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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
Continued no-till management can change many soil properties and crop yield compared with tillage. Broadcast phosphorus (P) and potassium (K) fertilization with no-till results in significant accumulation of both nutrients near the soil surface and, therefore, subsurface band fertilization could be more effective. A study was initiated in 1994 to compare no-till and chisel-plow tillage and fertilizer placement methods for a corn-soybean rotation. Floyd is the predominant soil, and the area initially tested Very High in P (33 ppm, Bray-1) and Optimum in K (140 ppm). The study includes four trials: P for corn, P for soybean, K for corn, and K for soybean. Both crops are grown each year by alternating adjacent areas. Treatments are applied for both crops, which are planted using a 30-in. row spacing. Cornstalks of plots managed with tillage are chisel-plowed in the fall and field-cultivated in spring. Soybean residues only are field cultivated in spring.

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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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Materials and Methods

Continued no-till management can change many soil properties and crop yield compared with tillage. Broadcast phosphorus (P) and potassium (K) fertilization with no-till results in significant accumulation of both nutrients near the soil surface and, therefore, subsurface band fertilization could be more effective. A study was initiated in 1994 to compare no-till and chisel-plow tillage and fertilizer placement methods for a corn-soybean rotation. Floyd is the predominant soil, and the area initially tested Very High in P (33 ppm, Bray-1) and Optimum in K (140 ppm). The study includes four trials: P for corn, P for soybean, K for corn, and K for soybean. Both crops are grown each year by alternating adjacent areas. Treatments are applied for both crops, which are planted using a 30-in. row spacing. Cornstalks of plots managed with tillage are chisel-plowed in the fall and field-cultivated in spring. Soybean residues only are field cultivated in spring.

The fertilizer placement methods have been broadcast, deep band (both in the fall), and planter band (spring). Deep bands are applied at a 30-in. spacing and 5 to 7 in. deep with a toolbar equipped with coulters and knives that strip till the soil. Planter bands are applied 2 in. below and 2 in. besides the seeds with dry fertilizer attachments. Fertilizer rates are a control, rates 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 double these rates (56 lb P_2O_5/acre or 70 lb K_2O/acre). Additional treatments apply once every 2 years the high annual rate before corn or soybean. A strip-tillage check is included for the no-till treatments.

Results and Discussion

Tables 1 and 2 show average grain yields for the 14-year period and for the last 2 years. Data for treatments applying once every other year twice the high annual P or K rate before corn or soybean are not shown because yields were similar to those for the annual rates. Crop yields, mainly for corn, have increased over time and that is reflected in the data. Soybean yields across fertilized treatments have been about the same for both tillage systems (on average about 1 bushel/acre higher with tillage). However, corn yield has been higher for chisel-plow tillage (8 bushels/acre for the 14-year averages and 3 bushels/acre for the last 2 years). This difference has varied greatly over time, ranging from almost none to 21 bushels/acre. Rainfall, spring temperature, and green snapping (worse for chisel-plowed corn one year) have explained the differences.

No crop has shown a consistent yield response to P even after 14 years cropping (Table 1) because initially the soil tested Very High in P. By fall 2006 soil P of the non-fertilized plots had decreased to the Optimum soil-test class. Plots receiving the 56-lb annual rate increased soil P further. In agreement with little or no response to P, no differences have been observed between the P placement methods. In contrast to grain yield results, measurements until the early 2000s showed that deep-band or planter-band P increased crop early growth and P uptake further (data not shown) compared with the broadcast treatment.

Potassium fertilization effects on crop yield are shown in Table 2. The crops began to respond to

K fertilization in 1997 for both tillage systems. Responses have increased over time because soil-test K of the control plots has been decreasing and began testing Low in 2003. Yields in Table 2 also show small differences between the fertilized plots. All fertilized treatments were statistically similar for soybeans managed with no-till or tillage and for corn managed with tillage in both time periods. The only statistically significant difference for no-till corn in both time periods was the lower yield for the broadcast low K rate than for all other fertilized treatments, even though the maximum yield was achieved with one of the deep-band K rates. The results indicate little or no effect of strip tillage alone for any crop or tillage system.

Conclusions

The tillage method seldom influenced soybean yield but corn yield has been lower for no-till. Strip-tillage has not improved no-till grain yield consistently. Grain yield has not responded to P fertilization because soil-test P of control plots has been Optimum or higher, although banded P has increased early growth more than broadcast P. Large yield response to K has been observed recently because soil-test K of control plots has decreased into the Low category. Long-term averages showed that banded fertilization has improved grain yield over the broadcast method slightly only for no-till corn and the lowest K rate only.

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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	1994-2007	174.5	175.2	174.0	175.3	174.8	176.6	174.8	174.4
	2006-2007	191.7	189.3	194.2	193.0	192.1	193.9	192.4	191.4
No-till	1994-2007	165.2	165.1	168.0	166.5	168.4	166.9	164.7	167.7
	2006-2007	188.7	186.1	191.0	191.2	192.3	187.6	187.0	184.7
		Soybean yield (bu/acre)							
Chisel	1994-2007	57.2	56.7	57.7	57.6	58.1	57.7	58.1	58.0
	2006-2007	65.3	64.0	66.3	67.2	66.9	66.4	65.7	66.8
No-till	1994-2007	57.0	55.1	56.7	55.9	55.5	55.5	56.3	56.3
	2006-2007	63.3	64.2	65.1	64.3	63.4	62.8	62.8	65.3

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	1994-2007	167.4	168.5	176.4	177.4	176.3	180.2	180.0	175.9
	2006-2007	183.5	182.3	193.9	192.6	192.4	201.3	198.1	194.2
No-till	1994-2007	154.3	156.7	165.1	172.2	174.1	170.8	168.6	171.4
	2006-2007	160.9	163.6	188.5	196.8	194.6	197.8	189.8	193.3
		Soybean yield (bu/acre)							
Chisel	1994-2007	52.1	50.5	55.7	56.3	55.9	57.5	56.1	56.7
	2006-2007	51.2	50.1	63.3	63.7	62.9	65.0	62.4	63.7
No-till	1994-2007	51.0	49.9	55.3	56.0	56.3	56.2	55.0	56.0
	2006-2007	51.4	50.4	61.7	64.5	63.6	63.5	62.0	64.9