Yield of Corn and Soybean Managed with Tillage or No Tillage as Affected by the Phosphorus and Potassium Placement Method

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Introduction

No-till management limits the incorporation of crop residue and fertilizer with soil, which results in wetter and colder soils in early spring and accumulation of organic matter, phosphorus (P) and potassium (K) near the soil surface. Subsurface banding of P and K could be more effective than broadcast fertilization by applying nutrients below the soil surface. Therefore, a long-term study was established in 1994 to evaluate P and K rates and placement methods for corn and soybean managed with no-till and chisel-plow/disk tillage. The study evaluated broadcast, planter-bands, and deep bands until 2001 when the deep-band treatment was discontinued. This report summarizes results since 2002.

Materials and Methods

Separate P and K trials were established in 1994 on areas with Marshall soil series. Corn and soybean were planted using a 30-in. row spacing on adjacent areas with identical treatments and the crops alternated sides each year to complete a rotation. Plots with cornstalks were chisel-plowed in the fall, and plots with cornstalks or soybean residue were disked in the spring. Since 2002, the P and K placement methods have been broadcast and banded using granulated triple superphosphate (0-46-0) and potassium chloride (potash, 0-0-62) fertilizers. The broadcast treatments were applied in the fall and bands were placed 2 in. below and 2 in. beside the seeds with planter attachments. Other than a non-fertilized control for each nutrient, annual applications with both placement methods are one-half the estimated maintenance rate (28 lb P_2O_5/acre or 35 lb K_2O/acre) and the full rate (56 lb P_2O_5/acre or 70 lb K_2O/acre). Other broadcast application rates were twice the maintenance rates applied once for either crop or annually for both crops.

Results and Discussion

Tillage effects. Soybean grain yield has not been affected by tillage. Corn yield often has been higher with tillage than with no-till in normal or wet years, but often has been higher with no-till in droughty years. Therefore, long-term averages show very small tillage differences for corn. Corn yield differences between the tillage treatments since 2002 were three bushels/acre or less (Tables 1 and 2).

Phosphorus effects. Initial soil P in 1994 for the P trial areas was in the Optimum interpretation category, and values for the control plots decreased to Low in 2003 and to Very Low in 2010. Therefore, the yield response to P has increased over time. Table 1 shows the broadcast 56-lb rate applied annually or 112-lb applied every year has maximized crop yield. Yield responses were 12 to 19 bushels/acre for corn and 3 to 6 bushels/acre for soybean. Yield with banded P has not been significantly different from yield with broadcast P. The corn yield averages since 2002 show the difference between the non-fertilized and fertilized treatments was greater with no-till than with tillage.

Potassium effects. Initial soil K in 1994 was in the High interpretation category. Values of the

control plots decreased to a value between Optimum and High by 2002, and there was no crop response to K until then. However, Table 2 shows small corn yield increases (5 to 9 bu/acre) were observed since 2002 with both tillage systems (but not for soybean). The K fertilizer placement methods did not differ for any crop or tillage system until 2015. Results for corn during the last two years are puzzling, however, because the high band K decreased yield with tillage but not with no-till.

Conclusions

The tillage system has not affected soybean yield. Corn yield has been higher with tillage in some years and higher with no-till in others, so the long-term averages showed no differences. Yield responses to P and K began increasing in recent years when soil-test values of non-fertilized plots decreased into the Optimum or lower interpretation categories. The long-term averages showed no differences between broadcast and planter-banded P or K placement methods for any crop or tillage system.

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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	56b	112	28	56
		---------- Corn yield (bu/acre) ----------						
2002-17	Chisel-disk	185	194	196	198	198	192	194
	No-till	181	193	196	195	196	188	194
2012-17	Chisel-disk	232	246	251	251	249	238	246
	No-till	233	249	254	253	248	234	253
		---------- Soybean yield (bu/acre) ----------						
2002-17	Chisel-disk	58.7	61.7	61.7	61.4	63.1	61.2	61.2
	No-till	58.5	62.3	63.7	62.9	62.9	60.7	62.4
2012-17	Chisel-disk	69.7	72.8	76.8	74.2	74.8	72.6	71.8
	No-till	71.0	73.9	73.9	74.1	74.2	70.9	74.3

56b = twice the annual 56 lb-rate applied once for the 2-year rotation.

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	70b	140	35	70
		---------- Corn yield (bu/acre) ----------						
2002-17	Chisel-disk	189	192	195	195	195	192	191
	No-till	192	196	195	197	198	197	195
2012-17	Chisel-disk	228	245	240	238	231	231	223
	No-till	234	240	240	238	239	232	240
		---------- Soybean yield (bu/acre) ----------						
2002-17	Chisel-disk	58.1	57.6	57.5	57.9	56.5	58.3	57.4
	No-till	60.1	60.1	59.8	58.9	60.0	60.9	60.8
2012-17	Chisel-disk	69.9	72.0	71.5	72.0	70.0	70.7	69.6
	No-till	71.8	73.7	72.0	71.5	72.5	73.4	75.4

70b = twice the annual 70-lb rate applied once for the 2-year rotation.