2004

Phosphorus and Potassium Fertilizer Placement for Corn and Soybeans Managed with No-till and Chisel-Disk Tillage

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

Bernard J. Havlovic
Iowa State University, bhavlovi@iastate.edu

Jeff Butler
Iowa State University

Phosphorus and Potassium Fertilizer Placement for Corn and Soybeans Managed with No-till and Chisel-Disk Tillage

Abstract
No-till management results in little or no incorporation of residues and fertilizers with soil. Broadcast fertilization could be inefficient with no-till because phosphorus (P) and potassium (K) accumulate at or near the soil surface. Subsurface banding of fertilizers with planter starter attachments or before planting could be more effective. A long-term study was initiated in 1994 at the Armstrong Farm and at other research farms to evaluate P and K fertilizer placement for corn and soybeans managed with no-till and chisel-plow tillage.

Keywords
Agronomy

Disciplines
Agricultural Science | Agriculture | Agronomy and Crop Sciences

Phosphorus and Potassium Fertilizer Placement for Corn and Soybeans Managed with No-till and Chisel-Disk Tillage

Antonio P. Mallarino, professor
Department of Agronomy
Bernard Havlovic, superintendent
Jeff Butler, crops specialist

Introduction

No-till management results in little or no incorporation of residues and fertilizers with soil. Broadcast fertilization could be inefficient with no-till because phosphorus (P) and potassium (K) accumulate at or near the soil surface. Subsurface banding of fertilizers with planter starter attachments or before planting could be more effective. A long-term study was initiated in 1994 at the Armstrong Farm and at other research farms to evaluate P and K fertilizer placement for corn and soybeans managed with no-till and chisel-plow tillage.

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 on Marshall soil in rotation by alternating crops each year between adjacent areas. The tillage and fertilization treatments are applied for both crops, which are planted with 30-inch row spacing. Cornstalks of plots managed with chisel-plow tillage are chisel-plowed in the fall and field-cultivated in spring, whereas soybean residues are field-cultivated in spring. The planter is equipped with row cleaners and dry fertilizer attachments. The fertilizer placement methods are broadcast, deep-band, or banded with the planter. The broadcast and deep-band fertilizers are applied in the fall. Deep bands are applied 30 inches apart and 5–7 inches deep, and crop rows are placed on top of the coulter-knife tracks. The deep-band treatment was discontinued after the 2002 crop season. Planter bands are applied about 2 inches below and 2 inches to the side of the seeds. Fertilizer rate treatments include a check, a coulter-knife check, and rates of P and K supplying about one-half the maintenance needs (28 lb P_2O_5/acre or 35 lb K_2O/acre) and full maintenance needs (56 lb P_2O_5/acre or 70 lb K_2O/acre). The coulter-knife check evaluates physical effects of the knives on crop yield. Additional treatments are combinations of placements and a one-time application of the 2-year maintenance rates.

Results and Discussion

Results for the last few years of the study have shown different tillage effects on grain yield compared with earlier years. Soybean yield has not differed between tillage systems, but in 2001 and 2002 it averaged 7 bushels/acre more for no-till. Corn yield usually was higher for chisel-disk tillage during the early years (about 4 bushels/acre more on the average) but during 2001 and 2002 averaged about 10 bushels/acre more for no-till. These trends can be explained by higher crop yields with no-till management during recent years with deficient soil moisture.

No crop has shown a significant yield response to P fertilization, although soybeans showed small responsive trends during 2001 and 2002 (Table 1). Soil-test P (0–6 inch depth) was in the Optimum class in 1994. By fall 2002, soil P of the check plots had decreased to the upper Low class (14 ppm, Bray-1 test) whereas soil P of plots that received 56 lb P_2O_5/acre/year was High to Very High. A larger response was expected during the last 2 or 3 years, but yields have been low and highly variable, mainly in 2000 and 2002, as the result of drought. The P application method did not affect crop yields. Banded P greatly increased early growth of crops managed with both tillage systems (data not shown) but grain yields were not increased. Potassium fertilization has resulted in small and inconsistent yield increases over time (Table 1). No yield response was expected because soil-test K was High in 1994. By fall 2002, soil K of the check plots had decreased to values between Optimum and High (176 ppm, ammonium acetate test) whereas soil K of plots that received 56 lb P_2O_5/acre/year was Very High. Soybeans showed no response to K in any period, but corn showed a small average corn response for the 1994 to 2000 period. Corn yield increases have varied greatly across years, tillage systems, and placement methods. An initial small advantage for deep-band K was not observed in recent years. The deep-band

effects include zone tillage effects. Results for other research farms and farmers' fields have shown an advantage of deep band K for no-till corn.

Soybean yields seldom differed between tillage systems in the early years of the study, but were greater for no-till in recent years. Corn yields were greater for chisel-disk tillage in early years, but were greater for no-till in recent years. The results were explained by greater yields of no-till crops during years with deficient soil moisture.

Crops have not responded to P fertilization or placement method, probably because soil-test P has been within the Optimum class, and only recently did soil P values of check plots decrease to the upper Low class. Large effects of banded P on early crop growth (especially in corn) did not translate into higher grain yield. Potassium fertilization has produced small and variable corn responses, probably because initially soil K was High and in recent years was borderline between Optimum and High. The lowest rate used achieved maximum yields, and there were no consistent differences between placement methods. No-till corn has shown larger responses to deep-band K at other locations.

Table 1. Effects of tillage, fertilizer placement method, and annual phosphorus and potassium rates on corn and soybean grain yields during a 9-year period.

		Phosphorus placement and rate (lb P_2O_5/acre)							Potassium placement and rate (lb K_2O/acre)						
			Broadcast		Deep band†		Planter band			Broadcast		Deep band		Planter band	
Period	Tillage	Check	28	56	28	56	28	56	Check	35	70	35	70	35	70
		Soybean grain yield (bu/acre)													
1994-2000	Chisel	54.5	55.1	54.5	55.3	54.5	53.9	54.3	54.8	53.9	54.3	54.4	55.0	55.9	55.6
	No-till	55.5	55.4	55.7	54.1	55.7	55.5	55.5	56.2	56.3	55.5	54.4	57.0	56.4	55.6
2001-2002	Chisel	32.9	33.7	36.5	34.6	35.2	33.1	36.6	35.1	35.6	35.2	37.8	33.6	35.0	36.0
	No-till	39.1	43.1	43.8	41.7	42.7	44.8	44.7	40.6	41.8	42.0	41.0	41.7	43.0	41.0
		Corn grain yield (bu/acre)													
1994-2000	Chisel	161	165	165	163	164	160	165	156	159	161	162	162	158	158
	No-till	162	163	158	158	163	158	159	152	157	157	157	155	157	150
2001-2002	Chisel	144	138	139	146	146	132	135	136	132	148	138	140	140	142
	No-till	151	159	156	152	156	153	160	156	148	150	158	144	154	144

† The deep-band treatment was discontinued in fall 2001, and residual effects were evaluated in 2002.