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# Placement Methods of Phosphorus and Potassium for Corn and Soybean Managed with No-till and Chisel-plow/Disk Tillage

## **Abstract**

No-till management limits 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, this long-term study was established in 1994 to evaluate P and K fertilizer placement methods and grain yield of corn-soybean rotations managed with no-till and chisel-plow/disk tillage.

## **Keywords**

RFR A1196, Agronomy

## **Disciplines**

Agricultural Science | Agriculture | Agronomy and Crop Sciences

# Placement Methods of Phosphorus and Potassium for Corn and Soybean Managed with No-till and Chisel-plow/Disk Tillage

RFR-A1196

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## Introduction

No-till management limits 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, this long-term study was established in 1994 to evaluate P and K fertilizer placement methods and grain yield of corn-soybean rotations managed with no-till and chisel-plow/disk tillage.

## Procedures

The study consists of separate P and K trials on areas where Webster soil predominates but there are small areas of Canisteo soil. Corn and soybean were planted using a 30-in. row spacing on adjacent areas with identical design. Corn and soybean crops switch each year to complete a rotation over time. The tillage consisted of chisel-plowing plots with cornstalks in the fall and field cultivation for both crop residues in the spring. 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 2 in. beside the seeds. The fertilizer rates were zero (P control), 28 or 56 lb

P<sub>2</sub>O<sub>5</sub>/acre/year, and zero (K control), 35 or 70 lb K<sub>2</sub>O/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<sub>2</sub>O<sub>5</sub>/acre or 140 lb K<sub>2</sub>O/acre.

## Summary Results

*Tillage Effects.* Soybean grain yield was seldom affected by tillage. Corn grain yield often was higher with tillage than with no-till, however, the differences were smaller in very dry years. Therefore, long-term yield averages show a corn yield advantage for management with tillage. Calculations for plots fertilized with the high P and K rates (from Tables 1 and 2) showed that yield differences for the 18-year period were 10 bushels/acre for corn but only 2 bushels/acre for soybean. In the last two rather wet years, however, the average yield advantage for tillage was 19 bushels/acre for corn and 2 bushels/acre for soybean. These results clearly confirm the need for long-term research.

*Phosphorus Effects.* Initial soil-test P was in the upper Low interpretation class (12 ppm, Bray-1) but values for the plots receiving no P decreased to the Very Low range by fall 2004 (5 ppm). Therefore, yield response to applied P increased over time. The average increase in corn yield with the high P rate for the 18-year period was 31 and 34 bushels/acre with tillage and no-till, respectively (Table 1). The difference in yield was less in the last two years probably because of excess moisture. The soybean yield increases due to P application also were large, and ranged from

10 to 12 bushels/acre for the 18-year and the last-two-year periods. The results for corn show the yield increase with high P rate was small compared with the low P rate with tillage, but was large with no-till (Table 1). This result was not observed for soybean, and was not apparent for corn in early years.

The P application method has not significantly affected grain yield of corn or soybean managed with or without tillage (Table 1). Results up to 2001 showed no consistent yield differences between broadcast, deep-band, or planter-band P for any crop or tillage; and no difference was observed since then between broadcast and planter-band methods. 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 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 or insufficient application rates).

*Potassium Effects.* Crop response to K also was observed since the early years of the study, because initial soil-test K was in the upper range of the Low category (124 ppm). The yield response has been larger in recent years, although soil-test K of control plots has not decreased into the Very Low category.

The average corn yield increase with the high K rate for the 18-year period was 25 and 34 bushels/acre for tillage and no-till, respectively (Table 2). In the last two years, the yield increase was smaller with tillage but much larger with no-till, which could be explained by excess moisture in spring. The

greater yield increase for no-till corn is interesting because it agrees with results observed for P. The soybean yield increases due to K application were large, and ranged from 7 to 10 bushels/acre for the 18-year and also the last-two year periods.

Until 2001, when the deep-band treatment was discontinued, the K placement method had little or no effect on yield of crops managed with tillage. However, banded K (mainly deep-band) resulted in slightly higher average yield of no-till corn than broadcast K. Since then, results have shown very small and inconsistent advantage for either the broadcast or planter-band methods. Calculations from yields in Table 2 for the 18-year period indicate that corn and soybean yield with tillage was 1.4 and 3.7 percent higher for broadcast K, but with no tillage was 2.1 and 2.4 percent higher for planter-band K. Studies at other research farms or farmers' fields have shown no large consistent differences for broadcast or planter-band K placement methods. However, the other studies have shown a consistent 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<sub>2</sub>O<sub>5</sub> or 140 lb K<sub>2</sub>O) are not shown because these did not increase yield further compared with the lower rates.

### Conclusions

Corn grain yield has been higher with tillage compared with no-till in most years of the study. Soybean grain yield did not differ between no-till and chisel-plow/disk systems. There have been large corn and soybean yield responses to P and K fertilization managed with tillage or no-tillage, but differences between the broadcast and planter-band placement methods have been small and inconsistent over time.

**Table 1. Phosphorus fertilizer effects on crop yield.**

Period	Tillage	Placement method and lb P <sub>2</sub> O <sub>5</sub> /acre†						
		Control	Broadcast			Planter band		B+S
			28an	56an	112bia	28an	56an	56an
----- Corn yield (bu/acre) -----								
18 years	Chisel	138	167	170	169	165	170	170
	No-till	125	153	159	160	153	160	162
2010-11	Chisel	138	165	163	168	169	168	166
	No-till	123	141	144	148	144	148	144
----- Soybean yield (bu/acre) -----								
18 years	Chisel	38.7	48.8	49.4	49.1	48.1	49.7	49.7
	No-till	35.8	45.1	47.9	46.2	44.7	46.1	46.1
2010-11	Chisel	38.3	50.1	49.9	50.0	49.1	51.2	50.8
	No-till	37.4	45.8	48.1	45.6	47.6	46.7	46.0

† 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.**

Period	Tillage	Placement method and lb K <sub>2</sub> O/acre †						
		Control	Broadcast			Planter band		B+S
			35an	70an	140bia	35an	70an	70an
----- Corn yield (bu/acre) -----								
18 years	Chisel	146	171	171	169	169	169	174
	No-till	127	156	160	164	159	163	160
2010-11	Chisel	153	170	167	164	167	169	172
	No-till	102	141	147	145	155	153	144
----- Soybean yield (bu/acre) -----								
18 years	Chisel	40.7	46.6	49.3	47.8	46.2	46.1	48.2
	No-till	36.5	43.1	44.8	47.7	44.1	46.0	44.4
2010-11	Chisel	40.9	47.9	51.2	47.5	45.7	44.9	49.1
	No-till	36.8	45.0	46.4	49.1	45.0	48.1	46.3

† 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.