SOYBEAN AND CORN YIELD RESPONSE TO FERTILIZER PLACEMENT AND TILLAGE SYSTEM

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ABSTRACT

Nutrient availability and, consequently, yields can be strongly influenced by tillage system and fertilizer placement. Also, different genotypes and rooting systems can affect nutrient uptake and plant growth. The objective of this study was to evaluate fertilizer placement and tillage system effects on yields in soybean and corn with different varieties/hybrids. The experiment was established in two locations in Kansas and the experimental design was a randomized complete block with a split-plot. The fertilizer treatments consisted of a control, deep band only and broadcast only. Tillage systems were no-till and strip-till. Two varieties of soybean were used, one considered highly suitable in poor drained areas (PD), and the other perform better in good drainage conditions (GD). Hybrids of corn used were a drought tolerant (DT) and a conventional (CT). Yields were recorded at harvest. Soybean yields showed significant differences in tillage and variety. Corn yields were found to be different according to fertilizer placement. Interactions among factors were found in corn. Fertilizer has no effect in soybean yields. Strip-till operation showed no advantages in soybean neither in corn since the yields were lower or equal to no-till.

INTRODUCTION

The effect of fertilizer placement on soybean and corn can be important depending on tillage systems. Some conditions can limit the nutrient availability such as low soil temperature, leading to reduce root growth (Havlin et al., 2005) and nutrient uptake (Mackay and Barber, 1985) leading to low yields. No-till can enrich those conditions under cool and wet soils hindering the P diffusion. However, Mallarino (1999) found that deep band P increased early growth and P uptake in corn compared to broadcast application in no-till system.

Crops with contrasting root systems may differ in the ability to extract nutrients. Results from previous studies showed significant differences in nutrient concentration and uptake among corn hybrids with different genetic backgrounds (Gordon et al., 1998). It is possible that different rooting systems can show a significant interaction with fertilizer application method. The goal of this study was to evaluate fertilizer placement and tillage system effects on yields in soybean and corn with different varieties/hybrids.

MATERIALS AND METHODS

The experiment was established at two locations in Kansas in 2014. The Scandia location is located west of Scandia, KS, on the North Central Agronomy Experiment Field. This location used supplemental irrigation to maintain adequate soil moisture limiting water stress throughout the growing season. The Ottawa location is located south of Ottawa, KS, on the East Central Agronomy Experiment Field. The Ottawa location was under rainfed conditions. Soil samples were collected in blocks, one composite sample of 20 cores was taken for each block, totalizing 4

samples per location. Samples were analyzed for P by the Mehlich-3 method (Frank et al., 1998) and K with the ammonium acetate method (Warncke and Brown, 1998). Soil pH was measured using a 1:1 soil:water ratio (Watson and Brown, 1998), and soil organic matter (OM) was determined by Walkley–Black method (Combs and Nathan, 1998). Soil test results are shown in Table 1.

Plot size was 10 ft wide and 40 ft long with four rows planted at 30 in spacing. The experimental design was a randomized complete block with a split-plot, where tillage and variety/hybrid were whole plots and fertilizer placement was split-plot, with four replications. The fertilizer treatments consisted of a control, deep band only and broadcast only. These three fertilizer treatments were combined with two tillage systems and two different varieties/hybrids of soybean and corn selected based on contrasting root systems. The two varieties of soybeans used were 94Y40, considered highly suitable in poor drained areas (PD) and P44T63R, which perform better in good drainage conditions (GD). The two hybrids of corn used were P1151 AM, a drought tolerant hybrid (DT), and P1105 AM, the conventional hybrid (CT). The two tillage operations were no-till and strip-till. Fertilizer was applied 2-3 weeks before planting. Deep band treatment rate was 40 lb ac^{-1} N as UAN (28-0-0, N-P2O5-K2O respectively) and 40 lb ac^{-1} P_2O_5 as ammonium polyphosphate (10-34-0, N-P_2O_5-K_2O respectively) for corn; 20 lb ac^{-1} N as UAN (28-0-0, N-P_2O_5-K_2O respectively) and 40 lb ac^{-1} P_2O_5 as ammonium polyphosphate (10-34-0, N-P_2O_5-K_2O respectively) for soybeans. Broadcast treatment rates were the same as deep band for both crops. Nitrogen for corn was applied at 120 lb ac^{-1} for the Ottawa location and 180 lb ac^{-1} for the Scandia location.

Grain yields were recorded at harvest and analyzed by location using PROC GLIMMIX (SAS 9.3). Separation of means at a significant level of P = 0.10 were completed using the LINES option in PROC GLIMMIX.

RESULTS AND DISCUSSION

Soybean yields showed significant differences in tillage and variety (Table 2). In Ottawa, the poor drainage variety (PD) showed higher yield than the good drainage. The opposite was found in Scandia (Table 3). Regarding to tillage, no-till was found to have higher yields in Scandia, but no significant differences in Ottawa.

Corn yields were affected by fertilizer placement (Table 2). Interactions between tillage and fertilizer, and, hybrid and fertilizer also showed significant differences. At Ottawa, broadcast treatment showed higher yields followed by deep band and control (Table 4). The interaction between tillage and fertilizer showed that no-till x broadcast; no-till x deep band; and strip-till x broadcast were the best combinations for yield. Also, the interaction between hybrid and fertilizer showed that DT x broadcast had the higher yield.

In Scandia, fertilized plots yielded significantly higher than the control plots. However, no differences were found between deep band and broadcast treatments.

CONCLUSIONS

The fertilizer treatment showed no effect on soybean yields in this study. Strip-till showed no yield increase for soybean or corn, since the yields were lower or equal to no-till. The interaction between the factors showed no differences in soybean.

For corn, broadcast fertilization showed higher yields than deep band in high STP soil, but no differences among fertilizer placement were found in a lower STP location.

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Table 1: Soil test values for two sites in 2014.

		Soil test values			
Location	Crop	STP	STK	pH	OM
		----- ppm -----			%
Ottawa	Pre-soybean	25.1	175.5	6.5	3.1
Ottawa	Pre-corn	25.9	164.8	6.2	3.9
Scandia	Pre-soybean	14.1	526.5	6.6	3.3
Scandia	Pre-corn	13.4	527.8	6.5	3.0

Abreviations: STP, soil test for phosphorus; STK, soil test for potassium; OM, organic matter.

Table 2. Levels of significance for tillage, placement and varieties/hybrids effects on soybean and corn yields in each location in 2014.

Variables	Ottawa	Scandia
	Yield	
	Soybean	
	---------- p > F ---------	
Tillage (T)	0.203	*0.069
Variety (V)	*<0.001	*0.003
T x V	0.404	0.429
Fertilizer (F)	0.415	0.265
T x F	0.902	0.681
V x F	0.225	0.306
T x F x V	0.287	0.502
	Corn	
Tillage (T)	0.363	0.682
Hybrid (H)	0.736	0.894
T x H	0.374	0.632
Fertilizer (F)	*<0.001	*0.074
T x F	*0.057	0.282
H x F	*0.011	0.760
T x F x H	0.403	0.138

* Significance at 0.10 alpha level.

Table 3. Tillage, placement and variety effects on soybean yield in each location in 2014.

Variables			Ottawa	Scandia
			Yield	
			------- bu ac^{-1} -------	
Tillage(T)	No till		23	62 a†
	Strip till		25	58 b
Variety (V)	PD		28 a	57 b
	GD		20 b	62 a
T X V	No till	PD	27	59
	No till	GD	20	65
	Strip till	PD	29	56
	Strip till	GD	20	60
Fertilizer (F)	Control		23	59
	Broadcast		23	61
	Deep band		25	60
T x F	No till	Control	23	62
	No till	Broadcast	23	62
	No till	Deep band	24	62
	Strip till	Control	24	57
	Strip till	Broadcast	24	60
	Strip till	Deep band	26	58
V x F	PD	Control	28	58
	PD	Broadcast	26	58
	PD	Deep band	29	58
	GD	Control	19	61
	GD	Broadcast	21	64
	GD	Deep band	20	62

Abbreviations: PD, poor drainage variety; GD, good drainage variety.

† Letters indicate a significant difference at $\alpha < 0.10$ using Proc GLIMMIX (SAS 9.3).

Table 4. Tillage, placement and hybrid effects on corn yield in each location in 2014.

Variables			Ottawa	Scandia
			Yield	
			------- bu ac^{-1} -------	
Tillage(T)	No till		128	202
	Strip till		126	198
Hybrid (H)	DT		127	200
	CT		128	200
T X H	No till	DT	127	206
	No till	CT	130	200
	Strip till	DT	127	197
	Strip till	CT	126	201
Fertilizer (F)	Control		98 c†	185 b
	Broadcast		146 a	210 a
	Deep band		138 b	205 a
T x F	No till	Control	96 c	187
	No till	Broadcast	146 a	222
	No till	Deep band	143 a	199
	Strip till	Control	100 c	184
	Strip till	Broadcast	145 a	199
	Strip till	Deep band	133 b	213
H x F	DT	Control	93 e	184
	DT	Broadcast	148 a	216
	DT	Deep band	140 bc	204
	CT	Control	103 d	187
	CT	Broadcast	143 ab	205
	CT	Deep band	136 c	208

Abbreviations: DT, drought tolerant hybrid; CT, conventional hybrid.

† Letters indicate a significant difference at $\alpha < 0.10$ using Proc GLIMMIX (SAS 9.3).

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