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Antonio P. Mallarino
Iowa State University, apmallar@iastate.edu

Kevin Van Dee
Iowa State University

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Abstract
A study was initiated in 1994 to evaluate long-term effects of phosphorus (P) and potassium (K) fertilizer rates and placement methods on yield of corn and soybean managed with no-till or chisel-plow tillage. No-till management results in little or no incorporation of residue and fertilizer with soil. Broadcast fertilization could be inefficient with no-till because both nutrients accumulate near the soil surface. Therefore, subsurface banding of P and K fertilizers could be more effective.

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

Antonio P. Mallarino, professor
Department of Agronomy
Kevin Van Dee, superintendent

Introduction

A study was initiated in 1994 to evaluate long-term effects of phosphorus (P) and potassium (K) fertilizer rates and placement methods on yield of corn and soybean managed with no-till or chisel-plow tillage. No-till management results in little or no incorporation of residue and fertilizer with soil. Broadcast fertilization could be inefficient with no-till because both nutrients accumulate near the soil surface. Therefore, subsurface banding of P and K fertilizers could be more effective.

Materials and Methods

The study consists of four separate trials: P for corn, P for soybeans, K for corn, and K for soybeans. Both crops are grown in rotation each year on adjacent areas of Mahaska and Nira soils. Tillage and fertilization treatments are applied for both crops, which are planted with a 30-in. row spacing. Plots managed with tillage are chisel-plowed in the fall and field-cultivated or disked in spring. Fertilizer placement methods evaluated were broadcast, planter-band, and deep-band until 2001, when the deep-band placement was discontinued. Broadcast fertilizers are applied in the fall. Planter attachments apply bands 2 in. below and 2 in. beside the seeds.

Fertilizer rates applied since 1994 with broadcast and planter-band placement methods for each P or K trial have been a control, a low annual rate (28 lb P_2O_5/acre or 35 lb K_2O/acre), a higher annual rate (56 lb P_2O_5/acre or 70 lb K_2O/acre) with the high rate applied one-half broadcast and one-half with planter, and twice the high rate broadcast before corn or soybean every other year (112 lb P_2O_5/acre or 140 lb K_2O/acre).

Results and Discussion

Tillage Effects. Soybean yield seldom has differed between tillage systems. Corn yield usually has been higher with tillage, however, and the difference has increased over time. If the initial two years of the trial are excluded, for example, yield differences averaged 3, 10, and 18 bushels/acre from 1996 to 1999, 2000 to 2003, and 2004 to 2007, respectively. Perhaps increased residue accumulation explains this result, because there have been isolated dry years distributed over the evaluation period.

Fertilization Effects. Yields from treatments that apply 112 lb P_2O_5/acre or 140 lb K_2O/acre annually or every-other year before corn or soybean, and 56 lb P_2O_5/acre or 70 lb K_2O/acre one-half broadcast and one-half planter-band have not differed from annual broadcast rates of 56 lb P_2O_5/acre or 70 lb K_2O/acre. Therefore, these results are not shown in tables or discussed further.

Results for P. Long-term yield averages in Table 1 show little crop response to P because there was no response until 2003. Since 2003, both crops have shown yield responses, although the yield response in no-till has been larger. Yields from the low and high P rates differed occasionally in the last few years. Soil-test P was high in 1994, decreased to a value between Low and Optimum classes by 2002, and has been in the Low class since. The larger response for no-till was explained mainly by a more detrimental effect of P deficiency in the non-fertilized checks than with tillage. In the last two years the tillage difference was 33 bushels/acre for the corn checks but only 16 bushels/acre for the P fertilized plots.

Yield differences between P placement methods have been small and inconsistent. The planter-band method occasionally resulted in higher yields of corn, which is reflected in small yield differences in the long-term averages (Table 1). The largest yield difference was in 2005 and was explained by drought. The apparent differences between placement methods and rates were not statistically different and, furthermore, data for the last two years show no clear yield differences due to fertilizer placement.

Results for K. Both crops have shown a yield response to K fertilizer since 1994 (Table 1), although yield differences between the low and high K rates have been very small. According to ISU soil-test interpretations (last updated for 2003), initial soil-test K was borderline between Low and Optimum classes, but values for the checks had decreased into the Low class by 2001. The yield responses to K were larger for no-till (as it was for P) because K deficiency had a more detrimental effect on yield with no-till than with tillage. In the early years of the study, yield responses to K fertilizer were slightly larger for the deep-band placement method (not shown) that was discontinued in 2001. Yields for the broadcast and planter-band methods seldom have differed. A small yield advantage observed for the planter-band method in 2004 and 2005 for no-till corn was not observed in the last two years.

Conclusions

Tillage has not had consistent effects on soybean yield over the years. Corn yield has been higher with tillage, however, and the yield difference of no-till has increased over time.

Crop responses to fertilization developed slowly and recently have increased because soil-test values of non-fertilized plots have decreased into the Low interpretation class. The responses have been larger for crops managed with no-till because nutrient deficiencies translate into lower yields for this system as compared with tillage. Yield differences between broadcast and planter-band fertilizer placement methods have been small and inconsistent, and long-term yield averages did not differ.

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Table 1. Average effects of tillage, fertilizer placement method, and annual P and K application rates on corn and soybean grain yield from 1994 to 2007 and for the last two years (2006 and 2007).

			Phosphorus (lb P_2O_5/acre)					Potassium (lb K_2O/acre)				
				Broadcast		Planter band			Broadcast		Planter band	
Years	Crop	Tillage	Check	28	56	28	56	Check	35	70	35	70
			---------- Grain yield (bu/acre) ----------									
94–07	Soybean	Chisel	53.6	54.6	55.0	53.8	55.2	52.8	55.9	55.4	54.4	54.9
		No-till	51.2	53.0	53.7	52.9	53.6	51.4	54.4	53.8	53.3	52.4
	Corn	Chisel	172	172	176	176	176	171	177	180	180	184
		No-till	151	160	161	163	166	154	165	166	166	166
06–07	Soybean	Chisel	54.8	55.8	55.7	55.0	55.6	53.0	56.5	55.6	56.1	56.0
		No-till	55.0	57.1	58.9	57.7	58.6	53.1	59.0	57.5	57.7	57.0
	Corn	Chisel	195	193	207	192	203	185	189	200	201	203
		No-till	162	183	183	178	188	155	188	182	182	181