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Long-term Evaluation of Tillage Systems and Fertilizer Placement Methods for Corn and Soybean

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

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Long-term Evaluation of Tillage Systems and Fertilizer Placement Methods for Corn and Soybean

RFR-A9104

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Introduction

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

Materials and Methods

The study consists of four separate trials: P for corn, P for soybeans, K for corn, and K for soybean. Both crops are grown in rotation on adjacent areas of Marshall soil by alternating crops each year. Tillage and fertilization treatments are applied for both crops, which are planted with a 30-in. row spacing. Cornstalks of plots managed with tillage are chisel-plowed in the fall and disked in spring. Soybean residue is field cultivated in spring. The fertilizer placement methods were broadcast, deep-band, and band with the planter until 2001, when the deep-band method was discontinued due to budget reasons. The broadcast fertilizers are applied in the fall. Planter bands are applied 2 in. below and 2 in. to the side of the seeds. Fertilizer rates for both placement methods are a control, annual application of a low rate (28 lb P_2O_5/acre or 35 lb K_2O/acre), and annual application of a high rate (56 lb P_2O_5/acre or 70 lb K_2O/acre). Other treatments include a combination of planter-band and broadcast methods, broadcast twice the high broadcast rate every other year before corn or soybean, and (since 2002) annual applications of 112 lb P_2O_5/acre or 140 lb K_2O/acre.

Results and Discussion

Tillage effects. Corn yield with tillage or no-till has been similar or slightly higher with tillage in normal or wet years, but has been higher with no-till in very dry years. Soybean yield seldom has been affected by tillage. Therefore, yields for fertilized plots shown in Tables 1 and 2 for both crops show small or no tillage differences for the 16-year period. There were small or no tillage differences during the last two years, when crop yields were the highest observed in the study.

Phosphorus effects (Table 1). Small corn and soybean yield responses to P fertilization began to be observed in the early 2000s. Initial soil-test P was in the Optimum class, the level for the control plots decreased to a value between Optimum and Low by fall 2002, and levels remained in the Low class since then. The soybean yield response has been increasing. In the last two years the average yield increase was about 4 bushels/acre with tillage and 6 bushels/acre with no-till. The corn grain yield response has varied greatly, however. The increase with any tillage ranged from 3 to 12 bushels/acre during the last four years, but on average was only 4 bushels/acre in the last two even though yields were the highest. The P application method has not affected yield consistently, which is shown by averages for the 16-year averages or the last two years. In contrast, banded P has increased early crop growth greatly, mainly for corn managed with no-till (not shown).

Potassium effects (Table 2). Initial soil-test K was in the High category and, therefore, it is not surprising that the 16-year averages for both crops show no response to K. Soybean showed no response even in the last two years. Corn has shown small and inconsistent yield responses to K in the past, but in the last few years no-till corn has been showing consistent responses. The average yield increase in the last two years was 9 bushels/acre. The difference with tilled corn is interesting because soil-test K of control plots was approximately similar for both tillage systems but, as expected, there was more stratification for no-till. The yield response to K placement methods has been small and inconsistent for both tillage systems. Results until 2001 showed a small occasional advantage of deep-band K for no-till corn. Results for the broadcast and planter-band methods have shown small and inconsistent differences, although in the last two years yield increases were lower for the high banded K rate. Research at other research farms or farmers' fields with lower soil-test K levels has shown benefits from deep-band K for corn managed with no-till, strip-till, or ridge-till but no benefit for deep-band P.

Results for other P and K treatments applied for both tillage systems are not shown because effects on yield have been statistically similar to yield resulting from the higher rates shown in Tables 1 and 2. These include applying 56 lb P_2O_5/acre or 70 lb K_2O/acre one-half broadcast and one-half with the planter, applying fertilizer annually or twice the amount every two years, and applying 112 lb P_2O_5/acre or 140 lb K_2O/acre every year.

Conclusions

Differences in soybean yield between no-till and chisel-plow/disk systems have been small and inconsistent over time. Corn yield has been similar or higher with tillage in normal or wet year but has been higher with no-till in very dry years. Grain yield responses to P and K began to be observed in the early 2000s, when soil-test values of the control plots decreased into the Low class for P and the Optimum class for K. Broadcast or planter-band fertilizer placement methods have not affected corn or soybean yield consistently. These results may change in the future as crop responses to fertilization may become larger and more consistent.

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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	161	166	166	162	165
	NT	162	166	164	161	164
2008-09	CH	199	199	205	201	205
	NT	201	207	205	202	202
		----- Soybean yield (bu/acre) -----				
16 years	CH	62	64	64	63	64
	NT	62	66	66	66	66
2008-09	CH	65	69	69	69	67
	NT	65	71	73	71	71

†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	171	171	175	172	172
	NT	171	175	175	178	172
2008-09	CH	221	223	228	221	215
	NT	216	224	226	226	220
		----- Soybean yield (bu/acre) -----				
16 years	CH	52	51	52	53	53
	NT	55	55	55	55	55
2008-09	CH	64	62	64	63	63
	NT	66	63	65	65	65

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