KANSAS FERTILIZER RESEARCH 2002

Report of Progress 903

Kansas State University
Agricultural Experiment Station
and Cooperative Extension Service

INTRODUCTION

The 2002 edition of the Kansas Fertilizer Research Report of Progress is a compilation of data collected by researchers across Kansas. Information was contributed by staff members of the Department of Agronomy and Kansas Agricultural Experiment Station, as well as agronomists at the various Agronomy Experiment Fields and Agricultural Research or Research-Extension Centers.

The investigators whose work is cited in this report greatly appreciate the cooperation of many county agents; farmers; fertilizer dealers; fertilizer equipment manufacturers; agricultural chemical manufacturers; and the representatives of the various firms who contributed time, effort, land, machinery, materials, and laboratory analyses. Without their support, much of the work reported here would not have been possible.

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Cover photo provided by Chad Godsey, KSU Soil Testing Laboratory

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Precipitation Data (Inches)

2001	Manhattan	S.W. KS RES-EXT. CTR Tribune	S.E. KS EXP. STA. Parsons	E. CEN EXP. FLD. Ottawa
August	6.87	1.76	2.57	3.16
September	5.67	0.42	4.08	3.90
October	1.47	0.12	4.21	2.16
November	0.71	0.29	3.36	0.22
December	1.00	0.11	0.96	0.55
Total 2001	38.90	13.74	37.77	33.65
Dept. Normal	5.08	-2.22	-2.25	-5.56
2002				
January	1.00	0.39	2.39	2.36
February	0.43	0.11	0.16	0.66
March	0.60	0.07	0.50	0.89
April	3.54	0.38	3.94	4.55
May	5.67	1.19	10.87	5.97
June	0.42	1.04	3.22	4.87
July	3.84	0.33	2.76	1.02
August	2.93	1.43	3.22	1.93
September	2.93	1.30	3.62	1.20

2001	N. CEN EXP. FLD. Belleville	KANSAS RV VALLEY EXP. FLD.	S. CEN. EXP. FLD. Hutchinson	FT. HAYS EXP. STN. Hays
August	0.54	4.82	1.25	1.84
September	6.71	2.14	3.06	5.45
October	2.21	1.90	1.15	1.18
November	0.56	1.30	0.11	0.50
December	Trace	0.00	0.16	0.04
Total 2002	35.89	29.96	22.96	29.11
Dept. Normal	5.00	-8.08	-7.36	6.48
2001				
January	0.51	1.51	1.91	0.52
February	0.95	0.58	0.58	0.31
March	0.83	0.58	0.78	0.39
April	2.19	3.58	2.58	2.17
May	3.44	0.96	2.88	2.09
June	2.16	0.92	6.59	0.94
July	0.47	3.26	1.40	2.54
August	2.58	1.59	6.04	4.02
September	1.33	3.65	0.83	1.32

WHEAT FERTILIZATION STUDIES
KANSAS STATE UNIVERSITY - DEPARTMENT OF AGRONOMY

EVALUATION OF CONTROLLED-RELEASE NITROGEN FERTILIZER FOR WINTER WHEAT PRODUCTION

R.E. Lamond, C.B. Godsey, and K. McVay

Summary

Urea-containing fertilizers can be subject to N loss via volatilization when surface applied without incorporation. When winter wheat is topdressed in the recommended time frame (November through February), volatilization losses are not a concern under normal environmental conditions. As topdressing is delayed, volatilization potential increases. Controlled release urea (urea with a polymer coating, CRU) releases N at a slower rate and could reduce the risk of volatilization.

In 2002, wheat yields were compared when either ammonium nitrate, urea, or CRU was topdressed on March 12. Yields with ammonium nitrate and urea were equal, but yields with CRU were significantly lower. With this late-planted wheat, N release from the coated urea was slow enough to decrease yields. The CRU did produce significantly higher grain protein.

Introduction

Volatilization loss of N can be a factor if urea-containing fertilizers are surface broadcast without incorporation under warm, moist conditions. Topdressing urea on wheat in the winter poses little risk of volatilization, but if topdressing is delayed, volatilization may be a bigger concern. Polymer coated, slow-release ureas may reduce risk of volatilization N losses.

Procedures

This study was initiated at the North Agronomy Farm on 'Jagger' winter wheat seeded late November 2001, following soybean harvest. On March 12, 2002, N rates of 30, 60 or 90 lb N/A were topdressed as either ammonium nitrate, urea, or CRU. A no-N check treatment was also included. Grain yields were determined and samples retained for protein analysis.

Results

With the late planting date, the wheat did not fully emerge until late February and yields were greatly affected by spring tillering. With good conditions through grain fill, excellent yields were obtained for the late planting date. Yields are summarized in Table 1.

Grain yields and protein were increased with N application up to 90 lb N/a. At least part of the response to N fertilizer was a dramatic increase in spring tillers. Ammonium nitrate and urea performed similarly and resulted in higher yields than the CRU. The poor performance of the CRU resulted from delayed N release, which limited spring tiller production. The CRU did produce higher grain protein, probably due to release of N too late to go to grain yield but soon enough to go into grain protein. This work will be repeated in 2003. A companion study on no-till grain sorghum is presented in the last section of this report.

Table 1. Evaluation of nitrogen rates and sources on no-till wheat, North Agronomy Farm, Manhattan, Kansas.

N	N	Leaf	Grain	
Rate	Source	N	Yield	Protein
lb/a		%	bu/a	%
0	--	1.76	31	10.1
30	Am. Nitrate	1.76	39	9.5
60	Am. Nitrate	2.31	49	10.2
90	Am. Nitrate	2.37	51	11.9
30	Urea	1.92	40	9.7
60	Urea	2.10	46	10.5
90	Urea	2.30	52	11.6
30	CRU	1.85	32	10.3
60	CRU	2.14	40	10.9
90	CRU	2.15	41	11.7
	LSD (.10)	0.14	8	0.7
Mean Values:				
N	30	1.84	37	9.8
Rate	60	2.18	45	10.6
	90	2.27	48	11.7
	LSD (.10)	0.14	4	0.4
N	Am. Nitrate	2.12	46	10.5
Source	Urea	2.11	46	10.6
	CRU	2.05	38	11.0
	LSD (.10)	NS	4	0.4

All N topdressed on March 12, 2002.

EVALUATION OF N RATES AND GLYPHOSATE ON NO-TILL WHEAT FOLLOWING GRAIN SORGHUM

R.E. Lamond, K. Rector, and C.B. Godsey

Summary

Grain sorghum, being a perennial, can continue to take up moisture and nutrients from the soil after harvest up to a killing freeze. This can possibly explain erratic performances of wheat no-till planted after grain sorghum. In this study, spraying grain sorghum after harvest with glyphosate (Roundup) produced slightly higher yields (2.8 bu/a). Application of higher than recommended N rates produced slightly higher yields.

Introduction

Planting winter wheat without tillage following grain sorghum harvest is a popular practice in Kansas. Since grain sorghum is a perennial, it can continue to take up soil moisture and nutrients until a killing freeze occurs. This situation provides at least a partial explanation of very erratic performance of wheat following sorghum and the observation that higher N rates may be needed under these circumstances.

Procedures

This study was conducted in Marion County. Following grain sorghum harvest, glyphosate (Roundup) was applied to one-half of the plots. Winter wheat was no-till planted with 30 lb N/a applied as a starter for all treatments. Later, N rates of an additional 70, 100, or 130 lb N/a were topdressed. Grain yields were determined at harvest.

Results

With good growing conditions up through grain fill, excellent yields were achieved (Table 2). There were good moisture conditions both in the fall-winter and spring. Even so, spraying the grain sorghum after harvest with glyphosate produced slightly higher yields. With the excellent yields, the best yields were obtained with 130 lb N/a, although yield was not significantly better than with 100 lb N/a. These results, in addition to results of related work, suggest higher N rates should be recommended for wheat following grain sorghum. This adjustment is being built into the revised Kansas State University recommendations.

Table 2. Evaluation of nitrogen rates and glyphosate on no-till wheat following grain sorghum, Marion Co., Kansas, 2002.

N Rate*	Roundup	Grain Yield
lb/a		bu/a
70	No	65.6
100	No	67.6
130	No	72.9
70	Yes	69.8
100	Yes	73.6
130	Yes	71.1
LSD (.10)		NS
LSD (.20)		4.6
Mean Values:		
N Rate	70	67.7
	100	70.6
	130	72.0
LSD (.10)		NS
LSD (.20)		3.2
Roundup	No	68.7
	Yes	71.5
LSD (.10)		NS
LSD (.20)		2.6

*All treatments received 30 lb N/a as a starter.

EVALUATION OF CHLORIDE FERTILIZATION ON WINTER WHEAT

R.E. Lamond, K. Rector, and C.B. Godsey

Summary

Several years of research on Cl fertilization of wheat in Kansas has shown consistent response to Cl fertilization whenever soil Cl levels are low (<20 lb/a or 3-4 ppm). In this study, wheat yields were significantly increased by Cl fertilization.

Introduction

Chloride fertilization has been shown to increase yields of small grain crops. The positive yield response can be due to a typical nutrient response on soils with a low level of Cl. Research has also shown Cl fertilization can slow the progression of certain leaf diseases, which also could be a mechanism for higher yields. It is not unusual to find low soil Cl levels in central Kansas since soil potassium (K) levels are usually high enough that no additional K is recommended. Potassium chloride (KCl) is the usual K source, but since K is rarely needed, little of this fertilizer is used in this region. As a result, no Cl has been applied over the years, likely resulting in low soil Cl levels.

Procedures

Chloride at rates of 10, 20, or 30 lbs Cl/a was topdressed as KCl on established winter wheat in Marion County. A soil sample was taken from the study area and showed a low Cl level (3 ppm) and a high K level of 200 ppm. Wheat grain yields were determined at harvest.

Results

Results are summarized in Table 3. Even with relatively low yields at the study site, application of Cl fertilizer on this low Cl soil resulted in a significant increase in wheat grain yields. These results corroborate earlier work. Current recommendations for wheat are to apply 10-20 lb Cl/a if soil Cl levels are low (< 6 ppm).

Table 3. Evaluation of chloride application on winter wheat, Marion Co., Kansas, 2002.

Cl Rate	Grain Yield
lb/a	bu/a
0	29.6
10	34.5
20	31.3
30	33.9
LSD (.05)	3.1
LSD (.10)	2.5

Cl topdressed as KCl, soil Cl = 3 ppm.

GRASS FERTILIZATION STUDIES
KANSAS STATE UNIVERSITY - DEPARTMENT OF AGRONOMY

BROMEGRASS FERTILIZATION STUDIES

R.E. Lamond, H.C. George, C.B. Godsey, and G.L. Kilgore

Summary

Nitrogen (N) is the major component of fertilization programs for cool-season grasses. However, bromegrass used for haying or grazing removes large amounts of phosphorus (P) from the soil. Results from these studies confirm that bromegrass responds to P fertilization, particularly when P soil test levels are low. Good efficiency of applied N will not be achieved until P needs are met. Results also indicate a consistent response to the addition of sulfur (S).

Introduction

A significant acreage of established smooth bromegrass in Kansas has low soil test levels of phosphorus (P) and/or potassium (K). Also, recent research has shown bromegrass to respond consistently to sulfur (S) fertilization. When these nutrients are deficient, bromegrass can't fully utilize applied nitrogen (N). These studies were established to evaluate N-P-K-S fertilization of bromegrass.

Procedures

Studies were continued in 2002 at three sites in Miami County to evaluate N, P, and S fertilization. Sites were low to medium in available P. All fertilizer was applied in February, and grass was harvested in late May at all sites. Forage samples were retained for analyses.

Results

The 2002 results are summarized in Table 1. Forage yields were average at all locations, and yields were consistently increased by N application. Nitrogen fertilization also significantly increased forage protein levels. Phosphorus fertilization increased brome forage yields, particularly at sites with low soil P tests. At the sites with soil P levels less than 10 ppm, the addition of 30 lbs P_2O_5/a produced an additional 955 lb/a of forage. On soils with low P levels, the inclusion of phosphorus in the fertilization program is essential for optimum forage production.

The addition of S fertilizer consistently produced higher yields. The addition of S produced an extra 1200 lb/a of forage, averaged over the three sites. These results confirm earlier work indicating that bromegrass is a consistent responder to S fertilization. Producers who are managing bromegrass for maximum forage production should consider including S in their nutrient management plans. Results of this work over the past 4 years confirm that P is an essential part of bromegrass fertilization programs, especially when soil P tests are low (<10 ppm). These studies will be continued in 2003.

Table 1. Fertility management on bromegrass, Miami Co., Kansas, 2002.

			Forage						
			Site "S"			Site "NE"			Site "NM"
N	P_2O_5	S	Yield	Pro	P	Yield	Pro	P	Yield
- - - - - - - lb/a - - - - - - -			lb/a			lb/a			lb/a
0	0	0	2450	8.5	.15	1070	9.1	.22	3390
40	0	0	4980	9.0	.12	3660	7.5	.18	5120
80	0	0	5890	10.7	.11	5330	9.0	.16	5980
120	0	0	6660	10.9	.11	6320	11.2	.22	6250
40	30	0	5800	8.3	.18	3690	8.6	.22	6500
80	30	0	6890	8.5	.15	5210	9.8	.25	6680
120	30	0	8190	12.1	.19	6440	10.9	.26	6540
80	30	20	8400	10.9	.18	6290	9.7	.25	7750
LSD (0.10)			880	1.9	.03	1085	1.8	.05	1300
Mean Values									
N	40		5390	8.6	.15	3670	8.0	.20	5810
Rate	80		6390	9.6	.13	5270	9.4	.20	6330
	120		7430	11.5	.15	6380	11.1	.24	6400
LSD (0.10)			640	1.4	NS	470	1.4	NS	NS
P_2O_5	0		5840	10.2	.11	5100	9.2	.18	5780
Rate	30		6960	9.7	.17	5110	9.8	.24	6570
LSD (0.10)			520	NS	.02	NS	NS	.03	730
Soil Test P, ppm				4			24		8

SOIL FERTILITY RESEARCH
SOUTHWEST RESEARCH - EXTENSION CENTER

IMPACT OF LONG-TERM NITROGEN AND PHOSPHORUS FERTILIZATION ON SOIL CHEMICAL PROPERTIES

A.J. Schlegel

Summary

Soil organic matter was increased by nitrogen (N) and phosphorus (P) fertilization. Soil pH was decreased by increased N rates. Application of 40 lb P_2O_5/a was not sufficient to maintain soil test P levels for corn but was for grain sorghum. Increasing N rates for both corn and sorghum increased residual soil NO_3-N. Phosphorus fertilization reduced accumulation of residual NO_3-N up to 50%.

Introduction

This study was initiated in 1961 to determine responses of continuous corn and grain sorghum grown under flood irrigation to nitrogen (N), phosphorus (P), and potassium (K) fertilization. Long-term results show that P and N fertilizer must be applied to optimize production of irrigated corn and grain sorghum in western Kansas. Soil chemical properties in the surface soil and residual NO_3-N in the soil profile were determined after 40 years of fertilization.

Procedures

Fertilizer treatments were initiated in 1961 to corn and grain sorghum in adjacent fields. Treatments were N rates of 0, 40, 80, 120, 160, and 200 lb N/a without P and K; with 40 lb P_2O_5/a and zero K; and with 40 lb P_2O_5/a and 40 lb K_2O/a. In 1992, the treatments for the corn study were changed with the K variable being replaced by a higher rate of P (80 lb P_2O_5/a). All fertilizers were broadcast by hand in the spring and incorporated prior to planting. The soil is a Ulysses silt loam. Both studies were furrow-irrigated to minimize water stress. Soil samples (0-6 in. and 0 to 12 ft) were taken in both studies following harvest in 2000.

Results

Long-term N applications decreased soil pH while increasing soil organic matter (Tables 1 and 2). Phosphorus fertilization had no effect on soil pH while slightly increasing OM in both studies. In the corn study, soil test P was 8 ppm higher with 40 lb/a P_2O_5 than without P (12 vs. 4 ppm), but was still less than at the start of the study (17 ppm Bray-1 P in 1961). Application of 80 lb/a P_2O_5 for 9 years to corn increased soil test P to 21 ppm. In the sorghum study, soil test P increased with increasing N rates. Averaged across N rates, K fertilization increased soil K levels by 70 ppm.

Soil NO_3-N concentrations to 12 ft depth for selected treatments are shown in Tables 3 and 4. Soil NO_3-N increased with increasing N rates, but was quite variable at the higher N rates, especially in the corn study. The estimated amount of residual NO_3-N for three profile depths (0-2 ft, 2-5 ft, and 5-12 ft) and the total in the profile are shown in Tables 5 and 6. In the corn study, increasing N rates increased residual NO_3-N for all profile depths. Similar trends were also observed with sorghum. In general, P fertilization reduced NO_3-N content with a 50% reduction in the sorghum study.

Table 1. Effects of long-term nitrogen and phosphorus fertilizers on soil properties of irrigated corn, Tribune, KS, Fall, 2000.

Nitrogen	P_2O_5	pH	OM	CEC	Bray-1 P
- - - - - - - lb/a	- - - - - - -		%	meq/100g	ppm
0	0	7.9	2.0	32.52	2
0	40	7.9	2.1	32.8	16
0	80	7.9	2.1	31.1	25
40	0	7.9	2.2	31.4	4
40	40	7.9	2.2	30.9	12
40	80	7.8	2.2	31.5	22
80	0	7.8	2.2	31.5	6
80	40	7.7	2.3	30.4	10
80	80	7.8	2.3	31.4	23
120	0	7.8	2.2	31.8	3
120	40	7.8	2.2	32.0	10
120	80	7.8	2.2	31.3	17
160	0	7.7	2.2	30.7	4
160	40	7.6	2.4	30.4	13
160	80	7.6	2.4	31.4	17
200	0	7.5	2.3	28.3	5
200	40	7.5	2.4	30.5	11
200	80	7.4	2.4	29.0	26
ANOVA					
N		0.001	0.001	0.001	0.120
Linear		0.001	0.001	0.001	0.407
Quadratic		0.005	0.212	0.136	0.017
P_2O_5		0.550	0.004	0.909	0.001
Linear		0.309	0.020	0.870	0.001
Quadratic		0.695	0.013	0.686	0.534
N x P		0.976	0.864	0.481	0.251
MEANS					
N, lb/a	0	7.9	2.1	32.1	14
	40	7.9	2.2	31.3	13
	80	7.8	2.3	31.1	13
	120	7.8	2.2	31.7	10
	160	7.6	2.3	30.9	11
	200	7.4	2.4	29.3	14
$LSD_{0.05}$		0.1	0.1	1.3	3
P_2O_5, lb/a	0	7.7	2.2	31.0	4
	40	7.7	2.3	31.2	12
	80	7.7	2.3	31.0	21
$LSD_{0.05}$		0.1	0.1	0.9	2

Table 2. Effects of long-term (40 yr) nitrogen, phosphorus, and potassium fertilizer on soil properties of irrigated grain sorghum, Tribune, KS, Fall, 2000.

Nitrogen	P_2O_5	K_20	pH	OM	CEC	Bray-1 P	K
- - - - - - - - lb/a - - - - - - - - -				%	meq/100g	- - - ppm - - -	
0	0	0	7.7	2.2	29	5	636
0	40	0	7.6	2.2	28	23	625
0	40	40	7.6	2.2	28	20	688
40	0	0	7.6	2.2	27	5	640
40	40	0	7.2	2.4	27	17	652
40	40	40	7.4	2.2	27	23	747
80	0	0	7.1	2.3	27	10	653
80	40	0	7.3	2.4	28	26	657
80	40	40	7.3	2.4	28	23	717
120	0	0	7.3	2.3	28	8	652
120	40	0	7.1	2.4	28	27	661
120	40	40	7.1	2.5	28	36	747
160	0	0	7.0	2.2	26	11	622
160	40	0	6.9	2.3	27	34	657
160	40	40	7.0	2.4	28	24	704
200	0	0	6.8	2.4	27	22	657
200	40	0	6.9	2.4	28	28	618
200	40	40	6.8	2.5	27	34	692
<u>ANOVA</u>							
N			0.001	0.031	0.018	0.005	0.052
Linear			0.001	0.008	0.037	0.001	0.835
Quadratic			0.737	0.466	0.721	0.695	0.004
P_2O_5-K_20			0.532	0.045	0.690	0.001	0.001
Zero P vs. P			0.414	0.013	0.405	0.001	0.001
P vs. PK			0.442	0.944	0.835	0.796	0.001
N x PK			0.738	0.878	0.760	0.404	0.454
<u>MEANS</u>							
N, lb/a		0	7.6	2.2	28	16	650
		40	7.4	2.3	27	15	680
		80	7.2	2.4	28	19	675
		120	7.2	2.4	28	23	687
		160	7.0	2.3	27	23	661
		200	6.8	2.4	27	28	656
$LSD_{0.05}$			0.2	0.1	1	7	27
P_2O_5-K_20, lb/a		0	7.3	2.3	27	10	643
		40-0	7.2	2.4	28	26	645
		40-40	7.2	2.4	28	26	716
$LSD_{0.05}$			0.2	0.1	1	5	19

Table 3. Soil NO_3-N concentration after long-term nitrogen and phosphorus fertilization of irrigated continuous corn, Tribune, KS, Fall 2000.

		Depth, ft											
N	P_2O_5	1	2	3	4	5	6	7	8	9	10	11	12
		NO_3-N, ppm											
0	0	2	1	1	1	1	1	2	1	1	1	1	2
	40	5	2	2	2	3	2	2	2	2	3	2	2
	80	3	2	2	1	1	1	1	1	2	1	2	1
80	0	38	7	5	5	6	5	5	5	6	4	4	5
	40	4	3	2	2	2	2	2	2	2	2	2	2
	80	38	4	14	7	5	8	6	6	4	4	4	6
160	0	4	2	2	2	4	6	10	9	10	9	9	8
	40	89	15	11	10	26	21	31	10	31	12	7	8
	80	40	2	2	2	6	4	3	7	6	3	2	3
200	0	141	32	25	31	46	39	19	12	29	16	9	11
	40	5	3	3	4	5	5	7	7	7	6	5	7
	80	79	13	6	9	25	17	10	9	25	6	6	5

Note: The 80 lb/a rate of P_2O_5 was applied starting in 1992, prior to then it was 40 lb/a. All other rates were applied annually since 1961.

Table 4. Soil NO_3-N concentration after long-term (40 yr) nitrogen and phosphorus fertilization of irrigated continuous grain sorghum, Tribune, KS, Fall 2000.

		Depth, ft											
N	P_2O_5	1	2	3	4	5	6	7	8	9	10	11	12
		NO_3-N, ppm											
0	0	1	1	2	2	1	1	1	1	1	1	1	2
	40	1	2	2	1	1	1	1	1	1	1	2	1
80	0	21	5	10	10	23	8	9	8	11	9	9	13
	40	13	5	10	6	8	4	7	6	11	4	8	5
120	0	25	10	11	19	20	16	15	12	19	16	12	11
	40	22	4	7	11	10	5	7	7	12	6	6	8
160	0	48	27	27	23	25	15	18	23	25	18	13	14
	40	11	5	6	6	12	6	5	7	8	4	5	8
200	0	23	14	17	19	25	13	16	18	31	23	18	36
	40	15	8	6	7	21	9	7	7	15	9	8	11

Note: Fertilizer was applied annually since 1961.

Table 5. Profile soil NO_3-N following long-term nitrogen and phosphorus fertilization to irrigated corn, Tribune, KS, Fall 2000.

		Profile			
N	P_2O_5	0-2'	2-5'	5-12'	0-12'
		- - - - - - - - - - - - - - - - -NO_3-N, lb/a - - - - - - - - - - - - - - -			
0	0	14	12	34	59
	40	23	23	50	96
	80	17	16	34	67
80	0	162	55	117	333
	40	25	22	47	94
	80	152	86	126	364
160	0	22	24	205	251
	40	375	152	398	925
	80	152	33	94	279
200	0	624	340	453	1417
	40	28	38	149	216
	80	331	130	260	721
ANOVA					
N		0.001	0.001	0.001	0.001
P		0.360	0.042	0.118	0.153
NxP		0.001	0.001	0.001	0.001
MEANS					
N, lb/a	0	18	17	39	74
	80	113	54	97	264
	160	183	70	233	485
	200	328	170	287	785
	$LSD_{0.05}$	149	47	81	317
P_2O_5, lb/a	0	205	108	202	515
	40	113	59	161	333
	80	163	67	129	358
	$LSD_{0.05}$	129	41	70	274

Note: The 80 lb/a rate of P_2O_5 was applied starting in 1992, prior to then it was 40 lb/a. All other rates were applied annually since 1961.

Table 6. Profile soil NO_3-N following long-term nitrogen and phosphorus fertilization to irrigated grain sorghum, Tribune, KS, Fall 2000.

		Profile			
N	P_2O_5	0-2'	2-5’	5-12’	0-12’
		- - - - - - - - - - - - - - -NO_3-N, lb/a - - - - - - - - - - - - - - -			
0	0	10	15	32	57
	40	10	12	29	51
80	0	91	143	220	454
	40	63	80	147	289
120	0	126	164	337	627
	40	92	92	170	355
160	0	271	249	421	941
	40	60	81	144	285
200	0	133	203	522	858
	40	85	114	224	423
ANOVA					
N		0.001	0.001	0.001	0.001
P		0.001	0.001	0.001	0.001
NxP		0.004	0.201	0.147	0.062
MEANS					
N, lb/a	0	10	14	30	54
	80	77	111	184	372
	120	109	128	253	491
	160	165	165	283	613
	200	109	159	373	641
	$LSD_{0.05}$	56	68	135	243
P_2O_5, lb/a	0	126	155	306	587
	40	62	76	143	281
	$LSD_{0.05}$	35	43	86	154

Note: Fertilizers were applied annually since 1961.

EFFECTS OF LAND APPLICATION OF ANIMAL WASTES ON SOIL PROPERTIES

A.J. Schlegel, L.R. Stone, and H.D. Bond

Summary

This study evaluated established best management practices for land application of animal wastes on crop productivity and soil properties. Swine (effluent water from a lagoon) and cattle (solid manure from a beef feedlot) wastes were applied at rates to meet corn phosphorus (P) or nitrogen (N) requirements along with a rate double the N requirement. Other treatments were N fertilizer (40, 100, and 140 lb N/a) and an untreated control. Soil test P was increased by application of both cattle and swine wastes, but more so by application of cattle manure. Nitrate-N accumulation below the crop root zone (5 ft) was not significantly increased by animal waste applications, unless they were applied at excessive rates (2xN rate). Soil organic carbon levels were increased by application of cattle manure, while application of swine effluent had no effect on soil C. Animal wastes can be effectively utilized for crop production by limiting application rates to recommended levels and monitoring soil test P levels.

Introduction

The potential for animal wastes to recycle nutrients, build soil quality, and increase crop productivity is well established. A concern with land application of animal wastes is that excessive applications may damage the environment through excessive accumulation (and subsequent loss) of nutrients. This study evaluated established best management practices for land application of animal wastes on crop productivity and soil properties.

Procedures

This study was initiated in 1999 to determine the effect of land application of animal wastes on crop production and soil properties. The two most common animal wastes in western Kansas were evaluated; solid cattle manure from a commercial beef feedlot and effluent water from a lagoon on a commercial swine facility. The rate of waste application was based on the amount needed to meet the estimated crop P requirement, crop N requirement, or twice the N requirement with allowances for residual soil nutrients (Table 7) and nutrient content of the wastes (Table 8). Other treatments were three rates of N fertilizer (40, 100, and 140 lb N/a) along with an untreated control.

Soil test P and organic C levels were determined in the surface soil (0-6 in.) and residual nitrate-N in the profile (0-8 ft) in the fall of 2001 after 3 annual applications of animal wastes. The amount of nitrate-N that accumulated below 5 ft, the assumed crop rooting depth, is shown in Table 9.

Results

Soil test P increased more with application of cattle manure than swine effluent (Table 9). Soil test P was greatest (about 100 ppm greater than the untreated control) when cattle manure was applied at the 2xN rate. Soil test P levels were twice as high with swine effluent than the untreated control. Although these levels of soil test P (even with 2xN cattle manure) are not hazardous to plant growth and are below the threshold values to limit application of swine wastes from larger operations, they do show the need to monitor soil test P levels when applying animal wastes. Application of both swine effluent and cattle manure at the 2xN rate increased residual nitrate-N in the 6-8 ft depth in the soil profile (below the expected root zone of corn), while application at recommended levels had little impact on the amount of residual nitrate-N. A positive impact from application of cattle manure was increased soil organic C levels, reflecting the greater amounts of C in solid manure than in lagoon effluent.

Table 7. Application rates of animal wastes, Tribune, KS, 1999 to 2002.

	Cattle Manure				Swine Effluent			
Application Basis	1999	2000	2001	2002	1999	2000	2001	2002
	- - - - - - ton/a - - - - - -				- - - - - - 1000 gal/a - - - - - -			
P requirement	15.0	4.1	6.6	5.8	28.0	75.0	62.0	63.4
N requirement	15.0	6.6	11.3	11.4	28.0	9.4	38.0	0
2xN requirement	30.0	13.2	22.6	22.8	56.0	18.8	76.0	0

Table 8. Analysis of animal wastes, Tribune, KS, 1999 to 2002.

	Cattle Manure				Swine Effluent			
Nutrient Content	1999	2000	2001	2002	1999	2000	2001	2002
	- - - - - - lb/ton - - - - - -				- - - - - lb/1000 gal - - - - -			
Total N	27.2	36.0	33.9	25.0	8.65	7.33	7.83	11.62
Total P_20_5	29.9	19.6	28.6	19.9	1.55	2.09	2.51	1.60

Table 9. Effects of three annual applications of animal waste on soil test P and C (0-6 in. depth) and residual soil nitrate-N below 5 ft depth (6-8 ft depth), Tribune, KS, Fall 2001.

Nutrient source	Rate†	Bray 1-P	Organic C	Profile Nitrate-N
		ppm	%	lb/a
Cattle manure	P	73	1.25	24
	N	94	1.35	41
	2 x N	127	1.59	147
Swine effluent	P	43	1.12	34
	N	35	1.07	41
	2 x N	36	1.07	180
N fertilizer	40 N	16	1.09	12
	100 N	18	1.05	18
	140 N	20	1.02	68
Control	0	22	1.07	22
$LSD_{0.05}$		24	0.12	50

† Rate of application is based on projected crop P requirement, N requirement, or twice (2x) the N requirement.

SOIL FERTILITY RESEARCH
SOUTHEAST AGRICULTURAL RESEARCH CENTER

EFFECT OF TIMING OF LIMITED-AMOUNT IRRIGATION AND N RATE ON SWEET CORN PLANTED ON TWO DATES

D.W. Sweeney and C.W. Marr

Summary

In 2001, irrigation did not increase the number of harvestable ears, but did increase individual ear weight. Early planting increased total fresh weight and individual ear weight. Nitrogen applied at 120 lb/a increased number of ears and total fresh weight.

Introduction

Field corn responds to irrigation and timing of water deficits can affect yield components. Sweet corn is considered as a possible value-added, alternative crop for producers. Even though large irrigation sources, such as aquifers, are lacking in southeastern Kansas, supplemental irrigation could be supplied from the substantial number of small lakes and ponds in the area. Literature is lacking on effects of irrigation management, nitrogen (N) rate, and planting date on the performance of sweet corn.

Procedures

The experiment was established on a Parsons silt loam in spring 1999 as a split-plot arrangement of a randomized complete block with three replications. The whole plots included four irrigation schemes: 1) no irrigation, 2) 2 in. at V12 (12-leaf stage), 3) 2 in. at R1 (silk stage), 4) 1 in. at both V12 and R1; and two planting dates (targets of late April and mid-May). The subplots were three N rates – 40, 80, and 120 lb/a. Sweet corn was planted on April 25 and May 15, 2001. Sweet corn from the first planting date was picked on July 6 and 11 and that from the second planting date was picked on July 24 and 30, 2001.

Results

Although the total number of ears was unaffected by planting date, the total fresh weight and individual ear weight were greater for sweet corn planted in late April than that planted in mid-May (Table 1). Irrigation did not increase the total number of ears in 2001, perhaps because of approximately 50% greater than normal rainfall during June. However, individual ear weights were significantly greater with irrigations at V12 or R1 compared to no irrigation. Nitrogen fertilization at 120 lb/a resulted in greater than 10% more ears and more total fresh weight. However, individual ear weight was not affected by N fertilization rate.

Table 1. Effects of irrigation scheme and nitrogen rate on sweet corn planted at two dates, Southeast Agricultural Research Center, KS.

Treatment	Total Ears	Total Fresh Weight	Individual Ear Weight
	no./a	ton/a	g/ear
Planting Date (2001)			
April 25	19900	5.52	252
May 15	19300	4.77	225
LSD $_{(0.05)}$	NS	0.53	10
Irrigation Scheme			
None	19300	4.81	224
V12 (2")	20000	5.41	246
R1 (2")	18800	5.08	246
V12-R1 (1" at each)	20400	5.30	236
LSD $_{(0.05)}$	NS	NS	14
N Rate, lb/a			
40	18400	4.80	239
80	18900	5.05	238
120	21100	5.59	237
LSD $_{(0.05)}$	1500	0.38	NS

TILLAGE AND NITROGEN FERTILIZATION EFFECTS ON YIELDS IN A GRAIN SORGHUM - SOYBEAN ROTATION

D.W. Sweeney

Summary

In 2001, grain sorghum yields were unaffected by tillage. Yields were increased by approximately 50% by nitrogen fertilization, although there were no differences among N sources.

Introduction

Many rotational systems are employed in southeastern Kansas. This experiment was designed to determine the long-term effect of selected tillage and nitrogen (N) fertilization options on the yields of grain sorghum and soybean in rotation.

Procedures

A split-plot design with four replications was initiated in 1983, with tillage system as the whole plot and N treatment as the subplot. The three tillage systems were conventional, reduced, and no tillage. The conventional system consisted of chiseling, disking, and field cultivation. The reduced-tillage system consisted of disking and field cultivation. Glyphosate (Roundup) was applied each year at 1.5 qt/a to the no-till areas. The four N treatments for the odd-year grain sorghum crops from 1983 to 1999 were: a) no N (check), b) anhydrous ammonia knifed to a depth of 6 in., c) broadcast urea-ammonium nitrate solution (UAN - 28% N), and d) broadcast solid urea. The N rate was 125 lb/a. Harvests were collected from each subplot for both grain sorghum (odd years) and soybean (even years). Effects of residual N were addressed for soybean, even though N fertilization was applied only to grain sorghum.

Results

In 2001, grain sorghum yields averaged near 70 bu/a (data not shown). Yields were unaffected by tillage. Applying N in any form increased grain sorghum yields by 25-30 bu/a, but there were no differences among N sources.

EFFECTS OF RESIDUAL SOIL PHOSPHORUS AND POTASSIUM FOR GLYPHOSATE-TOLERANT SOYBEAN PLANTED NO-TILL

D.W. Sweeney

Summary

In 2001, antecedent soil K test levels had a greater effect on yield and yield components than soil P test levels.

Introduction

The response of soybean to phosphorus (P) and potassium (K) fertilization can be sporadic and producers often omit these fertilizers. As a result, soil test values can decline. Acreage planted with no tillage may increase because of new management options such as glyphosate-tolerant soybean cultivars. However, data are lacking regarding the importance of soil P and K levels on yield of glyphosate-tolerant soybean grown with no tillage.

Procedures

The experiment was established on a Parsons silt loam in spring 1999. Since 1983, fertilizer applications have been maintained to develop a range of soil P and K levels. The experimental design is a factorial arrangement of a randomized complete block with three replications. The three residual soil P levels averaged 5, 11, and 28 ppm, and the three soil K levels averaged 52, 85, and 157 ppm at the conclusion of the previous experiment. Roundup Ready® soybean was planted on May 26, 1999, May 30, 2000, and June 18, 2001 at approximately 140,000 seed/a with no tillage.

Results

In 1999, wet conditions during the early part of the growing season followed by dry conditions resulted in low overall soybean yields of less than 14 bu/a (data not shown). Increasing soil P test level from 5 ppm to over 10 ppm increased yield about 20%. This was primarily because of an increased number of seeds per plant. Soil P levels did not affect population or seed weight. Soil test K levels had no effect on yield or yield components. In 2000, drought conditions resulted in lower average yields (<12 bu/a) than in 1999. As a result, yield or yield components were either not affected or were influenced by an unexplainable interaction between P and K fertility levels (data not shown).

In 2001, environmental conditions were somewhat more favorable than 1999 and 2000, resulting in soybean yields greater than 20 bu/a (Table 2). Although greater soil P levels appeared to slightly increase yield, the difference was not significant. However, increased number of pods/plant with increased soil test P may suggest a potential for increased yield under better growing conditions. Soil K level increased glyphosate-tolerant soybean yield by as much as 37% compared to plots that have never received K fertilizer. This yield increase appeared to be related to increases in seed weight, pods/plant, and seeds/pod as soil K level increased.

Table 2. Effects of antecedent soil phosphorus and potassium test levels on glyphosate-tolerant soybean yield and yield components, Southeast Agricultural Research Center, 2001.

Initial Soil Test Level	Yield	Population	Seed Weight	Pods/plant	Seeds/pod
	bu/a	plants/a	mg		
P (ppm)	22.5	98 000	133	21	1.8
5	25.4	100 000	130	28	1.7
11	24.2	96 000	125	30	1.8
28	NS	NS	NS	4	NS
LSD $_{(0.05)}$					
K (ppm)					
52	20.1	99 000	119	22	1.6
85	24.4	96 000	132	29	1.8
157	27.6	98 000	137	28	1.9
LSD $_{(0.05)}$	3.5	NS	9	4	0.2
PxK Interaction	NS	NS	NS	NS	NS

EFFICIENT NITROGEN MANAGEMENT FOR SEED AND RESIDUAL FORAGE PRODUCTION OF ENDOPHYTE-FREE TALL FESCUE

D.W. Sweeney and J.L. Moyer

Summary

Clean seed yield of endophyte-free tall fescue was greater with late fall application than with late winter application at the 150 lb/a N rate. Forage aftermath was increased with increasing N rates up to 150 lb/a and subsurface knife applications, but was unaffected by N timing.

Introduction

Nitrogen fertilization is important for fescue and other cool-season grasses. However, management of nitrogen (N) for seed production is less defined, especially because endophyte-free tall fescue may need better management than infected stands. Nitrogen fertilizer placement has been shown to affect forage yields, but data are lacking regarding the yield and quality of the aftermath remaining after seed harvest. The objective of this study is to determine the effect of timing, placement, and rate of N applied to endophyte-free tall fescue for seed and aftermath forage production.

Procedures

The experiment was established as a 2x3x5 factorial arrangement of a completely randomized block design with three replications. The two N timings were late fall (Dec. 2, 1998, Dec. 6, 1999, and Dec. 4, 2000) and late winter (Feb. 24, 1999, Mar. 1, 2000, and Mar. 6, 2001). The three placements for urea-ammonium nitrate solution were broadcast, spoke (approx. 3 in. deep), and knife (approx. 4 in. deep). The five N rates were 0, 50, 100, 150, and 200 lb/a. Each fall, all plots received broadcast applications of 50 lb P_2O_5/a and 50 lb K_2O/a. Seed harvest was on June 11, 1999, June 8, 2000, and June 11, 2001 and forage aftermath was harvested on June 14, 1999, June 12, 2000, and June 14, 2001.

Results

In 2001, late fall application of N at rates up to 150 lb/a resulted in increased clean seed yield (Figure 1). With late winter application, clean seed yield increased with increasing rates to 100 lb N/a but did not appear to benefit from higher N rates. This likely was associated with the number of panicles/m^2.

Yield of the forage aftermath left following seed harvest was increased by increasing N rates up to 150 lb/a but was not increased further by N applied at 200 lb/a (Figure 2). Subsurface placement by knifing resulted in more than 0.2 tons/a additional aftermath forage than broadcast surface or spoke subsurface N applications in 2001, with no effect due to timing of N fertilization (data not shown).

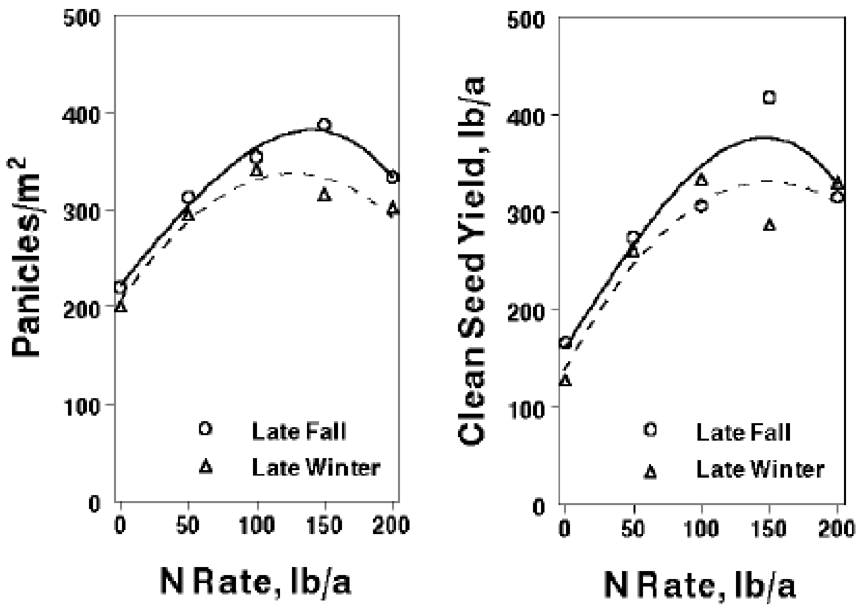

Figure 1. Effects of nitrogen timing and rate on clean seed yield and panicle count of endophyte-free tall fescue in 2001, Southeast Agricultural Research Center.

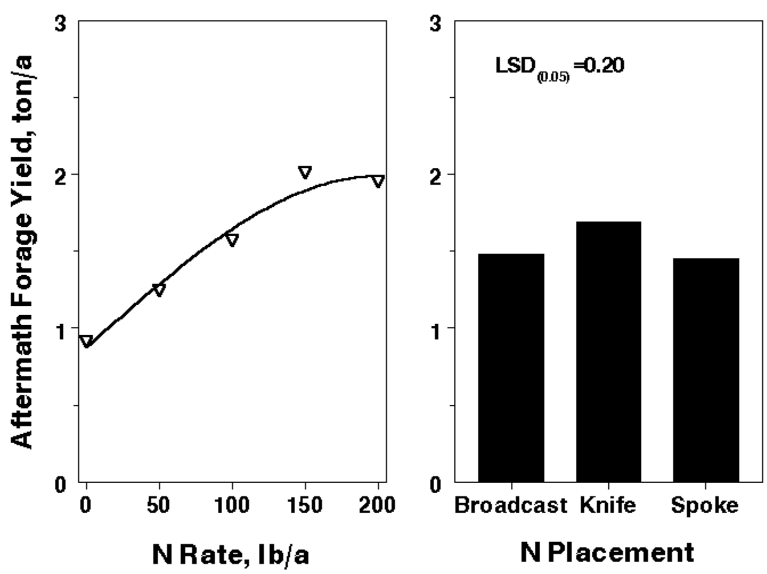

Figure 2. Effects of nitrogen rate and placement on forage aftermath following seed harvest of endophyte-free tall fescue in 2001, Southeast Agricultural Research Center.

EVALUATION OF STARTER AND POP-UP FERTILIZERS ON GRAIN SORGHUM PLANTED NO-TILL

D.W. Sweeney

Summary

In 2000 and 2001, starter and pop-up fertilizers had little effect on grain sorghum growth, yield, or yield components.

Introduction

Starter and pop-up fertilizers have the potential to improve early growth of grain sorghum, thus increasing yield. The objective of these experiments was to determine the effect of starter and pop-up fertilizers on the production and growth of grain sorghum planted no-till in southeastern Kansas.

Procedures

Two experiments were established at the Mound Valley Field of the Kansas State University Southeast Agricultural Research Center. The soil was a Parsons silt loam, a typical claypan soil of the area. Initial soil test values were 6.9 pH (1:1 soil:water), 31 ppm P (Bray-1), and 135 ppm K (1M ammonium acetate).

Experiment 1 was a 3 x 4 factorial arrangement of a randomized complete block design with four replications. The three placements of the starter fertilizer were 2x2, 2x0 (two inches to the side of the row on the surface), and 0x0 (over the row on the surface). The four starter rates were 15-30-10, 30-30-10, 45-30-10, and 60-30-10. All 12 treatments had additional UAN broadcast prior to planting for a total N rate of 120 lb/a. Two additional reference treatments were included in each replication: 120-30-10 applied broadcast before planting and a 0-0-0 control. Experiment 2 was a 3 x 2 factorial arrangement of a randomized complete block design with four replications. The three pop-up fertilizer rates were 5-15-5, 15-15-5, and 30-15-5. The second factor was NBPT (urease inhibitor) applied at 0 or 2.4 qts per ton of 28% UAN. These six treatments also had additional UAN broadcast prior to planting to make a total N rate of 120 lb/a. Three additional reference treatments were included in each replication: 120-15-5 applied broadcast before planting with or without NBPT and a 0-0-0 control. In both experiments, fertilizer solutions were formulated using UAN (28% N) and 7-21-7.

Pioneer 8500c grain sorghum was planted in 30-in. rows in both experiments in both years. Planting dates for Experiment 1 were June 13, 2000 and May 23, 2001 and for Experiment 2 were July 5, 2000 and May 23, 2001. In both experiments, whole plant samples were taken at the 8-leaf, boot, soft dough, and physiological maturity (black layer) growth stages. Yield was determined by harvesting with a plot combine. In addition, initial stand, head count, and seed weight were measured and the number of kernels per head was calculated.

Results

Environmental conditions in both years were generally hot and dry, especially in early July, all of August, and early September. Conditions were more severe in 2000, but even in 2001 plants appeared stressed by low rainfall amounts that likely did not satisfy ET requirements.

Experiment 1

Across both years, the main effects of starter placement or rate or their interaction did not significantly affect dry matter production at the 8-leaf, boot, soft dough, or physiological maturity growth stages. Contrasts showed no differences between starter treatments compared to the 120-30-10 broadcast reference treatment. However, adding fertilizer compared to the unfertilized control resulted in 30-50% greater dry matter production.

Similar to dry matter production, across both years, the main effects of starter placement or rate or their interaction did not significantly affect yield or yield components. Contrasts (p=0.05) show that applying starter fertilizers did not improve yield or alter yield components compared to the 120-30-10 broadcast reference treatment. However, at p=0.10, yield was significantly greater when 120-30-15 was broadcast prior to planting than when using a starter. Yield was approximately doubled by adding fertilizer compared to the unfertilized control primarily because of increased number of kernels/head.

Experiment II

Across years, pop-up fertilizer rate, NBPT, or their interaction did not affect dry matter production. Contrasts showed pop-up fertilization did not increase dry matter over that obtained by broadcasting 120-15-5 prior to planting. Also, fertilization appeared to result in greater dry matter only at boot and soft dough compared to the no-fertilizer control.

Increasing the pop-up rate decreased the number of heads/a, but this was not significantly reflected in yield, although the trend was suggestive (data not shown). Contrasts again failed to show any difference between pop-up fertilization and broadcasting 120-15-5 prior to planting. Fertilization increased yield by increasing the number of kernels/head.

Poor growing conditions and late planting dates appeared to result in little effect of starter or pop-up fertilizers on grain sorghum growth, yield, or yield components in the claypan soils of southeastern Kansas.

SOIL FERTILITY RESEARCH
NORTH CENTRAL KANSAS EXPERIMENT FIELDS

EFFECTS OF CROPPING SYSTEM AND NITROGEN FERTILIZATION ON NO-TILLAGE GRAIN SORGHUM PRODUCTION

W.B. Gordon, D.A. Whitney, and D.L. Fjell

Summary

The 2002 growing season was characterized by a very hot, dry summer. The summer rainfall total was the lowest since1934. The overall test average was only 53 bu/a. When averaged over all N rates, yields of sorghum grown in rotation with soybeans were 9 bu/a greater than continuous grain sorghum.

When averaged over nitrogen (N) rates, 1982-1995 yields were 23 bu/a greater in sorghum rotated with soybeans than in continuous sorghum. When no N was applied, rotated sorghum yielded 32 bu/a greater than continuous sorghum. In the continuous system, grain sorghum yield continued to increase with increasing N rate up to 90 lb/a. In the soybean rotation, sorghum yields increased with increasing N rate only up to 60 lb/a. When averaged over N rate, no-tillage grain sorghum rotated with soybeans reached mid-bloom 7 days sooner than continuous grain sorghum. Two knife-applied N sources (anhydrous ammonia and 28% UAN) were evaluated during 1982-1989. No grain sorghum yield differences resulted from N source. The 21-year soybean yield average was 33 bu/a. Soybean yields in 2002 averaged only 6 bu/a. In 1996, four additional N rates (120, 150, 180, and 210 lb/a) were added to the experiment. When averaged over the period 1996-2002, yields were greater in the rotated system than in the continuous sorghum at all levels of N. Addition of N did not compensate for the rotational effect. Yields in the continuous system continued to increase with increasing N rate up to 90 lb/a. Yields in the rotated system were maximized with application of 60 lb/a N.

Introduction

Crop rotations were necessary to maintain soil productivity before the advent of chemical fertilizers. Biological fixation of atmospheric N is a major source of N for plants in natural systems. Biological fixation through legume-*Rhizobium* associations is utilized extensively in agricultural systems. Using a legume in a crop rotation system can reduce the N requirement for the following non-legume crop. Other benefits of legume rotations include breaking disease and insect cycles, helping weed control programs, and decreasing the toxic effects of crop residues. This study evaluates N rates for continuous grain sorghum and grain sorghum grown in annual rotation with soybeans in a no-tillage production system.

Procedures

This study was established in 1980 at the North Central Kansas Experiment Field, located near Belleville, on a Crete silt loam soil. Data are reported starting in 1982. Treatments included cropping system (continuous grain sorghum and grain sorghum rotated with soybeans) and N rates (0, 30, 60, and 90 lb/a). In 1982-1989, two N sources anhydrous ammonia and urea-ammonium nitrate solution (28% UAN) were evaluated. Both N sources were knife applied in the middle of rows from the previous year's crop. After 1989, anhydrous ammonia was used as the sole N source. In each year, N was knife applied 7-14 days prior to planting. Grain sorghum was planted at the rate of 60,000 seed/a, and soybean was planted at the rate of 10 seed/ft in 30-inch rows. Soybean yields were not affected by N applied to the previous sorghum crop and, therefore, are averaged over all N rates. In

1996, four additional N rates (120, 150, 180, and 210 lb/a were added to the experiment in order to further define N response.

Results

Summer rainfall averaged only 45% of normal. Temperatures also were above normal in July and August. When averaged over all N rates, grain sorghum rotated with soybeans yielded 9 bu/a greater than continuous grain sorghum. In the continuous grain sorghum system, grain yields (1982-1995) continued to increase with increasing N rate up to 90 lb/a (Table 1). Sorghum yields in the rotated system were maximized with an application of 60 lb/a N. When no N was applied, rotated sorghum yielded 32 bu/a greater than continuous sorghum. When four additional N rates were added, yields were greater in the soybean rotation than in the continuous system at all levels of N (Table 2). Addition of N alone did not make up yield losses in a continuous sorghum production system. Over the 21-year period (1982-2002), soybean yields averaged 33 bu/a and were not affected by N applied to the previous sorghum crop (Table 3). Two knife-applied N sources, anhydrous ammonia and 28% UAN, were evaluated from 1982-1989. When averaged over cropping system and N rate, yields were 60 and 59 bu/a for anhydrous ammonia and UAN, respectively. When averaged over N rates, the number of days from emergence to mid-bloom was 7 days shorter in the rotated system than in the continuous system (Table 1).

Table 1. Long-term effects of cropping system and nitrogen rate on grain sorghum yields and number of days from emergence to mid-bloom North Central Expt. Field, Belleville, KS.

N Rate	Cropping System	Grain Yield 1982-1995	Days to Mid-bloom 1992-1995
lb/a		bu/a	
0	Continuous	43	64
	Rotated	75	56
30	Continuous	59	61
	Rotated	84	55
60	Continuous	70	59
	Rotated	92	53
90	Continuous	80	58
	Rotated	92	53
System Means			
	Continuous	63	61
	Rotated	86	54
N Rate Means			
0		59	60
30		72	58
60		81	56
90		86	56
LSD (0.05)		9	1

Table 2. Effects of cropping system and nitrogen rate on grain sorghum yields, North Central Experiment Field, Belleville, KS, 1996-2002.

N	Cropping	Yield							
Rate	System	1996	1997	1998	1999	2000	2001	2002	Avg
lb/a		bu/a							
0	Continuous	92	51	55	73	37	59	32	57
	Rotated	120	88	87	112	46	75	43	82
30	Continuous	110	71	75	95	40	75	48	74
	Rotated	137	108	115	119	62	113	56	101
60	Continuous	131	110	118	115	68	96	51	98
	Rotated	164	128	142	127	66	128	59	116
90	Continuous	143	121	126	125	69	116	52	108
	Rotated	163	141	144	126	68	129	60	119
120	Continuous	148	122	128	123	69	117	51	108
	Rotated	162	144	145	128	65	128	59	119
150	Continuous	148	120	127	123	69	116	53	108
	Rotated	162	143	145	129	65	129	61	119
180	Continuous	148	121	128	126	68	117	52	109
	Rotated	162	144	145	129	65	129	59	119
210	Continuous	148	122	128	126	66	116	50	108
	Rotated	162	145	145	129	64	129	59	119
System Means									
	Continuous	134	105	111	113	61	101	48	96
	Rotated	154	130	134	125	63	120	57	112
N Rate Means									
0		106	70	71	92	42	67	38	70
30		124	90	95	107	51	94	46	88
60		148	119	130	121	67	112	55	107
90		153	131	135	126	69	122	56	114
120		155	133	137	126	67	123	55	114
150		155	132	136	126	67	123	57	114
180		155	133	137	127	67	123	56	114
210		155	134	137	127	65	123	55	114
LSD(0.05)		8	6	6	6	8	5	6	

Table 3. Yield of soybean grown in rotation with grain sorghum, Belleville, KS, 1982-2002.

Year	Yield	Year	Yield
	bu/a		bu/a
1982	38	1993	56
1983	15	1994	32
1984	20	1995	41
1985	28	1996	61
1986	48	1997	36
1987	48	1998	38
1988	18	1999	42
1989	25	2000	8
1990	30	2001	31
1991	12	2002	6
1992	58	Average	33

EFFECTS OF APPLICATION METHOD AND COMPOSITION OF STARTER FERTILIZER ON IRRIGATED RIDGE-TILLED CORN

W.B. Gordon and D.A. Whitney

Summary

Field studies were conducted at the North Central Kansas Experiment Field, located near Scandia, on a Crete silt loam soil. The study consisted of four methods of starter fertilizer application (in-furrow with the seed, 2 inches to the side and 2 inches below the seed at planting, dribble on the soil surface 2 inches to the side of the seed, and banded over the row on the soil surface) and five starter fertilizer combinations. The starters consisted of combinations that included either 5, 15, 30, 45, or 60 lb/a N with 15 lb/a P_2O_5 and 5 lb/a K_2O. A no-starter check plot also was included. Additional treatments included 2x2 starter with and without potassium. Dribble application of 30-30-5 starter fertilizer applied 2 inches to the side of the row was compared to dribble directly over the row. Nitrogen was balanced so that all plots received 220 lb/a N, regardless of starter treatment. Starter fertilizer combinations were made using liquid 10-34-0 ammonium polyphosphate, 28% UAN, and potassium thiosulfate (KTS). When starter fertilizer was applied in-furrow with the seed, plant populations were reduced by over 8,400 plants/a compared with the no starter check. Corn yield was 33 bu/a lower when starter fertilizer was applied in-furrow than when applied 2x2. Dribble application of starter fertilizer in a surface band 2 inches to the side of the seed row resulted in yields equal to 2x2 applied starter. Grain yield and V-6 dry matter were lower in starter treatments that only included 5 or 15 lb N/a. Other treatments were added to determine if K was responsible for any of the additional yield seen with the starter fertilizers or if N and P were the only elements necessary. Starter that included K improved yields (3-year average) by 12 bu/a.

Introduction

Use of conservation tillage, including ridge-tillage, has increased greatly in recent years because of its effectiveness in conserving soil and water. In a ridge-tillage system, tillage at planting time is confined to a narrow strip on top of the ridge. The large amount of residue left on the soil surface can interfere with nutrient availability and crop uptake. Liquid starter fertilizer applications have proven effective in enhancing nutrient uptake, even on soils that are not low in available nutrients. Many producers favor in-furrow or surface starter applications because of the low initial cost of planter-mounted equipment and problems associated with knives and colters in high-residue environments. However, injury can be severe when fertilizer containing N and K is placed in contact with seed. Surface applications may not be effective in high residue situations. The objective of this research was to determine corn response to starter combinations using four different application methods.

Procedures

Irrigated ridge-tilled experiments were conducted at the North Central Kansas Experiment Field on a Crete silt loam soil. Analysis by the KSU Soil Testing Laboratory showed that initial soil pH was 6.2; organic matter content was 2.4%; and Bray-1 P and exchangeable K in the top 6 inches of soil were 40 and 420 ppm, respectively. The study consisted of four methods of starter fertilizer application: in-furrow with the seed, 2 inches to the side and 2 inches below the seed at planting, dribble in a narrow band on the soil surface 2 inches to the side of the seed row, and banded over the row on the soil surface. In the row-banded treatment, fertilizer was sprayed on the soil surface in an 8-inch band centered on the seed row immediately after planting. Starter consisted of combinations that included either 5, 15, 30, 45, or 60 lb N/a with 15 lb P_2O_5/a and 5 lb K_2O/a. A no-starter check also was included. Nitrogen as 28% UAN was balanced so all plots received 220 lb/a, regardless of starter treatment. Additional treatments consisted of 2x2 placed starter with and without K. Dribbling starter fertilizer (30-30-5 rate) was compared to the same starter rate dribbled directly over the row. Starter fertilizer combinations were made using liquid 10-34-0 ammonium polyphosphate, 28% UAN, and KTS.

Results

When starter fertilizer was applied in-furrow with the seed, plant populations were reduced by more than 8,400 plants/a compared with the no starter check (Table 4). Corn yield was 33 bu/a lower when starter fertilizer was applied in-furrow with the seed than when applied 2 inches beside and 2 inches below the seed. Dribble application of starter fertilizer in a narrow surface band 2 inches to the side of the seed row resulted in yields equal to the 2x2 applied starter. The band over the row treatment resulted in yields greater than the in-furrow treatment but less than the 2x2 or surface band treatments. Grain yield and V6 dry matter accumulation was lower in the starter treatment that only included 5 or 15 lb N/a. Addition of K to the starter mix increased 3-year average grain yields by 12 bu/a (Table 5). When averaged over the 3 years of the experiment, there were no differences in 2x2 placement and dribble on the soil surface.

Table 4. Effects of starter application method and composition on corn grain yield, plant population and V-6 stage whole plant dry matter, North Central Kansas Experiment Field, Scandia, KS, 2002.

Application Method	Starter	Yield, 2002	Yield, 2000-2002	Population	V-6 Dry Matter
	lb/a	bu/a	bu/a	plants/a	lb/a
Check	0-0-0	175.2	164.4	31,425	385
In-furrow	5-15-5	188.6	172.0	24,822	392
	15-15-5	188.2	177.2	24,710	401
	30-15-5	184.5	174.4	22,754	390
	45-15-5	180.2	171.0	21,650	388
	60-15-5	170.0	162.8	21,122	345
2x2	5-15-5	202.0	193.9	31,422	452
	15-15-5	208.0	196.9	31,368	598
	30-15-5	222.2	215.7	31,480	708
	45-15-5	223.5	214.9	31,422	710
	60-15-5	222.0	214.3	31,458	711
Dribble 2x	5-15-5	200.6	189.8	31,452	445
	15-15-5	205.8	197.8	31,325	571
	30-15-5	218.0	211.9	31,388	700
	45-15-5	220.0	212.5	31,399	709
	60-15-5	221.0	212.7	31,410	710
Row band	5-15-5	195.8	179.4	31,408	448
	15-15-5	198.5	180.2	31,397	586
	30-15-5	212.2	191.5	31,429	678
	45-15-5	212.1	194.6	31,451	688
	60-15-5	213.6	200.6	31,422	689
Method Means					
In-furrow		182.3	171.1	23,012	383
2x2		215.5	206.2	31,430	636
Dribble 2x		213.0	204.9	31,395	627
Row band		206.4	190.1	31,421	617
LSD (0.05)		12.0		791	20
Starter Means					
5-15-5		196.8	183.8	29,776	434
15-15-5		200.1	188.0	29,700	539
30-15-5		209.4	199.1	29,263	619
45-15-5		208.9	198.2	28,981	624
60-15-5		206.2	197.6	28,853	613
LSD (0.05)		10.0		NS	22

Table 5. Starter fertilizer composition effects on corn grain yield, Scandia, KS.

	Starter N	Starter P_2O_5	Starter K	2000	2001	2002	Average
	lb/a			- - - - - - - - - -	bu/a	- - - - - - - - - -	
1.	15	30	5	170	180	172	174
2.	30	30	0	178	190	186	185
3.	30	15	0	178	192	185	185
4.	30	30	5	190	206	196	197

Means were compared using orthogonal contrasts. Treatment 4 was significantly greater than treatment 2 at the 0.01 level of significance.

CONTROLLED-RELEASE NITROGEN FERTILIZER IN STARTER FOR GRAIN SORGHUM PRODUCTION

W.B. Gordon and D.A. Whitney

Summary

No-tillage planting systems have generated interest in methods that allow total fertilizer application when planting, which would eliminate trips across the field. Previous research has shown that increasing the nitrogen (N) in starter fertilizer has been beneficial for no-tillage grain sorghum. Putting N and/or potassium (K) in direct seed contact, especially urea, may cause seedling injury, so products with slow N release, such as polymer-coated urea, may be effective. Two polymer-coated urea products were examined in this study: Type I (CRU I) and Type II (CRU II). The CRU II product has a thicker coating than the CRU I and the N is released at a slower rate. The polymer coated urea product CRU I at rates of 30 and 60 lb N/a added to mono ammonium phosphate (MAP) as a direct seed-applied starter increased yields over MAP alone or MAP plus un-coated urea. The CRU II material added to MAP increased yields over MAP alone at rates up to 90 lb/a. Un-coated urea reduced plant populations and yields at all rates of N.

Introduction

No-tillage planting of row crops has generated considerable interest in use of starter fertilizer. However, planters equipped with separate coulter/knives to place the fertilizer to the side and below the seed are not common in 12-row and larger planters, raising questions about putting fertilizer in the seed furrow as an alternative. Research at the North Central Kansas Experiment Field has shown a greater response to 30-30-0 starter placed to the side and below the seed compared to a 10-30-0 starter similarly placed. Fertilizer rate and source must be limited when placed in direct seed contact to avoid germination injury. This is especially true for P and K. Polymer-coated fertilizers for slow release of N can reduce the germination injury problem. This research was initiated to study the effects on germination and production of grain sorghum from applying a controlled released urea in direct seed contact.

Procedures

The study was initiated at the North Central Kansas Experiment Field near Belleville on a Crete silt loam soil. Soil pH was 6.0; organic matter was 2.4%; and Bray-1 P was 41 ppm. The grain sorghum hybrid Pioneer 8505 was planted without tillage into soybean stubble on May 21, 2002 at the rate of 54,000 seed/a. Starter fertilizer was applied in direct seed contact using 11-52-0 at 58 lb/a (a 6-30-0 starter rate) as the base for all starter treatments except for the N alone check treatments. Treatments with additional N in the starter were formulated using two controlled-release polymer coated urea products, CRU I and CRU II from Agrium. The Type II product has a thicker polymer coat than Type I and gives a slower N release. The polymer-coated urea products were compared with un-coated urea. Additional N was applied to grain sorghum plots at the V4 stage after plant samples had been taken for dry matter and nutrient analysis.

Results

The 2002 growing season was characterized by a very cool spring followed by a hot, dry summer. Rainfall for June through August averaged only 47% of normal, resulting in the driest summer since 1934. Grain yields were very poor. Grain sorghum stands were greatly reduced when un-coated urea was placed in contact with seed as compared to the polymer-coated urea products (Table 6). Grain yields also were reduced in treatments receiving un-coated urea, regardless of N rate. Yield declined in the CRU II plus MAP plots when

N rate exceeded 90 lb/a. Grain yields were increased significantly by the 30-30-0 and 60-30-0 CRU plus MAP starters compared to no starter or MAP alone. The yield increase from more N in the starter is consistent with previous research at the North Central Experiment Field that showed a 2x2-placed band of a 30-30-0 starter rate significantly improved yield over the traditional 10-30-0 starter.

Our results suggest that in a no-tillage sorghum system, increasing the N in the starter can increase yield compared to a traditional starter or no starter. However, germination injury can occur if the starter is placed in direct seed contact. The polymer-coated urea for controlled N release used in this study reduced stand loss and made use of higher N starters possible in systems where the fertilizer is placed in-furrow in direct contact with the seed.

Table 6. Effects of starter fertilizer rate and nitrogen source on plant population and grain yield of no-tillage grain sorghum at the North Central Kansas Experiment Field, Belleville, KS.

Starter					Yield	
N	P_2O_5	Sources	Balance N	Population	2002	2001-2002
lb/a			lb/a	plants/a	bu/a	
6	30	MAP	114	49,710	62	97
30	30	MAP+CRU I	90	49,618	72	107
60	30	MAP+CRU I	60	49,510	71	105
90	30	MAP+CRU I	30	48,326	68	100
120	30	MAP+CRU I	0	46,711	59	91
30	30	MAP+CRU II	90	47,654	73	107
60	30	MAP+CRU II	60	49,422	71	105
90	30	MAP+CRU II	30	46,111	72	105
120	30	MAP+CRU II	0	45,310	58	121
30	30	MAP+Urea	90	21,718	55	88
60	30	MAP+Urea	60	21,215	45	76
90	30	MAP+Urea	30	20,019	32	67
120	30	MAP+Urea	0	21,122	27	61
60	30	MAP+CRU I	0	46,432	70	102
60	30	MAP+CRU II	0	48,122	72	104
60	0	CRU I	60	48,654	70	102
60	0	CRU II	60	48,888	70	101
60	0	Urea	60	21,354	52	84
0	30	0-0-46	120	49,712	58	93
0	0	Check	0	49,822	42	67
0	0	Check	120	49,811	54	86
LSD(0.5)				1221	6	

SOIL FERTILITY RESEARCH
HARVEY COUNTY EXPERIMENT FIELD

EFFECTS OF SOYBEAN COVER CROP AND NITROGEN RATE ON NO-TILL GRAIN SORGHUM AFTER WHEAT

M.M. Claassen

Summary

Late-maturing Roundup Ready soybean drilled in wheat stubble at 135,000, 165,000, and 200,000 seeds/a produced an average of 2.25 ton/a of above-ground dry matter and a nitrogen (N) yield of 87 lb/a potentially available to the succeeding crop. Soybean cover crop did not affect grain sorghum yield the following growing season, but, when averaged over N rate, resulted in 0.15% N increase in flag leaves. Nitrogen fertilizer significantly affected sorghum maturity, heads/plant, leaf N concentration, yield, and bushel weight. Highest overall average yield of 103 bu/a occurred with 60 lb/a of N. Additional N fertilizer did not significantly increase leaf N or bushel weight.

Introduction

Research at the Kansas State University Harvey County Experiment Field over the past 8 years has explored the use of hairy vetch as a winter cover crop following wheat in a winter wheat- sorghum rotation. Results of long-term experiments showed that between September and May, hairy vetch can produce a large amount of dry matter with an N content on the order of 100 lb/a. However, significant disadvantages also exist in the use of hairy vetch as a cover crop. These include the cost and availability of seed; interference with the control of volunteer wheat and winter annual weeds; and the possibility of hairy vetch becoming a weed in wheat after sorghum.

New interest in cover crops has been generated by research in other areas showing the positive effect these crops can have on the overall productivity of no-till systems. In Ohio, use of a late-maturing Roundup Ready soybean has shown promise as a summer cover crop in a rotation from wheat to corn. The current experiment was conducted as a pilot project to assess soybean seeding rate and N rate effects on no-till grain sorghum after wheat.

Procedures

The experiment site was located on a Smolan silt loam soil. Following winter wheat harvest, weeds were controlled with Roundup Ultra + Banvel + Placement Propak (1 qt/a + 2 oz/a + 1% v/v) in early July. 'Asgrow 6701' Roundup Ready soybean was no-till drilled in 8-inch rows in randomized strips with four replications at 0, 135,000, 165,000, and 200,000 seeds/a on July 11, 2001. Unreplicated soybean plant samples from a 1 square meter area were harvested at the first killing frost (October 16). Whole-plant soybean dry matter yield estimates were obtained and subsamples analyzed for N content. Volunteer wheat was controlled in the fall with Roundup herbicide.

Soybean plants in existing wheat stubble were left undisturbed after maturity. Preplant weed control was accomplished with the application of Roundup Ultra + AAtrex 4L + Dual II Magnum + 2,4-D LV6 + Banvel (1.6 pt/a +1.5 pt/a + 1.33 pt/a + 1.33 oz/a + 2 oz/a) on May 20, 2002. Randomized N rates of 0, 30, 60, and 90 lb/a were broadcast as ammonium nitrate on May 31. 'Pioneer 8505' grain sorghum with Concep III and Gaucho seed treatments was no-till planted at 42,000 seeds/a in 30-inch rows on June 3, 2002. Sorghum was harvested on September 24.

Results

Soybean stand establishment and crop development were good. Ground cover and volunteer wheat control varied with soybean seeding rate. Although volunteer wheat was suppressed by the soybean cover crop, some wheat growth occurred. Fall application of Roundup herbicide was necessary. Despite the choice of a late maturing soybean, some pod set and minor seed development was noted. At termination by frost on October 16, soybean whole-plant above-ground dry matter yield estimates were 2.3, 2.5, and 2.0 tons/a with seeding rates of 135,000, 265,000 and 200,000/a, respectively. Nitrogen concentrations in soybean plant samples ranged from 1.88% to 2%, with an average of 1.92%. Corresponding N yields of soybean at these seeding rates were calculated to be 85, 100, and 75 lb/a.

Soybean cover crop increased grain sorghum leaf N concentration, but had no effect on yield nor any of the other variables measured (Table 1). This increase averaged 0.15% N across N rates, and there were no significant differences among soybean seeding rates of 135,000 to 200,000. Nitrogen fertilizer significantly decreased the number of days to half bloom as well as increased the number of sorghum heads/plant, sorghum leaf N concentration, yield, and bushel weight. Highest grain yield occurred with 60 lb/a of N fertilizer. Leaf N and grain test weight also did not increase significantly with additional N fertilizer.

Table 1. Effects of late-maturing soybean cover crop, soybean seeding rate, and nitrogen rate on no-till grain sorghum after wheat, Hesston, KS, 2002.

Cover Crop/ Seeding Rate[1]	N Rate[2]	Grain Yield	Bushel Wt	Stand	Half[3] Bloom	Heads/ Plant	Leaf N[4]
	lb/a	bu/a	lb	1000's/a	days	no.	%
None	0	88.5	59.4	36.8	60	1.0	2.18
	30	97.2	59.8	37.9	59	1.0	2.40
	60	103.8	60.7	36.0	57	1.1	2.47
	90	107.5	61.0	36.3	57	1.2	2.58
Soybean	0	88.7	59.9	36.2	60	1.0	2.24
135,000	30	90.2	59.3	36.2	58	1.0	2.57
	60	98.7	60.7	34.8	57	1.1	2.63
	90	103.1	60.7	37.1	56	1.1	2.74
Soybean	0	81.4	60.4	36.2	59	1.0	2.34
165,000	30	97.3	60.7	37.3	57	1.0	2.57
	60	107.7	60.4	37.0	57	1.1	2.70
	90	97.1	60.5	34.7	56	1.1	2.80
Soybean	0	83.1	59.7	36.5	60	0.9	2.20
200,000	30	104.9	60.7	36.5	57	1.1	2.45
	60	102.5	60.5	36.6	57	1.1	2.80
	90	102.0	60.5	36.3	57	1.1	2.67
LSD .05 across systems		10.3	0.70	NS	1.5	0.10	0.25
Means:							
Cover Crop/Seeding Rate							
None		99.2	60.2	36.8	58	1.1	2.41
Soybean/135,000		95.1	60.2	36.1	58	1.0	2.55
Soybean/165,000		95.9	60.5	36.3	57	1.0	2.60
Soybean/200,000		98.1	60.4	36.5	58	1.0	2.53
LSD .05		NS	NS	NS	NS	NS	0.11
N Rate							
0		85.4	59.9	36.4	60	1.0	2.24
30		97.4	60.1	37.0	58	1.0	2.50
60		103.2	60.6	36.1	57	1.1	2.65
90		102.4	60.7	36.1	57	1.1	2.70
LSD .05		5.1	0.33	NS	0.8	0.06	0.13

[1] Asgrow 6701 Roundup Ready soybean drilled in 8-inch rows on July 11, 2001.
[2] N applied as 34-0-0 on May 31, 2002.
[3] Days from planting (June 3, 2002) to half bloom.
[4] Flag leaf at late boot to early heading.

RESIDUAL EFFECTS OF HAIRY VETCH WINTER COVER CROP AND NITROGEN RATE ON NO-TILL WINTER WHEAT AFTER GRAIN SORGHUM

M.M. Claassen

Summary

Wheat production was evaluated in the third cycle of annual wheat-sorghum and wheat-vetch-sorghum rotations. Treatment variables included disk and herbicide termination methods for hairy vetch and nitrogen (N) fertilizer rates of 0 to 90 lb/a. Fertilizer N, as well as hairy vetch, raised wheat plant N levels. Without vetch in the rotation, wheat plant N increased only at 90 lb/a. Averaged over N rate, hairy vetch resulted in respective increases of 0.17% N to 0.33% N in disk and no-till systems. Nitrogen rate significantly increased wheat yield, but the residual benefit of the cover crop on wheat grain production was less apparent than in previous years. With vetch/disk, wheat produced 5.7 bu/a more than with vetch/no-till. But, at 0 lb/a of fertilizer N or at the average N rate, yields of wheat in hairy vetch systems were not significantly greater than in no-vetch. In wheat after sorghum without vetch, 30 and 60 lb/a of fertilizer N progressively increased yield. However, in wheat after vetch-sorghum, yields at these N rates did not differ significantly.

Introduction

Hairy vetch can be planted in September following wheat and used as a winter cover crop ahead of grain sorghum in an annual wheat-sorghum rotation. Soil erosion protection and N contribution to the succeeding crop(s) are potential benefits of including hairy vetch in this cropping system. The amount of N contributed by hairy vetch to grain sorghum has been under investigation. The longer-term benefit of vetch in the rotation is also of interest. This experiment concluded the third cycle of a crop rotation in which the residual effects of vetch as well as N fertilizer rates were measured in terms of N uptake and yield of wheat.

Procedures

The experiment was established on a Geary silt loam soil with the initial planting of hairy vetch following winter wheat in the fall of 1996. Sorghum was grown in 1997 with or without the preceding cover crop and fertilized with N rates of 0, 30, 60, or 90 lb/a. Winter wheat was no-till planted in 8-inch rows into sorghum stubble in the fall of 1997. In the third cycle of the rotation, hairy vetch plots were seeded at 25 lb/a in 8-inch rows on October 4, 2000. One set of vetch plots was terminated by disking on May 9. Hairy vetch in a second set of plots was terminated at that time with Roundup Ultra + 2,4-D_{LVE} + Banvel (1 qt + 1.5 pt/a + 0.25 pt/a). Weeds were controlled with tillage in plots without hairy vetch.

Vetch forage yield was determined by harvesting a 1 square meter area from each plot on May 9, 2001. Nitrogen fertilizer treatments were broadcast as ammonium nitrate on June 14. All plots received 35 lb/a of P_2O_5, which was banded as 0-46-0 at sorghum planting. 'Pioneer 8505' was planted in 30-inch rows at approximately 42,000 seeds/a on June 15, 2001. Weeds were controlled with a preemergence application of Lasso + AAtrex 4L (2.5 qt/a + 1 pt/a). Grain sorghum was combine harvested on October 11. Fertilizer N was broadcast as 34-0-0 on October 20, 2001, at rates equal to those applied to the prior sorghum crop. Variety 2137 winter wheat was no-till planted in 8-inch rows into sorghum stubble on October 20 at 120 lb/a with 37 lb/a of P_2O_5 fertilizer banded in the furrow. Wheat was harvested on June 26, 2002.

Results

Hairy vetch terminated near mid-May 2001 produced an average of 1.42 ton/a of dry matter, yielding 103 lb/a of N potentially available to the sorghum that followed (Table 2). In the absence of fertilizer N, an increase of 0.16% N in sorghum leaves occurred in the vetch versus no-vetch cropping systems. This represented a N contribution equivalent to 19 lb/a of fertilizer N. Leaf N levels in sorghum after vetch were not significantly affected by method of vetch termination or N rate. While vetch termination method had no affect on sorghum yield, the average vetch contribution to sorghum yield was equivalent to 43 lb/a of fertilizer N.

Precipitation total for the period from November 1 through May 31 was nearly 5.5 inches below normal. The residual effect of hairy vetch on wheat in the rotation was evident, but it was not as pronounced as in previous years. Vetch accounted for wheat plant height increases of 3 to 5 inches but only with zero fertilizer N. Averaged across N rates, vetch treatments were associated with significantly higher wheat plant N levels.

Increases ranged from 0.17% N to 0.33% N in disk and no-till systems, respectively. Plant N increases following vetch were most notable at 60 and 90 lb/a of fertilizer N. Vetch/ disk system resulted in a yield 5.7 bu/a greater than with vetch/no-till. However, at 0 lb/a of N as well as at the average N rate, wheat yields in vetch systems were not significantly greater than in the no-vetch system.

Without hairy vetch in the rotation, wheat after sorghum responded to N rate with increases in plant height and yield at 30 and 60 lb/a, while plant N increased only at 90 lb/a. Notably, however, the incremental increase in wheat yield at 30 versus 60 lb/a of N was significant in the crop rotation without vetch, but not when vetch was included as a prior winter cover crop.

Table 2. Residual effects of hairy vetch cover crop, termination method, and nitrogen rate on no-till wheat after grain sorghum, Hesston, KS, 2002.

Cover Crop/ Termination[1]	N Rate[2]	Vetch Yield[3] Forage	Vetch Yield[3] N	Sorghum Yield 2001	Wheat Yield	Wheat Bushel Wt	Wheat Stand	Wheat Plant Ht	Wheat Plant N[4]
	lb/a	ton/a	lb	bu/a	bu/a	lb	%	in.	%
None	0	--	--	83.0	8.8	58.7	83	18	1.23
	30	--	--	95.7	26.4	59.5	93	25	0.87
	60	--	--	101.7	38.3	58.9	91	28	1.13
	90	--	--	101.5	34.6	57.1	80	28	1.56
Vetch/Disk	0	1.42	107	100.9	13.9	59.3	84	21	1.17
	30	1.30	101	96.3	31.2	59.4	93	26	1.06
	60	1.46	108	100.0	36.4	58.1	89	28	1.42
	90	1.42	96	99.0	39.3	57.4	87	30	1.82
Vetch/No-till	0	1.50	106	97.2	14.3	59.3	83	23	1.27
	30	1.47	100	101.9	26.4	58.3	86	26	1.25
	60	1.50	109	99.6	29.4	57.3	90	29	1.58
	90	1.31	99	93.6	27.8	56.9	74	29	2.03
LSD .05		NS	NS	NS	9.9	1.8	13	2.0	0.38
LSD .10		NS	NS	NS	8.2	1.5	11	1.6	0.32
Means: Cover Crop/ Termination									
None		--	--	95.6	27.0	58.5	87	25	1.20
Vetch/Disk		1.40	103	99.1	30.2	58.5	88	26	1.37
Vetch/No-till		1.44	104	98.1	24.5	57.9	83	27	1.53
LSD .05		NS	NS	NS	NS	NS	NS	1.0	0.19
LSD .10		NS	NS	NS	4.1	NS	NS	0.8	0.16
N Rate									
0		1.46	106	93.9	12.2	59.1	83	21	1.22
30		1.38	101	98.0	28.0	59.1	91	26	1.06
60		1.48	108	100.4	34.7	58.1	90	28	1.38
90		1.36	97	98.0	33.9	57.1	80	29	1.80
LSD .05		NS	NS	NS	5.7	1.0	7	1.1	0.22
LSD .10		NS	NS	NS	4.8	0.9	6	0.9	0.18

[1] Hairy vetch planted on October 4, 2000, and terminated in the following spring.
[2] N applied as 34-0-0 on June 14, 2000 for sorghum and on October 20, 2001 for wheat.
[3] Oven dry weight and N content on May 9, 2001, just prior to termination.
[4] Whole-plant N concentration at early heading.

SOIL FERTILITY RESEARCH
KANSAS RIVER VALLEY EXPERIMENT FIELD

MACRONUTRIENT FERTILITY ON IRRIGATED SOYBEAN IN A CORN/SOYBEAN ROTATION

L.D. Maddux

Summary

A corn-soybean cropping sequence was evaluated from 1983 - 2001 (soybean planted in even years) for the effects of nitrogen (N), phosphorus (P), and potassium (K) fertilization. Previously applied N at 160 lb/a, P at 30 and 60 lb P_2O_5/a, and K at 60/150 lb K_2O/a increased soybean yields. No N or P response was observed in 1997 when a 2x2 starter was applied.

Introduction

A study was initiated in 1972 at the Kansas State University Kansas River Valley's Topeka Unit to evaluate the effects of nitrogen (N), phosphorus (P), and potassium (K) on irrigated soybean. In 1983, the study was changed to a corn/soybean rotation with corn planted in odd years. The objectives of the study are to evaluate the effects of applications of N, P, and K made to a corn crop on (a) grain yields of corn and the following soybean crop and (2) soil test values.

Procedures

The initial soil test in March, 1972 on this silt loam soil was 47 lb/a of available P and 312 lb/a of exchangeable K. Rates of P were 50 and 100 lb P_2O_5/a from 1972 - 1975 and 30 and 60 lb P_2O_5/a (1976 - 1995, 1999 - 2001). A 2x2 starter of 120 lb/a of 10-34-0, 12 lb N/a + 41 lb P_2O_5/a, was applied to all plots in 1997 and 1998. Rates of K were 100 lb K_2O/a from 1972 - 1975, 60 lb K_2O/a from 1976 to 1995, and 150 lb K_2O/a from 1997 - 2001. Nitrogen rates included a factorial arrangement of 0, 40, and 160 lb preplant N/a (with single treatments of 80 and 240 lb N/a). The 40 lb N/a rate was changed to 120 lb N/a in 1997. N, P, and K treatments were applied every year to soybean (1972 - 1982) and every other year (odd years) to corn (1983 - 1995, 1999 and 2001).

Soybean was planted each year in early to mid-May. Varieties planted were: Douglas - 1984; Sherman - 1986, 1988, 1990, 1992, 1996, and 1998; Edison - 1994; IA3010 - 2000; and Garst 399RR - 2002. Herbicides were applied preplant, incorporated each year. The plots were cultivated, furrowed, and furrow irrigated as needed. A plot combine was used for harvesting grain yields.

Results

Soybean yield results are shown in Table 1. Yields in 2000 and 2002 were lower than in previous years due to poor growing conditions (more days with high temperatures). Previously applied 160 N lb/a resulted in 7-year average yield increases of 3.1 bu/a (1984 - 1996), and increases of 4.0 bu/a in 2000, and 7.6 bu/a in 2002. The 40/120 lb N/a treatment was intermediate between the check and 160 lb N/a treatment. No significant difference was observed in 1998 when starter fertilizer was applied.

The 7-year average (1984 - 1996) response of soybean to 60 lb P_2O_5/a was 3.1 bu/a. No response was obtained in 1998 when starter fertilizer was applied. In 2000 and 2002, yield increases of 3.8 and 7.2 bu/a were obtained. The application of 30 lb P_2O_5/a also increased yields significantly except in 1998. Potassium fertilization resulted in yield increases of 2.3, 1.6, 5.8, and 2.1 bu/a. Significance was obtained at 8% and 15% levels of probability in 1998 and 2002.

Table 1. Effects of nitrogen, phosphorus, and potassium applications on soybean yields in a corn-soybean cropping sequence, Kansas River Valley Experiment Field, Topeka, KS.

Fertilizer Applied[1]			Soybean Yield			
N	P_2O_5[2]	K_2O	1984 - 1996	1998	2000	2002
---------lb/a---------			---------- bu/a ----------			
0	0	0	63.9	65.1	48.1	41.8
0	0	60/150	65.6	64.8	54.4	39.1
0	30	0	69.0	65.5	53.6	48.1
0	30	60/150	69.8	65.6	58.1	47.7
0	60	0	69.6	62.6	53.4	48.1
0	60	60/150	72.3	64.7	57.8	55.3
40/120	0	0	66.3	67.0	51.6	47.0
40/120	0	60/150	67.7	64.7	57.6	48.1
40/120	30	0	66.7	62.0	53.3	47.7
40/120	30	60/150	72.7	71.0	61.6	51.5
40/120	60	0	70.8	65.6	50.8	53.9
40/120	60	60/150	71.4	64.9	60.2	53.5
160	0	0	68.8	65.8	55.1	49.3
160	0	60/150	70.0	65.8	57.0	53.9
160	30	0	70.5	62.1	53.4	53.3
160	30	60/150	73.8	65.0	59.5	57.8
160	60	0	71.3	65.0	59.6	55.4
160	60	60/150	74.2	68.5	64.9	56.1
80	30	60/150	71.5	68.3	63.9	54.6
240	30	60/150	71.7	67.7	60.7	55.6
LSD(.05)			4.9	7.2	8.2	5.1
Nitrogen Means:						
0			68.4	64.7	54.2	46.7
40/120			69.3	65.9	55.9	50.3
160			71.5	65.4	58.2	54.3
LSD(.05)			2.2	NS	2.9	3.5
Phosphorus Means:						
	0		67.1	65.5	54.0	46.5
	30		70.4	65.2	56.6	51.0
	60		71.6	65.2	57.8	53.7
LSD(.05)			2.2	NS	2.9	3.5
Potassium Means:						
		0	68.6	64.5	53.2	49.4
		60/150	70.9	66.1	59.0	51.5
LSD(.05)			1.8	NS	2.4	NS

[1] Fertilizer applied to corn in odd years 1983 - 2001 and to soybean for 11 years prior to 1983 (the first number of a pair is the rate applied to corn from 1983 - 1995).

[2] P treatments not applied in 1997. Starter fertilizer of 10 gal/a of 10-34-0 was applied to all treatments in 1997 and 1998 (corn and soybean). N and K treatments were applied to corn in 1997.

EFFECTS OF PLACEMENT OF STARTER FERTILIZERS ON SOYBEAN

L.D. Maddux and S.A. Staggenborg

Summary

The effect of nitrogen (N) and phosphorus (P) placement and ratio on soybean production was evaluated at two sites in northeast Kansas in 2001 and 2002. The placement and ratio of N and P resulted in no significant differences in grain yield at either location.

Introduction

This study was conducted on an irrigated field at the Kansas River Valley Experiment Field, Rossville Unit, and on a dryland field at the Cornbelt Experiment Field near Powhattan. The objective was to evaluate the effect of nitrogen (N) and phosphorus (P) application, ratios, and placement on plant uptake and soybean yield.

Procedures

The study was conducted for 2 years on two sites. The first was at the Cornbelt Experiment Field on a dryland Grundy silty clay loam site previously cropped to soybean. Soil pH was 6.4, organic matter content was 3.2%, and P test level was 12 ppm. The second site was at the Kansas River Valley Experiment Field, Rossville Unit, on an irrigated Eudora silt loam site previously cropped to corn. Soil pH was 6.4, organic matter content was 1.6%, and P test level was 21 ppm.

Eight treatments were applied: (1) 0 N, 0 P check; (2) 8.8-30-0, 2x2 placement (10-34-0 applied at 7.6 gpa); (3) 30-30-0, 2x2 (18.0 gpa of 15-15-0 made from 10-34-0 and 28% UAN); (4 and 5) 10-34-0 applied in the seed furrow (IF) at 2 and 4 gpa; (6) 8.8-0-0, 2x2 placement; (7) 30-0-0, 2x2 placement; (8) 30-30-0, broadcast; and (9) 0-30-0 (made from phosphoric acid and water), broadcast.

Treatments were applied and plots were planted at 144,000 seeds/a in 30-in. rows May 16, 2001 and June 3, 2002 at Rossville and May 23, 2001 and May 31, 2002 at Powhattan. Soybean varieties used were Stine 4200-2 (2001) and Pioneer Brand 93B85 (2002) at Rossville and Taylor 394RR (2001) and Taylor 380RR (2002) at Powhattan. The Rossville site was sprinkler irrigated as needed. The plots were harvested using a plot combine.

Results

Yield results are shown in Table 2. Yields were low in 2002 at Powhattan because of hot, dry weather. No significant differences in grain yield were found at either location in either year.

Table 2. Effects of nitrogen and phosphorus placement on soybean yield, Rossville and Powhattan, KS, 2001-2002.

		Yield at Rossville		Yield at Powhattan	
Treatment[1]	Placement	2001	2002	2001	2002
		------------bu/a-----------			
Check	---	52.9	50.4	39.0	20.8
8.8-30-0	2x2	45.4	49.3	39.5	18.8
30-30-0	2x2	50.5	55.3	41.9	21.9
10-34-0, 2 gpa	In Furrow	52.8	54.9	38.9	19.4
10-34-0, 4 gpa	In Furrow	52.4	48.1	38.3	21.5
8.8-0-0	2x2	47.5	48.4	37.5	20.7
30-0-0	2x2	50.2	40.0	37.8	22.5
30-30-0	Broadcast	50.5	55.0	37.5	20.4
0-30-0	Broadcast	48.6	54.4	35.7	17.2
LSD(0.05)		NS	NS	NS	NS

[1] 7.6 gpa of 10-34-0 = 8.8-30-0; 18 gpa of 15-15-0 = 30-30-0 (i.e. 1:3 and 1:1 ratio N:P starters).

SOIL FERTILITY RESEARCH
EAST CENTRAL EXPERIMENT FIELD

INTEGRATED AGRICULTURAL MANAGEMENT SYSTEMS TO PROTECT KANSAS SURFACE WATERS

K.A. Janssen and G.M. Pierzynski

Summary

The purpose of this study was to evaluate, in a field-scale setting, effects of various combinations of tillage, fertilizer, and herbicide management practices for balanced control of cropland runoff contaminants for the Marais Des Cygnes River Basin. Evaluations following 4 years of treatments show that no-till can significantly reduce sediment losses in runoff, but combinations of best management practices (Integrated Agricultural Management Systems) will be needed to provide balanced water quality protection.

Introduction

Water quality is a major issue for Kansas producers and a major concern of the public. Total Maximum Daily Loads (TMDLs) are being implemented for various contaminants in Kansas streams and water bodies. The contaminants of most concern are sediment, nutrients, pesticides, and fecal coliform bacteria. In watersheds with waters not meeting standards, farmers and other land owners will be encouraged to implement Best Management Practices (BMPs) to reduce contaminant loading.

Farming operations that use no-till or maintain 30% or more crop residue cover after planting significantly reduce soil erosion and sediment in runoff. Tillage/planting systems that reduce tillage, however, provide little opportunity for incorporating fertilizer, manure, and herbicides. When surface applied, a greater portion of these crop inputs contact surface waters, resulting in increased runoff losses.

Consequently, a comprehensive management strategy beyond tillage reduction is needed to provide balanced water quality protection. A system of farming is needed that incorporates all best management practices (BMPs) so that all runoff contaminants are controlled. We refer to such a strategy as "Integrated Agricultural Management Systems."

The purpose of this study was to evaluate, in a field-scale setting, effects of various combinations of tillage, fertilizer, and herbicide management practices for balanced control of cropland runoff contaminants.

Procedures

The study was located on an approximately 10 acre, 2 to 5 percent slope, parallel terraced field near Lane, KS in Franklin County. Soils in the field were a mixture of Eram-Lebo (silty clay loam) with some Dennis-Bates complex (Argiudolls, Hapludolls and Paleudolls). Bray-1 P soil test initially was 13 ppm, which according to K-State recommendations is a low to medium soil test.

Three combinations of tillage, fertilizer, and herbicide management were evaluated starting in 1998. The combinations were: (1) No-till, with fertilizer and herbicides broadcast on the soil surface; (2) No-till, with fertilizer deep-banded (3-5 inch depth) and herbicides broadcast on the soil surface; and (3) Chisel-disk-field cultivate with fertilizer and herbicides incorporated by tillage. All treatments were replicated twice and were established between terraces to facilitate runoff water collection. The crops grown were grain sorghum and soybean in alternate years in rotation. The rate of fertilizer applied for grain sorghum was 70 lb N, 33 lb P_2O_5, and 11 lb K_2O per acre. No fertilizer was applied for soybean. Atrazine (1.5 lb ai/a) and Dual (metolachlor 1.25 lb ai/a) herbicides were applied for weed control in grain sorghum. For soybean, Roundup Ultra (glyphostate 1 lb ai/a) and metolachlor (1.25

lb ai/a) herbicides were applied.

Rainfall was recorded and runoff was collected by instrumentation of all treatment areas between terraces with weirs and automated ISCO samplers. The runoff water collected was analyzed for sediment, nutrients, and herbicide concentrations. Mass loss of contaminants was calculated by multiplying the runoff concentrations times runoff volumes.

Results

Averaged across all runoff sampling dates and years (1998-2001), 48% or 4.57 inches of the rainfall received during the growing season ran off in the no-till system and 29% or 2.71 inches ran off in the chisel-disk-field cultivate system (Figure 1). The amount of soil loss was three times greater with the chisel-disk-field cultivate system than for no-till (Figure 2). For the chisel-disk field cultivate system, average soil loss per growing season was 0.98 ton/a, with no-till it was 0.32 ton/a. Total P losses generally paralleled sediment losses (Figure 3).

Soluble P and atrazine herbicide losses in the runoff water were highest with surface applications in no-till (Figures 4 and 5). Incorporation of fertilizer and herbicides with tillage decreased losses. Highest runoff concentrations of soluble P and herbicides occurred during the first couple of runoff events after application (data not shown).

These data confirm that no-till can greatly reduce soil erosion and sediment in runoff from cropland. However, if fertilizer and herbicides are surface applied, runoff losses of these crop inputs may be increased compared to when they are incorporated by tillage. Therefore, to achieve balanced water quality protection when planting crops no-till, it will also be important to subsurface apply P fertilizer. This could be in the form of pre-plant deep banding (3-5 inch depth which was used here), 2x2 inch band placement of fertilizer with the planter, or some combination. Steps to reduce herbicide losses in no-till will also be needed. This might be partially accomplished by timing of the herbicide applications when the potential for runoff is less (fall, early spring, or postemergence applications compared to planting-time applications).

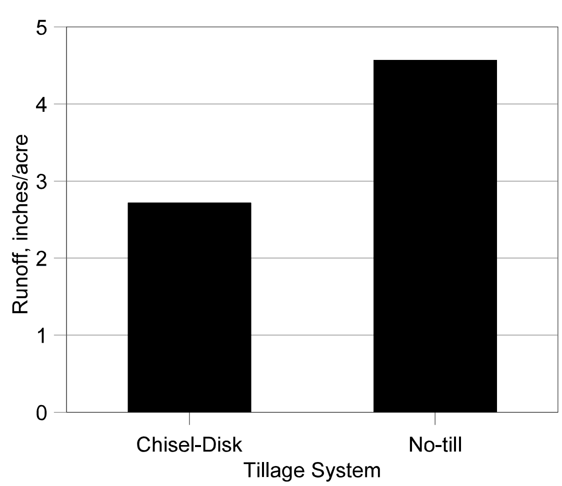

Figure 1. Volume of runoff as influenced by tillage (4-yr growing season avg.).

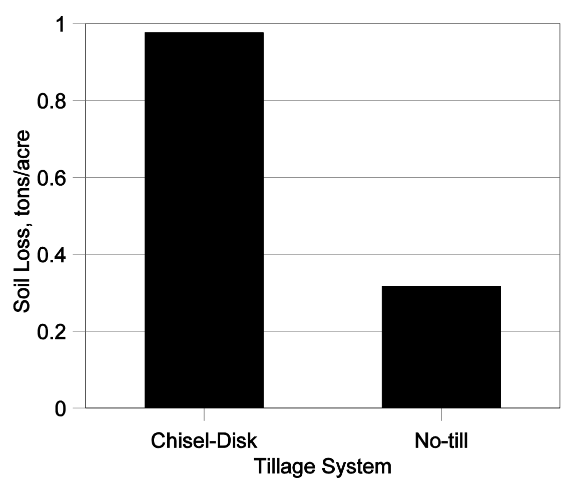

Figure 2. Soil loss as influenced by tillage (4-yr growing season avg.).

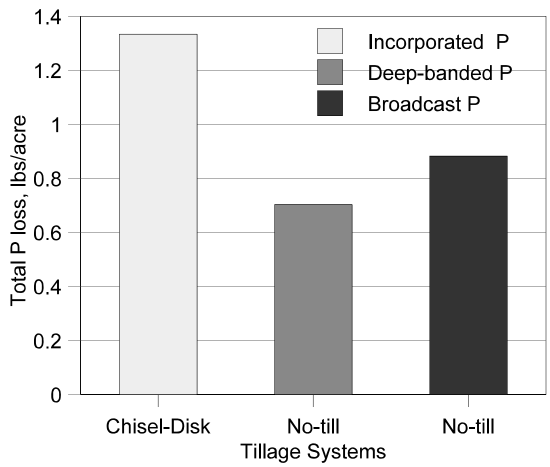

Figure 3. Total P loss as influenced by tillage and P placement (4-yr growing season avg.).

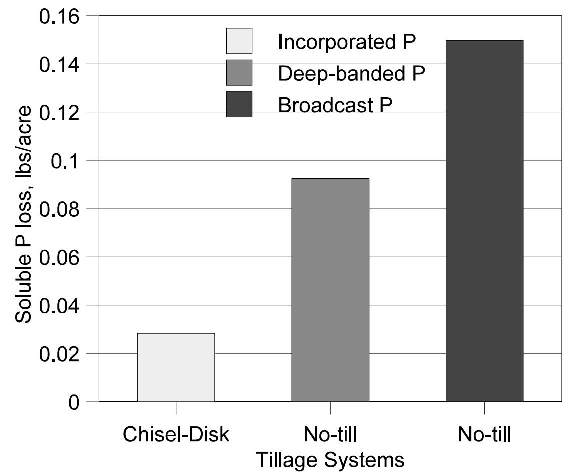

Figure 4. Soluble P loss as influenced by tillage and P placement (4-yr growing season avg.).

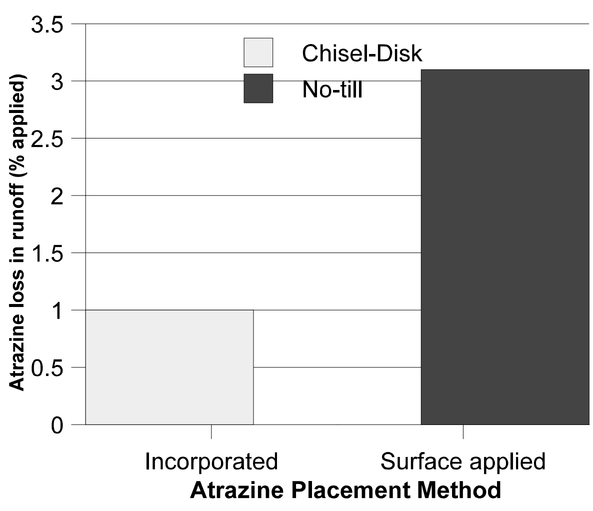

Figure 5. Atrazine loss as influenced by tillage and placement (2-yr growing season avg.).

CORN, GRAIN SORGHUM, AND SOYBEAN FERTILIZATION STUDIES KANSAS STATE UNIVERSITY, DEPARTMENT OF AGRONOMY

EVALUATION OF STRIP-TILLAGE AND NUTRIENT MANAGEMENT ON CORN

R.E. Lamond, W.B. Gordon, and C.B. Godsey

Summary

Strip-tillage has emerged as an alternative to no-till for row crop production. Tilling a small area where the rows of the next crop will be keeps the advantages of maintaining solid residue cover between the rows, while at the same time provides a narrow, tilled seedbed for the next crop. The soil in this narrow, tilled zone will warm up and dry out quicker than no-till. In the first year of this research, strip-tillage resulted in consistently greater early season corn growth than no-till at all fertilizer rates. Early season nutrient uptake was also greater with strip-tillage. With yields limited by hot and very dry conditions, there were no significant differences in grain yield due to tillage.

Introduction

Some Kansas corn producers have encountered problems with no-till systems. With the heavy residue cover associated with no-till, soils are slow to dry out and warm up, causing erratic emergence and slow early growth, particularly with early planting. Use of starter fertilizer under these conditions has proven helpful, but producers have shown great interest in an alternative - - strip-tillage. A strip-tillage system uses equipment that performs tillage in narrow (5-6 in. wide) bands or zones where the rows of next year's crop will be planted. This operation, usually done in the fall, allows the option of placing at least part of the nutrients 4-6 in. deep. Residue between rows remains undisturbed, providing erosion benefits associated with residue cover. The tilled zone should warm up and dry out quicker than soil in a no-till system, perhaps allowing quicker, better emergence and early growth of the crop.

Procedures

This research was conducted at the North Agronomy Farm (Manhattan, dryland) to evaluate strip-tillage and no-tillage as well as nutrient management on corn following corn. The site had been maintained in no-till for several years. In this initial year, strip-tillage was completed in March and all fertilizer was applied in a 2x2 placement during planting (April 5). Nitrogen rates of 30, 60, 90 and 120 lb/a with 30 lb P_2O_5/a, 5 lb/a K_2O and 5 lb/a S were applied on both strip-till and no-till treatments. A no-fertilizer check plot was included for both strip-till and no-till.

Plant populations and V-6 dry matter yields were determined as well as V-6 nutrient analyses. Leaf samples were taken at tassel for nutrient analysis. Grain yields were determined at harvest (August 29).

Results

Results from 2002 are summarized in Table 1. Even though corn emerged quicker with strip-till, there were no differences in final plant stands between strip-till and no-till (data not shown). Regardless of fertilizer rate, early season growth and nutrient uptake were consistently greater with strip-till compared to no-till, indicating warmer soil temperatures with strip-till. In spite of better early season growth and nutrient uptake, final grain yields were not significantly affected by tillage system. The lack of yield difference can likely be attributed to the abnormally hot, dry growing season. These conditions became the overall yield-limiting factor in 2002. With low yields, there were no significant differences among N rates; however, on average fertilizer treatments yielded 30 or more bushels than the no fertilizer check. This research will be continued in 2003.

Table 1. Nutrient management, tillage on corn, North Agronomy Farm, Manhattan, KS, 2002.

N - P- K - S	Tillage System	V-6 Dry Wt	V-6 Uptake N	V-6 Uptake P	V-6 Uptake K	Tassel N	Grain Yield
lb/a		- - - - - - - - - - - lb/a	- - - - - - - - - - - -			%	bu/a
0-0-0-0	Strip-till	273	8	1.4	9	1.46	36
30-30-5-5	"	518	17	1.9	14	1.89	59
60-30-5-5	"	545	18	2.2	14	2.66	59
90-30-5-5	"	518	19	2.0	14	2.42	70
120-30-5-5	"	595	22	2.3	15	2.57	66
0-0-0-0	No-till	211	6	0.9	6	1.47	22
30-30-5-5	"	392	13	1.6	11	2.07	62
60-30-5-5	"	434	16	1.6	10	2.40	65
90-30-5-5	"	337	13	1.4	11	2.45	58
120-30-5-5	"	522	20	2.0	13	2.71	70
LSD (0.10)		97	4	0.5	4	0.41	15
Mean Values:							
	0-0-0-0	242	7	1.2	8	1.46	29
N-P-K-S	30-30-5-5	455	15	1.8	12	1.98	61
lb/ac	60-30-5-5	490	17	1.9	12	2.54	62
	90-30-5-5	428	15	1.6	13	2.43	64
	120-30-5-5	558	21	2.1	14	2.64	68
LSD (.10)		68	3	0.3	3	0.29	11
	Strip-till	490	17	2.0	13	2.20	58
Tillage	No-till	379	13	1.5	10	2.22	55
LSD (.10)		43	2	0.2	2	NS	NS

Strip-tilled in March, all fertilizer applied as UAN, 10-34-0, KTS as a 2x2 with planter

EFFECTS OF NITROGEN MANAGEMENT AND TILLAGE ON GRAIN SORGHUM

R.E. Lamond, D.A. Whitney, G.M. Pierzynski, and C.B. Godsey

Summary

Since 1982, responses of grain sorghum to tillage system, nitrogen (N) rate, N source, and N placement have been investigated. Until 1995, N sources and placements used were ammonium nitrate, broadcast, and urea-ammonium nitrate solution, either broadcast or knifed, at rates of 0, 30, 60, 120 lb N/a. In 1995, the placement variable was dropped, and N sources (ammonium nitrate, urea, and AgrotaiN) were evaluated. In 2000, AgrotaiN was dropped as a N source and was replaced by CRU, a polymer-coated, slow- release urea that may be less susceptible to volatilization. All N was surface broadcast. The tillage systems used were no-till or conventional. In 2002, extremely dry conditions limited yields and results indicate that no-till and conventional tillage performed similarly. Nitrogen sources performed similarly in conventional tillage and no-till in 2002. Significant rainfall late in the season resulted in significant "sucker" heads, which resulted in the grain yields achieved, but limited effects of N sources and tillage.

Introduction

Tillage methods can influence the yield of grain sorghum through a number of mechanisms. Residue that accumulates at the soil surface under no-till systems can affect soil moisture content. Changes in soil moisture can directly influence yields, as well as alter N availability from mineralization of organic matter. A large amount of surface residue can act as a physical barrier and prevent fertilizer-soil contact when fertilizers are broadcast. In addition, the residue layer is enriched in urease, which can enhance ammonia volatilization and reduce the efficiency of urea-containing fertilizers, especially when they are broadcast applied.

This long-term study was altered slightly in 1995 to evaluate N sources, including ammonium nitrate; urea; and AgrotaiN, which is urea plus a urease inhibitor. In 2000, AgrotaiN was replaced by CRU, a polymer-coated, slow-release urea.

Procedures

Three N sources at three rates each (30, 60, 120 lb N/a) were used. These were ammonium nitrate, urea, and CRU. All materials were surface broadcast. The two tillage methods were conventional tillage, consisting of fall chisel and field cultivation before planting, and no tillage. The N was incorporated in the conventional-tillage system. A check plot without N was included within each tillage method. The treatments were replicated three times and arranged in a split-plot design with tillage as the main plot treatment and N source by N rate as the subplot treatments. Planting ('Pioneer 8505') and harvesting of grain sorghum were done on May 25 and October 3, respectively.

Results

Results are summarized in Table 2. Grain yields were increased significantly by N application up to 60 lb/a. All N sources performed similarly in conventional till and no-till. Due to abnormally dry conditions, sorghum growth was severely reduced and the primary heads failed to emerge. Late-season rainfall produced a crop of "sucker" heads that produced the yields achieved, but greatly limited tillage and N source effects. In addition, 21-year average yields show no difference between no-till and conventional tillage on the silty clay loam soil at this site.

Table 2. Effects of nitrogen management and tillage on continuous grain sorghum, North Agronomy Farm, Manhattan, KS, 2002.

N Rate	N Source	Tillage	Grain Yield
lb/a			bu/a
0	--	No-till	20
30	Am. nit.	No-till	33
60	Am. nit.	No-till	36
120	Am. nit.	No-till	43
30	Urea	No-till	32
60	Urea	No-till	46
120	Urea	No-till	42
30	CRU	No-till	28
60	CRU	No-till	37
120	CRU	No-till	43
0	--	Conventional	22
30	Am. nit.	Conventional	32
60	Am. nit.	Conventional	40
120	Am. nit.	Conventional	36
30	Urea	Conventional	34
60	Urea	Conventional	40
120	Urea	Conventional	43
30	CRU	Conventional	33
60	CRU	Conventional	41
120	CRU	Conventional	41
LSD (0.10)			6
Mean Values:			
N	30		32
Rate	60		40
	120		41
LSD (0.10)			3
N	Am. nit.		37
Source	Urea		39
	CRU		37
LSD (0.10)			NS
Tillage	No-till		38
	Conventional		37
LSD (0.10)			NS

EFFECTS OF LIME APPLICATION IN NO-TILLAGE CROPPING SYSTEMS

C.B. Godsey and R.E. Lamond

Summary

The acidifying effect of surface applied N fertilizers in no-tillage cropping systems creates problems for producers. One year after the initial lime application, soil pH increased significantly in the top inch with the addition of lime when compared to the control. Below the surface inch, no significant changes in soil pH were noted due to lime application in these no-tillage systems. Movement of lime may have been limited by lack of precipitation. Soybean grain yields in 2001 were limited by weather conditions.

Introduction

Throughout eastern and central Kansas no-tillage cropping systems are becoming more popular, raising concerns of how producers can manage acidic soils in these systems. Research has shown that surface applied N in no-tillage systems often leads to a decrease in soil pH, which often leads to elevated Al concentrations in the soil. In the past, most lime recommendations and lime application research have focused on thorough incorporation of lime material. This study was initiated to evaluate the effectiveness of surface applied lime materials in no-tillage cropping systems.

Procedures

Two no-tillage field sites (A and B) in Cowley County were identified that had below optimal soil pH (pH < 6.0). In 2000, seven treatments included four rates of Ag Lime (1000, 1000 annually for four years, 2000, and 4000 lb ECC Ag lime/a); two rates of Pell-Lime (1000 and 1000 annually for four years lb ECC Pell-Lime/a) and a no lime check treatment. All treatments were one-time applications except the two treatments indicated above that will be applied annually for four years. The initial lime applications were made in the Spring of 2000, prior to planting. Treatments were replicated four times in a randomized complete block design. Soil samples from each plot were collected in the Spring of both 2001 and 2002 at one inch increments to a depth of six inches and analyzed for pH. Grain yields were determined each year.

Results

Soil pH from samples collected in 2001 and 2002 from Site A and B are listed in Tables 3-7. Selected contrasts indicated lime application significantly increased soil pH in the top inch of soil in 2001 at site A (Pr>F = 0.01 for site A). Specifically, soil pH increased by an average of 0.37 at site A with the addition of lime. At site A, a significant treatment effect was detected in both years. Soil pH increased significantly in the top inch with the addition of 2000 and 4000 lb ECC Ag Lime/a when compared to the control at site A in 2001 (Table 7), while in 2002 all lime treatments significantly increased pH in the 0-1 inch depth when compared to the control (Table 6). In 2002, at site B a significant treatment difference was detected. All lime treatments significantly increased pH in the 0-1 inch depth when compared to the control (Table 6), however, no differences among lime treatments were detected. The neutralizing capability and movement of the lime may have been limited by the lack of precipitation during 2000 and 2001. Two years after the initial treatments it appears that lime has not moved past the surface inch of soil.

Grain yield was calculated for 2000, 2001, and 2002 (Table 7). No significant differences in grain yields were detected. In 2001, yields were below normal due to lack of moisture during the growing season. The average yield at Site A was only 4 bu/a, while at Site B the average grain yield was 19 bu/a. Potential treatment effect at site B in 2002 may have been masked by banding of phosphorus at time of wheat planting.

This research will be continued with annual soil sampling done in one-inch depth increments.

Table 3. Observed 1:1 soil pH at site A 2001.

	Treatments							
	Ag Lime lb ECC/a					Pell Lime lb ECC/a		
Depth	0	1000	1000 annually*	2000	4000	1000	1000 annually	LSD (0.10)
- in. -	- - - - - - - - - - - - - - pH - - - - - - - - - - - - - -					- - - - - - - - pH - - - - - - - -		
0-1	5.46	5.65	5.84	6.01	6.12	5.66	5.70	0.38
1-2	5.37	5.49	5.54	5.54	5.54	5.43	5.41	NS
2-3	5.64	5.60	5.66	5.67	5.61	5.54	5.57	NS
3-4	5.40	5.57	5.48	5.59	5.52	5.49	5.48	NS
4-5	5.73	5.65	5.65	5.73	5.64	5.56	5.60	NS
5-6	5.58	5.72	5.61	5.67	5.73	5.67	5.62	NS

*Treatment was applied annually for four years.

Table 4. Observed 1:1 soil pH at site A 2002.

	Treatments							
	Ag Lime lb ECC/a					Pell Lime lb ECC/a		
Depth	0	1000	1000 annually*	2000	4000	1000	1000 annually	LSD (0.10)
- in. -	- - - - - - - - - - - - - - pH - - - - - - - - - - - - - -					- - - - - - - - pH - - - - - - - -		
0-1	5.33	5.97	6.04	6.18	6.58	6.18	6.34	0.29
1-2	5.50	5.68	5.56	5.46	5.85	5.60	5.60	NS
2-3	5.61	5.70	5.61	5.84	5.79	5.63	5.83	NS
3-4	5.70	5.77	5.61	5.73	5.82	5.63	5.77	NS
4-5	5.75	5.84	5.74	5.82	5.91	5.59	5.88	NS
5-6	5.88	6.02	5.70	5.85	6.07	5.79	6.03	NS

*Treatment was applied annually for four years.

Table 5. Observed 1:1 soil pH at site B 2001.

	Treatments							
	Ag Lime lb ECC/a					Pell Lime lb ECC/a		
Depth	0	1000	1000 annually*	2000	4000	1000	1000 annually	LSD (0.10)
- in. -	- - - - - - - - - - - - - - pH - - - - - - - - - - - - - -					- - - - - - - - pH - - - - - - - -		
0-1	5.36	5.28	5.74	5.52	5.63	5.39	5.23	NS
1-2	4.75	4.79	4.81	4.58	4.63	4.69	4.48	0.16
2-3	4.62	4.77	4.54	4.72	4.79	4.70	4.71	NS
3-4	4.65	4.73	4.69	4.54	4.50	4.65	4.46	0.20
4-5	4.73	4.77	4.67	4.83	4.93	4.78	4.89	NS
5-6	4.92	4.87	4.96	4.89	4.82	4.91	4.77	NS

*Treatment was applied annually for four years.

Table 6. Observed 1:1 soil pH at site B 2002.

	Treatments							
	Ag Lime lb ECC/a					Pell Lime lb ECC/a		
Depth	0	1000	1000 annually*	2000	4000	1000	1000 annually	LSD (0.10)
- in. -	- - - - - - - - - - - - - - pH - - - - - - - - - - - - - -					- - - - - - - - pH - - - - - - - -		
0-1	4.97	5.60	5.39	5.47	5.64	5.73	5.83	0.54
1-2	4.74	4.92	4.90	4.92	4.93	4.87	4.76	NS
2-3	4.86	4.70	4.66	4.78	4.93	4.80	4.78	NS
3-4	4.75	4.77	4.85	4.64	4.85	4.72	4.58	NS
4-5	4.95	4.72	4.85	4.89	4.95	4.86	4.92	NS
5-6	4.97	4.93	5.05	4.99	4.92	5.03	4.82	NS

*Treatment was applied annually for four years.

Table 7. Grain yield from 2000-2002.

		Treatments							
		Ag Lime lb ECC/a					Pell Lime lb ECC/a		
Site	Crop	0	1000	1000 annually*	2000	4000	1000	1000 annually	LSD (0.10)
2000		- - - - - - - - - - - - - - pH - - - - - - - - - - - - - -					- - - - - - - - pH - - - - - - - -		
A	Soybean	19	24	26	22	28	20	20	NS
B	Sorghum	126	115	136	128	127	124	121	NS
2001									
A	Soybean	4	4	5	4	3	5	5	NS
B	Soybean	19	20	19	19	19	19	19	NS
2002									
A	Wheat	34	34	34	34	34	33	34	NS
B	Wheat	48	47	48	52	49	51	49	NS
B**	Soybean	45	49	46	50	51	50	51	NS

*Treatment was applied annually for four years.
**Double crop soybeans after wheat.

EVALUATION OF PELL-LIME AMENDMENTS TO CORRECT ACIDIC SOILS

C.B. Godsey and R.E. Lamond

Summary

The acidifying effect of surface applied N fertilizers in no-tillage cropping systems creates problems for producers. Lime treatments were applied in the Spring of 2002 at two field sites.

Introduction

Throughout eastern and central Kansas producers are faced with managing acidic soils. Past research has shown that surfaced applied N in no-tillage systems often leads to a decrease in soil pH, which often leads to elevated Al concentrations in the soil. This research was initiated to evaluate lime rates, compare liming materials, and evaluate the economics of liming.

Procedures

In 2002, two field sites (Marshall Co. and Osage Co.) in Kansas were identified that had below optimal soil pH (pH < 6.0). The Marshall Co. site is no-till and the Osage Co. site is conventional tillage. Nine treatments, including a check, consisted of four rates of Ag lime and Pell lime (200 lbs ECC/a, one-quarter, one-half, and full rate of the recommended lime application rate). All treatments were one-time applications except the 200 lbs ECC/a treatments which will be applied annually. Applications were first made in the Spring of 2002, prior to planting. Treatments were replicated three times in a randomized complete block design. Soil samples from each plot will be collected in the Spring of each year following 2002 at one inch increments to a depth of six inches and analyzed for pH. Grain yields were calculated for 2002.

Results

Soil pH from samples collected prior to treatment application from the Marshall County site indicated a soil pH of 5.3 and initial soil pH at the Osage County site was 5.0. Grain yields were calculated for 2002 (Table 8). No significant differences in grain yields were detected.

This research will be continued with annual soil sampling done in 1 inch depth increments.

Table 8. Effects of lime rates and sources on crop yields.

		Treatments									
		Ag Lime					Pell Lime				
Site	Crop	0	200[1]	1/4[2]	½[3]	Full[4]	200	1/4	½	Full	LSD (0.10)
Marshall Co.	Soybean	17	17	16	15	20	19	16	17	16	NS
Osage Co.	Corn	121	132	151	125	143	130	138	128	122	NS

[1] 200 lbs ECC/a applied annually.
[2] One quarter of the full recommended lime application rate to raise the soil to a pH of 6.8.
[3] One half of the full recommended lime application rate to raise the soil to a pH of 6.8
[4] Full recommended lime application rate to raise the soil to a pH of 6.8.

QUANTIFICATION OF SUBSURFACE NITRATE LOSSES IN IRRIGATED CORN PRODUCTION

J.L. Heitman, G.J. Kluitenberg, W.B. Gordon, and L.R. Stone

Summary

Preliminary data indicated that drainage was limited during the growing season in 2002 as crop water use generally exceeded water inputs. Work to quantify subsurface nitrate losses is continuing. Yields were not significantly different for 0, 100/100 (split), and 200 (pre-season) nitrogen treatments in the first year of treatment application.

Introduction

Efficient use of nitrogen fertilizer in irrigated corn production is important both in minimizing potential losses to groundwater and for maximizing economic return for the producer. The extent of nitrate leaching is controlled by both the concentration of nitrate in the soil solution and the quantity of soil solution that moves from the root zone. These two factors are, in turn, controlled by factors specific to each cropping system including soil properties, irrigation timing and quantity, nitrogen fertilizer application rate, and the method and timing of nitrogen fertilizer application. The objective of this study is to quantify subsurface losses of nitrate under irrigated corn and to compare losses associated with split nitrogen application versus those observed with full pre-season nitrogen application.

Procedures

A two-year study was initiated in the Spring of 2002 on private land in the Republican River Valley near the North Central Experiment Field (Scandia Unit). Soil at the field site is a Eudora loam. Three nitrogen treatments were established: 0, 100/100 (split), and 200 (pre-season) lb N/a. Nitrogen fertilizer was surface applied as dry ammonium nitrate (AN) and incorporated before planting. In 2002, corn ("Asgrow Rx 740") was planted on May 1. For the 100/100 split nitrogen treatment, an additional 100 lb N/a was applied as dry AN and incorporated with cultivation. Irrigation was applied following typical producer management practices.

In each field plot, tensiometers and a neutron probe were used to periodically record soil water potential and soil water content. Ceramic-cup solution samplers were used to collect water samples for determination of nitrate concentrations in the soil solution at the 5-ft depth. A drainage plot was established in the field to determine the water potential vs. hydraulic conductivity relationship at the 5-ft depth. Measurements of soil water potential, soil solution nitrate concentration, and hydraulic conductivity were used to estimate sub-surface losses of nitrate from the root-zone.

Results

At time of this report, work is still underway to determine estimates of sub-surface nitrate losses as soil hydraulic conductivity values are not yet available. Nitrate concentrations in soil water samples from the 5-ft depth did not change appreciably during the growing season. Conditions were dry during the growing season in 2002, and preliminary data suggest limited drainage from the root zone. Figure 1 shows water inputs to the field site from May 17-September 4. During this period, water demands from the growing crop generally exceeded inputs. As expected, profile water content decreased from June 5 to August 5, but began to recover in the upper 3 ft of the soil profile as crop water use declined between August 5 and October 7 (Figure 2).

Corn grain yields in 2002 for each treatment are shown in Table 9. Although the average yield was slightly lower for the 100/100 (split) nitrogen treatment, yields were not statistically different. Greater differences between nitrogen treatments are expected in year two following two years of consistent management. Further results, including estimates of subsurface nitrate losses, will be available at the conclusion of the study in 2003.

Table 9. Irrigated corn yields for three nitrogen treatments near Scandia, KS, 2002.

N Treatment	Yield
lb N/a	bu/a
200	163
100/100 (split)	146
0	164

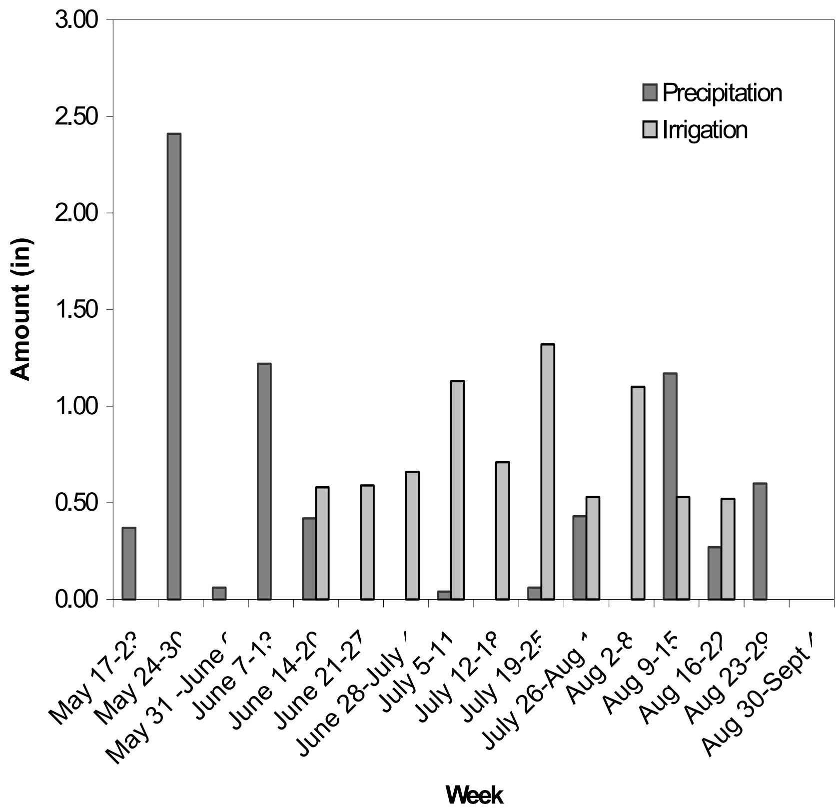

Figure 1. Weekly precipitation and irrigation water inputs near Scandia, KS, 2002.

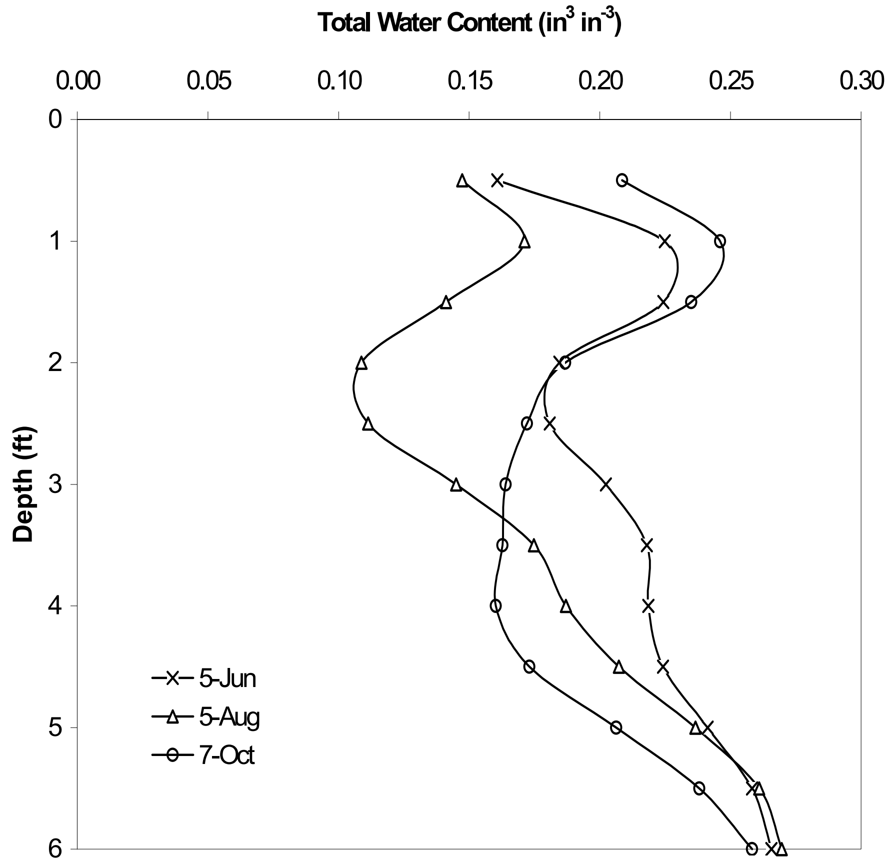

Figure 2. Total water content profiles for three dates near Scandia, KS, 2002.

NITRATE LEACHING CHARACTERISTICS FOR VARIOUS NITROGEN MANAGEMENT STRATEGIES ON IRRIGATED CORN

R.J. Gehl, J.P. Schmidt, L.R. Stone, L.D. Maddux, and W.B. Gordon

Summary

Efficient use of nitrogen (N) fertilizer for corn production is important for maximizing economic return to the producer and minimizing NO_3 leaching to groundwater. This research was initiated to quantify the NO_3 leaching potential in the irrigated sands along Kansas' waterways under current and alternative N and water management strategies for corn. Six fields were selected in 2001 along the Republican (1), Kansas (2), and Arkansas Rivers (3) and six nitrogen treatments were surface-applied NH_4NO_3 to small plots within each field as. At one field site, the N treatments were duplicated for each of two irrigation treatments (optimal and 25% greater than optimal). Also at this site, porous-cup tensiometers and solution samplers were installed in each plot for the four highest N treatments. Grain yield and soil NO_3-N (before and after the growing season) to a depth of 96 inches were determined for all plots. Yield results from 2001 indicate that 165 lb N/a was sufficient to achieve maximum corn yield at every location. Water samples collected throughout the growing season indicated that, after July 15, concentration of NO_3-N in soil water at the 60-inch depth was 2-3 times greater with the single pre-plant N applications as compared to the split N applications. Post-harvest soil samples indicated that NO_3-N was leaching to below the 60-inch depth for N treatments greater than 165 lb N/a and for the higher irrigation treatment.

Introduction

Quantification of NO_3 loss below the root zone is necessary to determine the contribution of agricultural practices to NO_3 contamination of ground water. The potential for NO_3 leaching is greatest when NO_3 concentration in the soil is high and water supply exceeds evaporation and transpiration, producing conditions conducive for downward water movement. Timing of N fertilizer application is central to minimizing N leaching, particularly on sandy-textured soils that are susceptible to rapid downward movement of water.

Combining N and water management practices that minimize nitrate leaching potential in corn production along environmentally sensitive tributaries in Kansas will be essential to maximizing economic return for producers and minimizing adverse effects on groundwater quality.

Objectives of this study include (i) quantification of NO_3 leaching potential in the irrigated sands along Kansas' waterways under current and alternative N and water management strategies for corn, and (ii) evaluating yield response to alternative N and water management practices for irrigated corn production.

Procedures

Field sites were selected at six Kansas locations in 2001 along the Republican (Scandia), Kansas (Manhattan, Rossville), and Lower Arkansas (Ellinwood, Pretty Prairie, St. John) Rivers. Soils at the locations ranged in textural class from silt loam to fine sand. Continuous corn is the crop rotation at every site except Scandia, which has a corn-soybean rotation, and each field is sprinkler-irrigated.

Plots at each field site were arranged in a randomized complete block design (RCBD) with four replications of six N treatments. Nitrogen was surface applied as NH_4NO_3 and treatments included 270 lb N/a applied pre-plant; 220 lb N/a applied pre-plant; 220 lb N/a applied pre-plant (½) and sidedress (½); 165 lb N/a applied pre-plant (⅓) and sidedress (⅔); 110 lb N/a applied pre-plant ($^1/_5$) and sidedress ($^2/_5$, $^2/_5$); and 0 lb N/a.

Treatments were adjusted at the Pretty Prairie and St. John sites due to producer management practices so that total N applied was similar to intended rates. The St. John location had 31 lb N/a applied as starter at planting. The Pretty Prairie East and West sites had 11 lb N/a applied as starter, as well as 45 and 60 lb N/a applied through the irrigation system, respectively. The N treatments at the Ellinwood site were duplicated for each of two irrigation treatments (optimal water rate and 25% greater than optimal water rate).

Three porous-cup tensiometers and one solution sampler were installed at the Ellinwood site in each replication of the four highest N treatments. Tensiometers were placed at depths of 12, 54, and 66 inches and solution samplers at 60 inches. In addition, irrigation gauges (16 total) were placed at the ends of each block to measure rainfall and irrigation during the growing season. Tensiometer measurements were collected at 7-10 day intervals during the growing season, and solution was collected every 10-14 days.

Soil samples were collected three times during the study year for NO_3-N analysis. Samples were collected at planting to a 96-inch depth in 12-inch increments, at the V-6 to V-8 growth stage to a 24-inch depth in 12-inch increments, and following harvest to a 96-inch depth in 12-inch increments. All soil samples were dried at 120^{o}F in a forced-draft dryer and ground to pass a 0.08-inch sieve. Nitrate-N in the soil samples was determined by analysis of 1 *M* KCl extracts.

Grain yield was determined by hand-harvesting a 20-ft length of each of the middle two rows in each plot. The entire plot area was harvested at the Rossville site with a combine modified for plot work.

Results

Yield results from 2001 indicated that 165 lb N/a was sufficient to achieve maximum corn yield at every location (Fig. 1). At the Ellinwood site, the 110 lb N/a (as three split applications) was sufficient to achieve maximum yield in the lower (1X) irrigation treatment but not in the higher (1.25X) irrigation treatment. The 110 lb N/a (as three split applications) treatment was also sufficient to achieve maximum yield at the East and West Pretty Prairie sites. The rates required to achieve maximum yield in this study were 50 to 70 lb N/a less than typically applied by producers in the study areas.

Water samples collected at the 60-inch depth throughout the growing season at Ellinwood indicated that after July 15, concentration of NO_3-N in soil water for the 1.25-X irrigation treatment increased to 2-3 times greater (as much as 160 ppm) with the single pre-plant N application as compared to the split N applications. This increase was not as pronounced in the 1-X irrigation treatment, although NO_3-N in soil water was noticeably higher for the 270 lb N/a treatment after July 15 (Fig. 2).

Post-harvest soil samples collected to 96 in (12-inch increments) indicated that NO_3-N was leaching to below the 60-inch depth at N rates greater than 165 lb N/a for the higher irrigation treatment at the Ellinwood site and at N rates greater than 165 lb N/a at the Scandia site (Fig. 3). The relatively high NO_3-N levels in the 20-60 inch depth at the Scandia site indicate a potential for additional leaching loss between fall and spring. At the East Pretty Prairie site, NO_3-N levels were highest at depths above 24 inches for N rates greater than 165 lb N/a. Because the west site at Pretty Prairie received similar N treatments and had much lower yields, excess N may have already leached below the sampled profile. The post-harvest soil samples from Rossville also suggest that NO_3-N levels had already leached from the profile to below 96 inches.

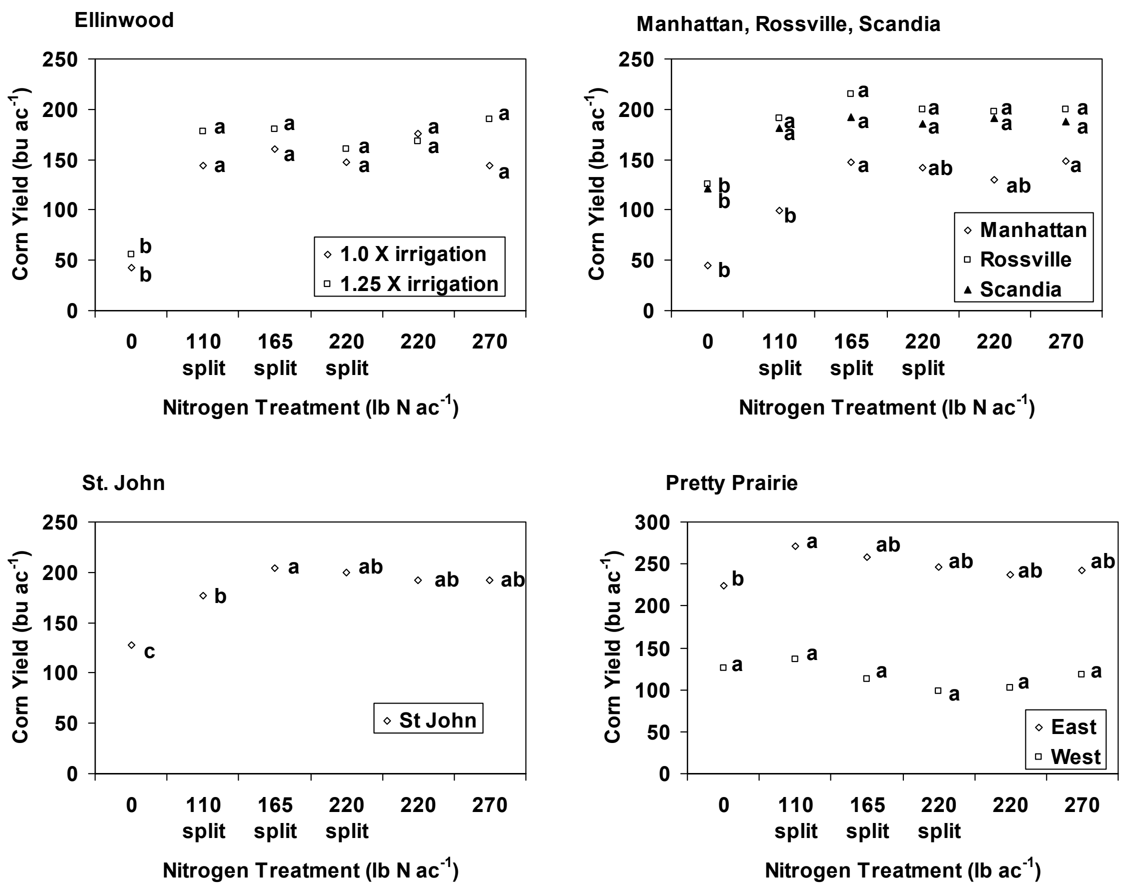

Figure 3. Grain yield as affected by N treatments for two water treatments at the Ellinwood site and one water treatment at five other sites. At each site, treatments with the same letter are not significantly different at a=0.05.

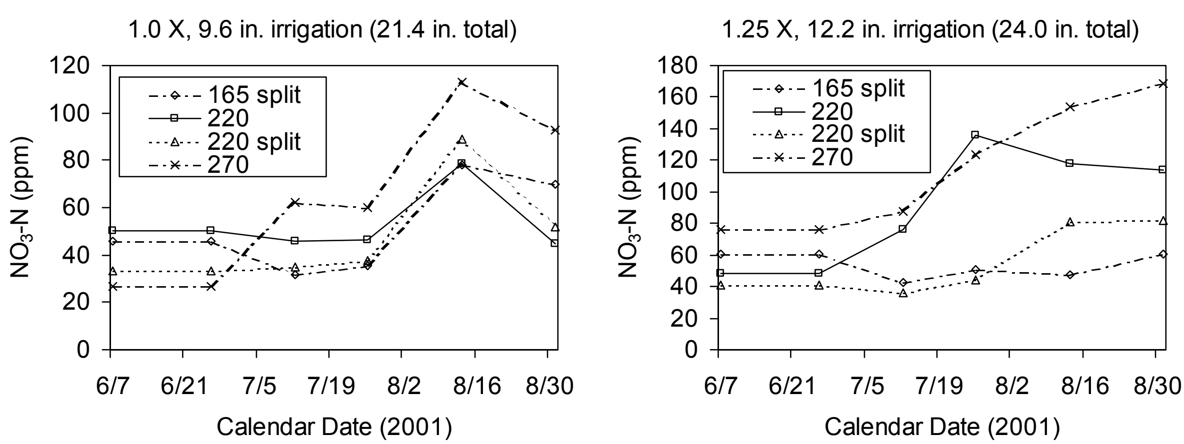

Figure 4. Soil water NO_3-N concentration at the 60-in. depth collected during the growing season at the Ellinwood site.

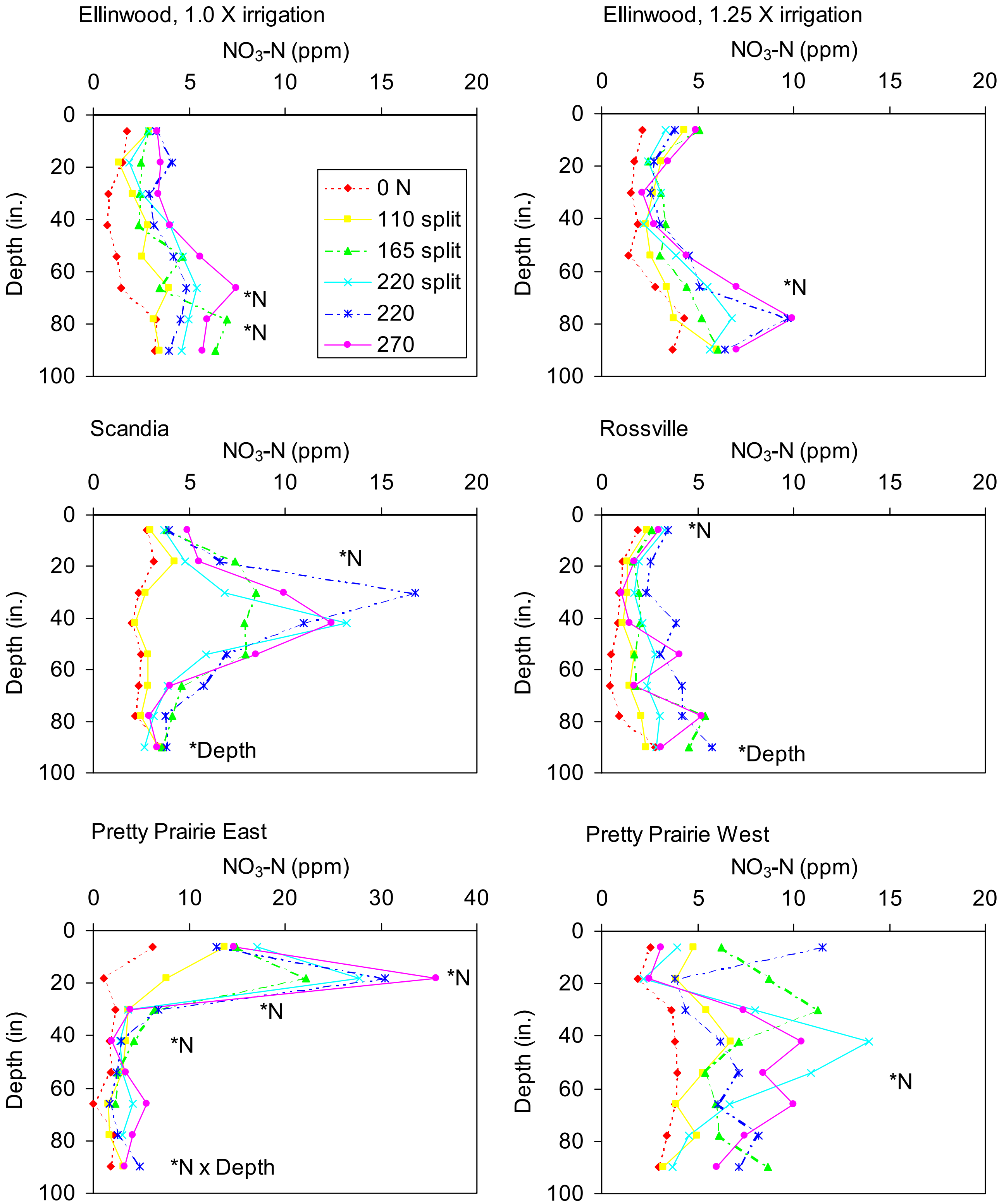

Figure 5. Post-harvest soil NO_3-N to 96 in. depth, collected in 12-in. increments. Statistical significance at α=0.05 is indicated by **N* for treatment interactions at a given depth, **Depth* for depth interactions, and **Depth X N* for treatment by depth interactions.

COMPARISON OF FERTILIZER RECOMMENDATIONS FROM SOIL TESTING LABORATORIES ON CORN YIELDS

G.L. Kilgore and D.E. Stites

Summary

It is important that producers base their fertilizer applications on soil test values. This research showed that although actual soil analytical results didn't vary much among four soil testing laboratories, considerable variation occurred in fertilizer recommendations. Corn yields ranged from 108.9 to 118.8 bu/a for the four laboratory recommendations and were not statistically different (LSD .05 = 13.6 bu). Fertilizer cost ranged from $22.40 to $48.40/a. Return per acre over fertilizer cost ranged from $219.41 to $253.96, with the no-treatment plot returning $204.09/a. Fertilizer recommendations from the K-State Soil Testing Lab resulted in the highest return over fertilizer cost.

Introduction

Producers often comment on K-State soil fertility recommendations. Most comments reflect the concern that K-State recommendations are not high enough because of greater recommendations seen from other sources. This study was established on a producer's farm to measure the yield of corn and other crops when fertilized with the recommendations from different soil testing laboratories. The data reported here are the first year of a 4-year study. The objective is to compare yields and economic return from different sources of fertilizer recommendations.

Procedures

The research site is located on an upland soil (Parsons silt loam) in Crawford County, just southeast of Girard, Kansas. A 0-6 inch soil sample was taken in the plot area. The sample was dried, ground, and divided into equal lots and submitted to four soil testing laboratories. The laboratories were K-State, University of Missouri, Columbia (UMC), Midwest laboratory, and Servi-Tech. All were notified that the sample was for corn after soybean rotation with a yield goal for corn of 110 bu and 35 bu for soybean. Each laboratory was asked to test the sample and supply test results and recommendations for both corn and soybean. Plots were then established in the field in a randomized complete block design. Recommended fertilizer was surface applied on the conventional tilled field. The cooperating producer planted 'Pioneer 34M94' on March 28, 2002 at approximately 26,500 seeds/a. No other fertilizer was applied. The producer applied herbicide uniformly across the field. At harvest, two rows, 16-ft long, were harvested from each plot. Yield calculations were made from the shelled grain. Initial soil test results (KSU Soil Testing Lab) from the study area were: pH 7.4, P 20 ppm, K 106 ppm, OM 2.0%, and Zn 2.1 ppm.

Results

Actual fertility recommendations are shown in Table 10. Significant differences are shown. Fertilizer cost ranged from $22.40 to $48.40/a. Yields from recommendations ranged from 108.9 to 118.8 bu/a, but were not significantly different (LSD .05 = 13.6). The no-fertilizer treatment control produced 83.3 bu/a (Table 11). Yields were above average for the shallow upland soil. There was significant difference in return per acre over fertilizer cost. K-State recommendations resulted in the highest returns at $253.96/a, while the lowest returns came from the no-fertilizer treatment at $204.09/a. Servi-Tech Recommendation was very close to K-State at a return of $251.46/a over fertilizer cost, Table 11. Final plant population was 23,958/a.

Next year, soybean will be planted and fertilized as recommended by each laboratory on the same plots established this year. Additional soil tests will be taken in the fall of 2003.

Table 10. Fertilizer recommendations for corn following soybean.

Laboratory	N	P_2O_5	K_2O	S
	- - - - - - - - - -	lb/a	- - - - - - - - - -	
K-State	80	10	20	0
University of Missouri (UMC)	100	70	65	0
Midwest	100	65	65	11
Servi-Tech	100	35	55	10

Table 11. Yield and economic return, 2002.

	Laboratory				
	No Treatment	K-State	UMC	Midwest	Servi-Tech
Yield, bu/a[1]	83.3	112.8	108.9	116.9	118.8
Fertilizer cost/a*	0	$22.40	$47.40	$48.40	$39.60
Return over fertilizer Cost /a**	$204.09	$253.96	$219.41	$238.00	$251.46

[1]Yield, LSD.05+13.6
*Fertilizer cost/lb: N = $0.215, P_20_5 = $0.24, K_20 = $0.14, S = $0.20
**Corn value = $2.45/bu

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CROP

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