Phosphorus and Potassium Placement for Corn and Soybean Managed with Tillage or No-Tillage

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Introduction

With no-tillage cropping systems there is little mixing of crop residue with soil, which results in wetter and colder soils in early spring, but better moisture control in summer. Also, with no-till, broadcast fertilization increases the concentration of phosphorus (P) and potassium (K) fertilizers only in the top 2 to 4 in. of soil. Banding of P or K fertilizers below the soil surface with the planter could increase nutrient uptake and yield. Therefore, a long-term study was established in 1994 at this farm to evaluate P and K fertilizer rates and placement methods effect on grain yield of corn and soybean managed with no-till or tillage. The study evaluated broadcast, planter-bands, and deep bands from 1994 until 2009, when the deep banding was discontinued. A previous progress report summarized those results. Since 2010, the study continued evaluating the broadcast and planter-band placement methods, and this report summarizes the results.

Materials and Methods

The soil at the experimental area is Floyd loam, which initially tested Very High in P (33 ppm, Bray-1) and Low in K according to current interpretations (140 ppm, K test of dried samples). 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 with identical design and treatments. The crops 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, whereas plots with soybean residue only are field cultivated in the spring. Since 2010, the P and K placement methods have been broadcast and banded with the planter using granulated triple superphosphate and potassium chloride (potash). Bands are placed 2 in. below and 2 in. beside the seeds. The broadcast treatments have been applied in the fall with few exceptions. Fertilizer rates for both placement methods are a control, one-half the estimated maintenance rate (28 lb P_2O_5/acre or 35 lb K_2O/acre), and the full maintenance rate (56 lb P_2O_5/acre or 70 lb K_2O/acre) applied annually. Other treatments include broadcasting only once before either crop 112 lb P_2O_5/acre or 140 lb K_2O/acre.

Results and Discussion

Tillage effects. Soybean grain yield seldom differed between tillage and no-till management, but corn yield has most often been higher with tillage than with no-till. Calculations from data in Tables 1 and 2 show on average across all fertilized treatments, corn yield was 8 bushels/acre less with no-till than with tillage for the 1994–2016 period, and 10 bushels/acre less for the last four years.

Phosphorus effects. Table 1 shows the crop responses to P fertilization summarized for the entire long-term period (1994 to 2016) and the last four years (2013 to 2016). There were no yield responses to P for about 15 years because the soil initially tested high in P. Small yield responses began to be observed about 2010, when soil P of the control plots receiving no P had decreased into values between the Optimum and Low interpretation classes (15 to 16 ppm). Soil P of these plots continued decreasing, and during the last two years have been between the Low and Very

Low categories (8 to 9 ppm). For this reason, data in Table 1 for the long-term P averages show very small crop yield response to P. On the other hand, averages for the last four years in Table 1 show moderate corn responses to P (on average 10 and 16 bu/acre with tillage and no-tillage, respectively) and small soybean responses (2 to 3 bu/acre). However, seldom were there statistically significant differences between the P rates or placement methods. Interestingly, as was observed previously in other research, the magnitude of the yield difference between the non-fertilized and fertilized treatments was greater with no-till than with tillage.

Potassium effects. Table 2 shows the yield responses to K fertilization summarized for the entire duration of the study and for the last four years. The crops began responding to K fertilization almost from the beginning because initial soil K was Low. The yield responses have increased over time because soil K of the control plots has been decreasing and began testing Very Low about 2005. In the last two years, soil K ranged from 100 to 120 ppm (K test of dried samples). Table 2 shows very large yield responses during the last four years, which on average across the fertilized treatments were 29 and 34 bushels/acre for corn with tillage and no-tillage, respectively, and 9 and 15 bushels/acre for soybean with tillage and no-tillage, respectively. However, there were no large or statistically significant differences between the K application rates or the K placement methods. Again, the magnitude of the yield response was greater for no-till than for tillage.

Conclusions

The tillage method has not influenced soybean yield, but corn yield has been lower with no-till. The crop yield responses to P and K fertilization have increased in recent years as the soil-test levels of control plots receiving no P or K has decreased to values within the Low or Very Low interpretation categories. However, there have been no large or consistent corn and soybean yield differences between broadcast or planter-band placement methods for any nutrient or tillage systems.

Acknowledgements

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Table 1. Phosphorus placement and application rate effects on crop yield.

		Placement method and rate (lb P_2O_5/acre)†					
			Broadcast			Planter band	
Period	Tillage	Control	28	56	56x2 ‡	28	56
		---------- Corn yield (bu/ac) ----------					
1994-2016	Chisel	186b	188ab	190a	190a	188ab	189ab
	No-till	175b	180a	181a	181a	179ab	181a
2013-2016	Chisel	206b	214ab	217a	217a	212ab	219a
	No-till	188b	199a	207a	204a	205a	205a
		---------- Soybean yield (bu/ac) ----------					
1994-2016	Chisel	58.7b	60.2ab	60.4a	60.2ab	60.0ab	60.4a
	No-till	58.9a	59.4a	59.1a	59.4a	59.3a	59.3a
2013-2016	Chisel	58.5b	62.5a	62.0ab	60.7ab	59.1ab	61.4ab
	No-till	61.6c	63.5abc	65.3a	63.0abc	65.1ab	62.7bc

†Yield values in a row followed by the same letter(s) do not differ ($P \leq 0.05$).
‡56x2, twice the annual 56 lb-rate applied once for the 2-year rotation before corn or soybean.

Table 2. Potassium placement and application rate effects on crop yield.

		Placement method and rate (lb K_2O/acre)†					
			Broadcast			Planter band	
Period	Tillage	Control	35	70	70x2 ‡	35	70
		---------- Corn yield (bu/ac) ----------					
1994-2016	Chisel	177b	191a	192a	194a	194a	190a
	No-till	164d	181c	187ab	188a	181bc	186abc
2013-2016	Chisel	193b	219a	223a	224a	220a	221a
	No-till	178c	209ab	216a	217a	204b	217a
		---------- Soybean yield (bu/ac) ----------					
1994-2016	Chisel	51.1c	55.8b	57.4a	57.2ab	56.9ab	57.1ab
	No-till	49.1b	56.4a	57.7a	57.4a	56.0a	58.1a
2013-2016	Chisel	45.7b	52.9a	55.2a	54.8a	55.0a	54.5a
	No-till	43.3b	56.0a	58.3a	58.6a	56.0a	60.1a

†Yield values in a row followed by the same letter(s) do not differ ($P \leq 0.05$).
‡70x2, twice the annual 70 lb-rate applied once for the 2-year rotation before corn or soybean.