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Phosphorus and Potassium Placement Methods for Corn and Soybeans Managed with No-Till and Chisel Plow Tillage

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Abstract
Compared with tillage, no-till management can change many soil properties and crop yields. Broadcast phosphorus (P) and potassium (K) fertilization may be inefficient in no-till because both nutrients accumulate near the soil surface. Banded fertilization could be more effective. A study was initiated in 1994 to compare no-till and chisel plow tillage and fertilizer placement methods for corn-soybean rotations. The study included four trials: P for corn, P for soybeans, K for corn, and K for soybeans. Both crops are grown each year by alternating them between adjacent field areas. The soil is mainly Floyd series, and initially tested Very High in P and High in K. Treatments were applied for both crops, which were planted in 30-in. row spacing. Cornstalks of plots managed with tillage were chisel plowed in the fall and field cultivated in the spring, whereas soybean residue was only field cultivated in the spring.

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Introduction

Compared with tillage, no-till management can change many soil properties and crop yields. Broadcast phosphorus (P) and potassium (K) fertilization may be inefficient in no-till because both nutrients accumulate near the soil surface. Banded fertilization could be more effective. A study was initiated in 1994 to compare no-till and chisel plow tillage and fertilizer placement methods for corn-soybean rotations. The study included four trials: P for corn, P for soybeans, K for corn, and K for soybeans. Both crops are grown each year by alternating them between adjacent field areas. The soil is mainly Floyd series, and initially tested Very High in P and High in K. Treatments were applied for both crops, which were planted in 30-in. row spacing. Cornstalks of plots managed with tillage were chisel plowed in the fall and field cultivated in the spring, whereas soybean residue was only field cultivated in the spring.

The fertilizer placement methods were broadcast (in the fall), deep bands (in the fall), and planter bands. Deep bands were applied at a 30-in. spacing 5–7 in. deep with a toolbar equipped with coulters and knives that strip till the soil. Planter bands were applied about 2 in. below and beside the seeds with dry fertilizer attachments. Fertilization rates were a check, a rate slightly higher than one-half the estimated average maintenance needs for the rotation (28 lb P_2O_5/acre or 35 lb K_2O/acre), and the full maintenance rates (56 lb P_2O_5/acre or 70 lb K_2O/acre). Additional treatments were applied once every two years at the maintenance rates for the rotation. A strip tillage check was included for no-till.

Summary Results

Tables 1 and 2 show average grain yields from 1994 to 2004 and for the last two years. Two-year averages represent recent results better than annual data because variations due to weather and switching of crops between field areas are smoothed. Weather differences resulted in below-average corn yield in 2003 and above-average yield in 2004. Soybean yields were below average in 2003 and average in 2004.

Soybean yield has been about the same for chisel plow tillage compared with no-till, but corn yield has been higher than for chisel plow tillage (8 bu/ac for an 11-year average). The difference has varied greatly over time, and since 2000 it ranged from 3 bushels/acre (the smallest ever) to 21 bushels/acre (the largest ever). Rainfall, spring temperature, and green snapping (worse for chisel plowed corn one year) tend to explain differences.

No crop has shown a consistent yield response to P (Table 1), which agrees with the initially Very High soil-test P. By fall 2003, soil-test P of check plots decreased to a value within the Optimum class and soil-test P of plots receiving the 56-lb rate had increased slightly. However, band P significantly increased both early growth and P uptake (data not shown).

Potassium fertilization did not influence corn and soybean yields until 1996, and responses have become larger in recent years for both crops and tillage systems (Table 2). This result is reasonable because soil-test K was High in 1994 and decreased to Low by fall 2003. Iowa State University recommends maintenance fertilization based on K removal when soil-test K is Optimum (130 to 170 ppm, by ammonium-acetate or Mehlich-3 K tests).

The fertilizer placement methods have differed significantly only for K and no-till corn, with yields for deep-band K about 2 bushels/acre higher for the two K rates. Recently, differences have increased, especially for the low rate (Table 2). For the high K rate, no-till corn yield was 2 to 4 bushels/acre higher with deep banding for the 11-year or last 2-year averages. However, in the last two years the 35-lb deep-band rate produced yields almost similar to the 70-lb rate broadcast or banded with the planter. This result has not been observed before at this site or at other research farms. Results indicate that deep-band K effects on yield were not due

to strip tillage.

Conclusions

The tillage method seldom influenced soybean yields but corn yields have has been lower for no-till. Strip till has not improved yields consistently. Grain yields have not responded to P fertilization because soil-test P of check plots has been Optimum or High, but band P has increased early growth more than broadcast P. Yield response to K was observed recently because soil-test K in check plots decreased to the Low class. Placement methods have differed significantly only for K and no-till corn, with higher yields for deep-band K. This result confirms the current recommendations for deep-banding K for no-till corn.

Acknowledgments

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Table 1. Effects of tillage and phosphorus fertilizer placement methods and rates on corn and soybean yields.

		Phosphorus Placement and Rate (lb P_2O_5/acre/year)							
		No P fertilizer		Broadcast		Deep bands		Planter bands	
Tillage	Years	Check	Strip till	28 lb	56 lb	28 lb	56 lb	28 lb	56 lb
		Corn yield (bu/acre)							
Chisel	1994-2004	169.6	170.5	167.7	169.8	169.0	170.3	169.1	169.1
	2003-2004	170.2	171.1	172.3	177.6	176.7	174.0	175.6	178.8
No-till	1994-2004	158.8	159.2	162.0	160.3	162.0	162.6	158.1	162.0
	2003-2004	159.7	157.9	158.3	155.8	157.2	162.5	148.7	159.5
		Soybean yield (bu/acre)							
Chisel	1994-2004	54.9	54.6	55.5	55.5	55.9	55.6	55.8	55.7
	2003-2004	49.2	47.5	50.3	51.5	51.0	52.2	51.2	50.1
No-till	1994-2004	54.5	52.2	54.2	53.4	53.3	53.9	53.8	53.7
	2003-2004	47.3	44.0	47.6	45.5	46.5	46.2	46.8	45.5

Table 2. Effects of tillage and potassium fertilizer placement methods and rates on corn and soybean yields.

		Potassium Placement and Rate (lb K_2O/acre/year)							
		No K fertilizer		Broadcast		Deep bands		Planter bands	
Tillage	Years	Check	Strip till	35 lb	70 lb	35 lb	70 lb	35 lb	70 lb
		Corn yield (bu/acre)							
Chisel	1994-2004	162.0	162.4	170.4	172.5	170.1	173.3	173.7	169.7
	2003-2004	167.7	161.9	176.6	185.6	184.8	187.6	186.1	180.1
No-till	1994-2004	153.6	155.5	158.5	164.5	167.8	166.1	161.4	164.6
	2003-2004	147.9	151.7	160.0	166.1	171.8	171.4	165.8	169.9
		Soybean yield (bu/acre)							
Chisel	1994-2004	52.2	50.9	53.7	54.4	54.1	55.1	54.4	54.5
	2003-2004	46.1	42.1	48.4	48.5	49.0	50.4	49.3	49.7
No-till	1994-2004	50.1	49.3	53.0	53.2	53.8	53.9	52.6	53.2
	2003-2004	40.4	39.7	45.2	45.4	46.3	45.4	44.8	44.9