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Tillage System and Fertilizer Placement Methods for Corn and Soybean Production

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Abstract
No-till management results in little or no incorporation of crop residues and fertilizer with soil. Subsurface banding phosphorus (P) and potassium (K) fertilizers with planter attachments or before planting could be more effective than broadcast fertilization because both nutrients accumulate at or near the soil surface. A long-term study was initiated in 1994 to evaluate P and K fertilizer placement for corn and soybean managed with no-till and chisel-plow tillage.

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Tillage System and Fertilizer Placement Methods for Corn and Soybean Production

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Introduction

No-till management results in little or no incorporation of crop residues and fertilizer with soil. Subsurface banding phosphorus (P) and potassium (K) fertilizers with planter attachments or before planting could be more effective than broadcast fertilization because both nutrients accumulate at or near the soil surface. A long-term study was initiated in 1994 to evaluate P and K fertilizer placement for corn and soybean managed with no-till and chisel-plow tillage.

Materials and Methods

The study consisted of separate trials for P and K on an area with Galva and Primghar soils. Tillage and fertilizer treatments were applied for both crops, which are grown each year on adjacent field areas and are planted with a 30-in. row spacing. The tillage involves chisel-plowing cornstalks in the fall and disking in spring, and disking soybean residue in spring only. The planter has row cleaners and granulated fertilizer attachments. Fertilizer placement methods were broadcast, deep-band, and planter-band until 2000, when deep banding was discontinued. Results for all methods were summarized in a previous report, so only broadcast and planter-band methods data are included in this report.

The broadcast fertilizers are applied in the fall, and planter bands are placed 2 in. below and 2 in. beside the seeds at planting. Fertilizer rates for each method have been a control, one-half the estimated annual maintenance rate (28 lb P_2O_5/acre or 35 lb K_2O/acre), and twice these amounts (56 lb P_2O_5/acre or 70 lb K_2O/acre) broadcast annually or only once before corn or soybean. Other treatments include combining band and broadcast methods and (since 2001) annual application of 112 lb P_2O_5/acre or 140 lb K_2O/acre. Data for 2004 were not included in the averages shown because a hailstorm severely reduced crop yield.

Results and Discussion

Corn yield has been consistently higher with tillage than with no-till for all treatments, but tillage has not affected soybean yield. The difference for corn across fertilized treatments shown in Tables 1 and 2 was 8 bushels/acre for the 16-year period and 18 bushels/acre for the last two years. The yield difference has been smaller in dry years, and about average in 2008, but very large in 2009. The larger difference in 2009 was explained by very cool temperatures during the season. The no-till corn was 6 to 8 in. shorter during most of the season. Previous reports for this study have shown that zone tillage done with deep-banding fertilizer and planting corn on top of the knife tracks (a treatment discontinued in 2000) increased corn yield but never reached levels resulting from chisel-plow tillage.

Phosphorus has greatly increased grain yield (Table 1) because the initial soil-test P was low, and for the control plots decreased to the Very Low class in the late 1990s. The relative yield increases due to P have been similar for the two tillage systems. In the early years there were no differences between the P rates, but since 2000 the low rate (28 lb P_2O_5/acre) has increased yield less than higher rates and the difference keeps increasing. The 56-lb annual rate had increased soil-test P to the

optimum class by the late 1990s and to the High class by 2006. Planter-band P has increased early crop growth more than broadcast P, especially for corn (not shown). In contrast to expectations from some farmers based on research with very different soils and climate, however, the P placement method has not consistently affected yield of any crop with any application rate. A similar result has been shown by four other similar long-term studies conducted at other research farms and by research on farmers' fields.

Potassium has not influenced soybean yield but occasionally has increased corn yield, mainly in recent years and for no-till. No yield response to K was expected initially because initial soil-test K was in the High class, but over time, levels of the control plots have decreased to Optimum where occasional responses are expected. Previous reports have shown that the small corn yield responses to K were observed mainly for no-till and for the deep-band placement method (discontinued in 2001), which also included a small effect of zone tillage. Larger benefits of deep-band K were observed at other farms with lower soil-test K levels, mainly with ridge-tillage, but no benefit was observed for deep-band P.

Results for other treatments are not shown because effects on grain yield have been statistically similar to results shown in Tables 1 and 2. These include combining broadcast and planter-band methods, applying rates of 56 lb P_2O_5/acre or 70 lb K_2O/acre only once before corn or soybean, and (since 2001), applying higher annual P and K rates.

Conclusions

Soybean yield has been similar for no-till and chisel-disk tillage systems, but yield of no-till corn has been less than with tillage. High P and K rates broadcast or banded with the planter have not reduced this difference. Phosphorus fertilization has increased yield greatly in this initially low-testing soil. Potassium fertilizer increased yield only occasionally because initial soil-test K was High and levels of control plots only recently dropped into the Optimum class. A rate of 28 lb/P_2O_5/acre/year maximized yield of both crops in the early years, but recently a 56-lb/acre annual rate or twice this amount applied every-other year before corn or soybean has maximized yield. A large effect of planter-band P on early corn growth compared with broadcast P has not translated into higher grain yield.

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Table 1. Phosphorus effects on crop yield.

		Placement and lb P_2O_5/acre/year				
			Broadcast		Planter Band	
Period	Till†	Control	28	56	28	56
		------ Corn Yield (bu/acre) -------				
16 years	CH	125	155	163	157	164
	NT	102	147	156	150	154
2008-09	CH	157	211	223	214	226
	NT	118	189	203	191	200
		----- Soybean Yield (bu/acre) -----				
16 years	CH	39.3	47.3	48.6	48.0	49.4
	NT	36.6	46.5	49.1	47.5	48.6
2008-09	CH	44.6	57.2	59.7	58.7	60.0
	NT	39.5	56.4	60.2	57.4	59.8

† Till, tillage: CH = chisel-plow/disk; NT- no-till.

Table 2. Potassium effects on crop yield.

		Placement and lb K_2O/acre/year				
			Broadcast		Planter Band	
Period	Till†	Control	35	70	35	70
		------ Corn Yield (bu/acre) -------				
16 years	CH	145	147	148	150	149
	NT	137	141	141	139	140
2008-09	CH	191	195	192	195	193
	NT	172	180	182	181	179
		----- Soybean Yield (bu/acre) -----				
16 years	CH	44.7	44.9	43.9	44.6	44.3
	NT	44.2	45.3	44.7	44.2	45.0
2008-09	CH	56.6	55.5	53.4	54.6	53.3
	NT	53.9	55.2	55.2	53.8	53.6

† Till, tillage: CH = chisel-plow/disk; NT- no-till.