed that yield differences for the 18-year period and for the last two years were one bushel/acre or less. In some years, however, differences between tillage systems were as high as 15 bushels/acre. These results clearly confirm the need for long-term research.

Phosphorus Effects. Initial soil-test P was in the Optimum interpretation class, values for the control plots decreased to Low in 2003 and to Very Low in 2010. Therefore, yield response to applied P has been increasing over time. The average increase in corn yield with the high P rate for the 18-year period was 4 and 5 bushels/acre for tillage and no-till, respectively (Table 1). The difference in yield increased to 9 and 16 bushels/acre for the last two years. Differences in soybean yield were much less, however, and yield increases ranged from 3 to 5 bushels/acre. Interestingly, results from the last two years show the high P rate was needed to maximize corn yield with no-till, but the low rate maximized yield with tillage (Table 1). This result was not observed

for soybean, or in previous years for corn. The P application method has not significantly affected grain yield (Table 1). Results up to 2001 showed no differences between broadcast, deep-band, or planter-band methods for any crop or tillage. Since then, soybeans have shown no yield differences and corn has shown very small and inconsistent differences. On average for the 18-year period, corn yield was slightly higher with broadcast P than with planter-band P for both tillage systems (2 and 0.5% higher for the low and high rates, respectively). In the last two years for the high P rate, the advantage for broadcast P was greater than planter-band P (3% higher with tillage and 5% higher with no-till). The planter-band 56-lb rate decreased yield slightly compared with the low planter-band rate or the high broadcast rate. In low and deficient P rates, yield of no-till corn was 2 percent higher with the planter-band compared with broadcast. Applying twice the high P rate before corn or soybean every other year or a combination of broadcast and planter-band P did not differ from the broadcast high P rate (Table 1). Studies at other research farms or farmers' fields also showed no grain yield differences between P placement methods.

In sharp contrast to results for grain yield, planter-band P has greatly increased early crop growth, especially for no-till corn (not shown). Therefore, the results show how misleading the effects of planter-band P on early corn growth can be, because banding did not result in higher yield, except occasionally with low and insufficient application rates.

Potassium Effects. The initial soil-test K was in the High class. Over the course of the study, the control plots have only decreased to a value borderline between Optimum and High. Therefore, K additions for any crop or tillage system resulted in small to no grain increases (Table 2). However, small increases began to be observed in recent years for corn. In the last two years, the yield increase with the high K rate was 2 and 6 bushels/acre with tillage and no-till, respectively. The small but greater yield increase for no-till is interesting because it agrees with results observed for P.

The grain yield response to K placement methods has been small and inconsistent for both tillage systems. Results up to 2001 occasionally showed a small advantage for deep-band K for no-till corn. In the last two years there was no clear difference for any crop, tillage system, or K rate. Calculations from yields in Table 2 for corn indicate no difference or up to a 3 percent advantage for broadcast K, even for no-till corn. Applying twice the high K rate before corn or soybeans every other year or a combination of broadcast and planter-band K did not differ from the annual high broadcast K rate (Table 2). In contrast to results for P, planter-band K seldom increased, and sometimes decreased, early crop growth (not shown). Studies at other research farms or farmers' fields with lower soil-test K levels also showed small or no differences for broadcast and planter-band placement methods. However, these other studies have always shown a benefit from deep-band K for ridge-till corn and soybeans, but only occasionally for no-till or strip-till.

Results for the highest annual broadcast P or K rates (112 lb P_2O_5 or 140 lb K_2O) are not shown because they did not increase yield compared with the lower rates.

Conclusions

Soybean grain yield has not been different for no-till and chisel-plow/disk systems. Corn grain yield has been similar or higher with tillage in normal to wet years, but has been higher with no-till in dry years. This has resulted in no significant differences in grain yield over the term of the study. The broadcast and planter-band P or K placement methods have not affected grain yield of corn or soybeans significantly.

Table 1. Phosphorus fertilizer effects on crop yield at the ISU Armstrong Research Farm, Lewis, Iowa.

			Placement Method and lb P_2O_5/acre †					
			Broadcast			Planter Band		B+S
Period	Tillage	Control	28an	56an	112bia	28an	56an	56an
		---------- Corn yield (bu/acre) ----------						
18 years	Chisel	163	168	167	169	165	166	167
	No-till	161	167	167	166	163	166	166
2010-11	Chisel	165	177	176	177	177	171	173
	No-till	155	167	175	173	171	167	169
		---------- Soybean yield (bu/acre) ----------						
18 years	Chisel	64.6	67.3	67.2	67.7	67.0	67.3	67.8
	No-till	65.1	68.8	69.6	70.1	69.5	69.5	69.2
2010-11	Chisel	62.5	67.9	67.7	68.1	67.7	66.6	67.7
	No-till	63.8	67.2	68.8	69.6	66.2	67.0	68.7

†B+S, 28-lb rate broadcast plus 28-lb rate banded with the planter; 28an and 56an, annual rates; 112bia, twice the 56-lb rate applied every other year before corn or soybean.

Table 2. Potassium fertilizer effects on crop yield at the ISU Armstrong Research Farm, Lewis, Iowa.

			Placement Method and lb K_2O/acre †					
			Broadcast			Planter Band		B+S
Period	Tillage	Control	35an	70an	140bia	35an	70an	70an
		---------- Corn yield (bu/acre) ----------						
18 years	Chisel	174	174	178	177	175	175	182
	No-till	175	178	179	179	181	176	183
2010-11	Chisel	168	175	172	171	170	169	170
	No-till	165	169	174	173	163	168	169
		---------- Soybean yield (bu/acre) ----------						
18 years	Chisel	54.4	53.0	53.5	53.6	54.7	53.9	53.7
	No-till	57.0	56.2	56.1	55.7	57.2	56.3	56.3
2010-11	Chisel	68.7	66.2	64.2	64.5	68.5	65.7	68.5
	No-till	67.3	65.9	64.6	64.1	68.9	66.5	66.4

†B+S, 35-lb rate broadcast plus 35-lb rate banded with the planter; 35an and 70an, annual rates; 140bia, twice the 70-lb rate applied every other year before corn or soybean.