KANSAS FERTILIZER RESEARCH 2001

REPORT OF PROGRESS 885

Kansas State University
Agricultural Experiment Station
and Cooperative Extension Service

INTRODUCTION

The 2001 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 Doug Wright of Mid–Kansas Coop.

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NOTE: Trade names are used to identify products. No endorsement is intended, nor is any criticism implied of similar products not mentioned.

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Publications, including this progress report, from K-State Research and Extension are available on the World Wide Web at http://www.oznet.ksu.edu

Precipitation Data (Inches)

2000	Manhattan	S.W. KS RES-EXT. CTR Tribune	S.E. KS EXP. STA. Parsons	E. CEN EXP. FLD. Ottawa
August	0.70	1.24	0.00	0.27
September	0.94	0.43	2.87	2.09
October	2.42	4.00	5.21	3.86
November	1.52	0.58	1.36	2.41
December	0.28	0.17	0.87	0.87
Total 2000	23.51	14.41	39.01	24.90
Dept. Normal	-10.17	-1.25	0.50	-13.37
2001				
January	0.71	1.52	2.52	1.69
February	2.74	0.37	2.97	3.84
March	1.24	0.53	1.92	2.03
April	3.40	0.34	2.65	1.35
May	5.56	3.63	4.07	5.07
June	7.03	1.22	7.13	6.49
July	3.27	3.43	1.33	3.19
August	6.87	1.73	2.57	3.16
September	5.67	0.42	4.08	3.90

2000	N. CEN EXP. FLD. Belleville	KANSAS RV VALLEY EXP. FLD.	S. CEN. EXP. FLD. Hutchinson	AGRIC. RES CTR—Hays
August	1.68	1.45	0.00	0.27
September	1.17	1.62	0.60	0.69
October	2.67	3.06	6.92	2.68
November	0.55	0.86	1.00	1.35
December	0.56	0.43	0.35	0.15
Total 2000	18.77	34.64	33.35	22.53
Dept. Normal	-8.79	-14.13	6.04	0.70
2001				
January	1.42	0.87	1.33	1.15
February	2.89	3.16	2.89	1.62
March	0.95	1.75	2.50	1.22
Apri	l3.30	2.52	1.81	1.42
May	5.87	1.58	4.05	6.72
June	4.64	4.59	3.40	3.25
July	6.80	2.24	1.25	4.72
August	0.54	2.95	1.25	1.84
September	6.71	1.63	3.06	5.45

GRASS FERTILIZATION STUDIES
KANSAS STATE UNIVERSITY - DEPARTMENT OF AGRONOMY

BROMEGRASS FERTILIZATION STUDIES

R.E. Lamond, H.C. George, B.D. Wood, C.J. Olsen, 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.

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 2001 at four sites in Miami County and one site in Douglas County to evaluate N, P, K, and S and experimental P materials. 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 2001 results are summarized in Tables 1 and 2. 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. 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 600 lb/a of forage, averaged over the five 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. These studies will be continued in 2002.

Table 1. Fertility management on bromegrass, northeast and southeast Kansas, 2001.

					Miami Co. S			Miami Co. N			Douglas Co.		
				P	Forage								
N	P_2O_5	K_2O	S	Source*	Yield	Prot.	P	Yield	Prot.	P	Yield	Prot.	P
	lb/a				lb/a	- - % - -		lb/a	- - % - -		lb/a	- % -	
0	0	0	0	--	2190	9.3	.16	1600	9.6	.18	3200	8.8	.15
45	0	0	0	--	4360	10.0	.13	2710	9.0	.13	4390	9.5	.13
45	20	0	0	MAP	5330	9.5	.18	3160	8.9	.16	4440	9.2	.16
45	20	0	0	0.5% SFP MAP	4920	9.5	.17	3550	9.6	.18	4910	8.5	.15
45	20	0	0	1.0% SFP MAP	4160	9.8	.17	3150	8.5	.18	4890	9.5	.17
90	0	0	0	--	5100	12.1	.13	3210	11.8	.15	5230	9.9	.13
90	20	0	0	MAP	5290	11.4	.17	4160	9.1	.16	5510	10.1	.16
90	20	0	0	0.5% SFP MAP	6010	10.9	.16	4710	10.2	.16	5370	10.5	.16
90	20	0	0	1.0% SFP MAP	5350	12.1	.17	4710	9.9	.16	5620	10.3	.15
90	20	30	0	MAP	5410	11.0	.16	4720	9.2	.15	5720	9.2	.13
90	20	30	10	MAP	5800	12.3	.18	5360	11.0	.17	6530	8.1	.14
	LSD (0.10)				800	1.2		1110	2.1	NS	780	NS	.01
Mean Values:													
N	45				4690	9.7	.16	3190	9.0	.16	4650	9.2	.15
Rate	90				5440	11.6	.16	4190	10.3	.15	5430	10.2	.15
	LSD (0.10)				410	0.6	NS	580	0.7	NS	390	0.6	NS
P	No P				4730	11.0	.13	2960	10.3	.14	4800	9.7	.13
Source	MAP				5310	10.5	.17	3820	9.0	.16	4970	9.7	.16
	0.5% SFP MAP				5470	10.2	.16	4130	9.9	.17	5140	9.5	.15
	1.0% SFP MAP				4750	11.0	.17	3930	9.2	.17	5260	9.8	.16
	LSD (0.10)				570	NS	.02	810	1.0	.02	NS	NS	.01
Soil Test P, ppm						4			4			4	

* MAP is monoammonium phosphate (11-52-0). SFP are experimental P materials.

Table 2. Fertility management on bromegrass, southeast Kansas, 2001.

N	P_2O_5	S	Miami Co. H Forage Yield	Prot.	P	S	Miami Co. W Forage Yield	Prot.	P	S
	lb/a		lb/a	- - - - - % - - - - -			lb/a	- - - - - % - - - - -		
0	0	0	2430	10.2	.23	.15	2180	8.5	.18	.14
40	0	0	5150	11.1	.25	.13	4860	10.4	.16	.14
80	0	0	5890	12.2	.25	.13	5370	11.0	.14	.14
120	0	0	7590	13.8	.25	.14	5080	13.3	.15	.17
40	30	0	5360	11.6	.24	.14	5390	9.2	.20	.13
80	30	0	7440	11.8	.26	.14	5910	10.5	.20	.14
120	30	0	7500	14.2	.25	.13	6370	11.0	.20	.14
80	30	20	7890	11.8	.24	.18	6650	8.9	.20	.17
	LSD (0.10)		1380	1.7	NS	NS	860	2.8	.02	.02
Mean Values:										
N	40		5250	11.4	.25	.13	5130	9.7	.18	.14
Rate	80		6660	12.0	.25	.13	5640	10.8	.17	.14
	120		7550	14.0	.26	.14	5730	12.1	.17	.15
	LSD (0.10)		1020	1.3	NS	NS	490	1.4	NS	NS
P_2O_5	0		6210	12.4	.25	.13	5100	11.5	.15	.15
Rate	30		6770	12.5	.25	.14	5890	10.2	.20	.14
	LSD (0.10)		NS	NS	NS	NS	400	1.2	.01	NS
Soil Test P, ppm			14				7			

SOIL FERTILITY RESEARCH
SOUTHWEST RESEARCH - EXTENSION CENTER

NITROGEN AND PHOSPHORUS FERTILIZATION OF IRRIGATED CORN AND GRAIN SORGHUM

A.J. Schlegel

Summary

Long-term research shows that phosphorus (P) and nitrogen (N) fertilizers must be applied to optimize production of irrigated corn and grain sorghum in western Kansas. In 2001, N and P fertilization increased corn yields up to 140 bu/a. Averaged across the past 9 years, corn yields were increased more than 100 bu/a by N and P fertilization. Application of 160 lb N/a generally is sufficient to maximize corn yields. Phosphorus increased corn yields by 70 bu/a when applied with at least 120 lb N/a. Application of 40 lb P_2O_5/a has been adequate for corn until the past 2 years, when yields were increased by a higher P rate. Grain sorghum yields averaged across 9 years were increased 45 bu/a by N and 20 bu/a by P fertilization. Near maximum yields were obtained in most years with 80 lb N/a. Potassium (K) fertilization had no effect on sorghum yield. In the corn study, soil organic matter was increased by N and P fertilization from 2.0% in the control to 2.4% with adequate N and P. Application of 40 lb P_2O_5/a was not sufficient to maintain soil test P levels.

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. The study is conducted on a Ulysses silt loam soil with an inherently high K content. No yield benefit to corn from K fertilization was observed in 30 years and soil K levels remained high, so the K treatment in the corn study was discontinued in 1992 and replaced with a higher P rate.

Procedures

Initial fertilizer treatments in 1961 to corn and grain sorghum in adjacent fields 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 without K; and with 40 lb P_2O_5/a and 40 lb K_2O/a. In 1992, the K variable for the corn study was 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. Corn hybrids Pioneer 3379 (1992-94), Pioneer 3225 (1995-97), Pioneer 3395IR (1998), Pioneer 33A14 (2000), and Pioneer 33R93 (2001) were planted at 32,000 seeds/a in late April or early May. The 1999 corn crop was lost to hail. Sorghum (Mycogen TE Y-75 from 1992-1996, Pioneer 8414 in 1997, Pioneer 8505 from 1998-2000, and Pioneer 8500 in 2001) was planted in late May or early June. Both studies were irrigated to minimize water stress. Furrow irrigation was used through 2000 and sprinkler irrigation in 2001. The center two rows of each plot were machine harvested after physiological maturity. Grain yields were adjusted to 15.5% moisture for corn and 12.5% for sorghum. Soil samples (0-6 inches) were taken in the corn study following harvest in 2000.

Results

Corn yields in 2001 were slightly higher than the long-term average (Table 1). Nitrogen and P fertilization increased corn yields by up to 140 bu/a. Only 120 lb N/a was required to obtain near maximum yields compared to the long-term average of about 160 lb N/a. Corn yields were 8 bu/a greater with 80 than with 40 lb P_2O_5/a, compared to the long-term average of 2 bu/a.

Grain sorghum yields in 2001 were greater than the long-term average (Table 2). Maximum sorghum yields were obtained with 80 lb N/a when applied with P. Phosphorus increased yields by about 20 bu/a, which was similar to the long-term average. The response to P tended to be less at the highest N rate. Potassium fertilization had no effect on yield.

Long-term N applications decreased soil pH while increasing soil organic matter (Table 3). Phosphorus fertilization had no effect on soil pH while slightly increasing OM. Soil test P was 8 ppm higher with 40 lb/a P_2O_5 than without P (12 vs. 4 ppm), but still less than at the start of the study (17 ppm Bray-1 P in 1961). Application of 80 lb/a P_2O_5 increased soil test P to 21 ppm.

Table 1. Effects of nitrogen and phosphorus fertilizers on irrigated corn, Tribune, KS, 1992-2001.

		Grain Yield									
Nitrogen	P_2O_5	1992	1993	1994	1995	1996	1997	1998*	2000	2001	Mean
- - - - lb/a - - - -		- bu/a -									
0	0	73	43	47	22	58	66	49	131	54	60
0	40	88	50	43	27	64	79	55	152	43	67
0	80	80	52	48	26	73	83	55	153	48	69
40	0	90	62	66	34	87	86	76	150	71	80
40	40	128	103	104	68	111	111	107	195	127	117
40	80	128	104	105	65	106	114	95	202	129	116
80	0	91	68	66	34	95	130	95	149	75	89
80	40	157	138	129	94	164	153	155	205	169	151
80	80	140	144	127	93	159	155	149	211	182	151
120	0	98	71	70	39	97	105	92	143	56	86
120	40	162	151	147	100	185	173	180	204	177	164
120	80	157	153	154	111	183	162	179	224	191	168
160	0	115	88	78	44	103	108	101	154	76	96
160	40	169	175	162	103	185	169	186	203	186	171
160	80	178	174	167	100	195	187	185	214	188	176
200	0	111	82	80	62	110	110	130	165	130	109
200	40	187	169	171	106	180	185	188	207	177	174
200	80	165	181	174	109	190	193	197	218	194	180
ANOVA											
N		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Linear		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Quadratic		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
P_2O_5		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Linear		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Quadratic		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
N x P		0.013	0.001	0.001	0.001	0.001	0.001	0.001	0.008	0.001	0.001
MEANS											
N, lb/a	0	80	48	46	25	65	76	53	145	48	65
	40	116	90	92	56	102	104	93	182	109	105
	80	129	116	107	74	139	146	133	188	142	131
	120	139	125	124	83	155	147	150	190	142	139
	160	154	146	136	82	161	155	157	190	150	148
	200	154	144	142	92	160	163	172	197	167	154
	LSD 0.05	14	7	13	7	10	12	11	10	15	6
P_2O_5, lb/a	0	96	69	68	39	92	101	91	149	77	87
	40	149	131	126	83	148	145	145	194	147	141
	80	141	135	129	84	151	149	143	204	155	143
	LSD 0.05	10	5	9	5	7	9	7	7	10	4

*Note: There was no yield data for 1999 because of hail damage.

Table 2. Effects of nitrogen, phosphorus, and potassium fertilizers on irrigated sorghum, Tribune, KS, 1992-2001.

N	P_2O_5	K_2O	1992	1993	1994*	1996	1997	1998	1999	2000	2001	Mean
			Grain yield									
- - - - lb/a - - - -			- - - - bu/a - - - -									
0	0	0	27	46	64	74	81	77	74	77	76	66
0	40	0	28	42	82	77	75	77	85	87	81	70
0	40	40	35	37	78	79	83	76	84	83	83	71
40	0	0	46	69	76	74	104	91	83	88	92	80
40	40	0	72	97	113	100	114	118	117	116	124	108
40	40	40	72	92	112	101	121	114	114	114	119	107
80	0	0	68	91	96	73	100	111	94	97	110	94
80	40	0	85	105	123	103	121	125	113	116	138	115
80	40	40	85	118	131	103	130	130	123	120	134	120
120	0	0	56	77	91	79	91	102	76	82	98	84
120	40	0	87	120	131	94	124	125	102	116	134	115
120	40	40	90	117	133	99	128	128	105	118	135	117
160	0	0	62	93	105	85	118	118	100	96	118	100
160	40	0	92	122	137	92	116	131	116	118	141	119
160	40	40	88	123	125	91	119	124	107	115	136	115
200	0	0	80	107	114	86	107	121	113	104	132	108
200	40	0	91	127	133	109	126	133	110	114	139	121
200	40	40	103	123	130	95	115	130	120	120	142	120
<u>ANOVA</u>												
Nitrogen			0.001	0.001	0.001	0.003	0.001	0.001	0.001	0.001	0.001	0.001
Linear			0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001
Quadratic			0.001	0.001	0.001	0.116	0.001	0.001	0.227	0.001	0.001	0.001
P-K			0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zero P vs. P			0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
P vs. P-K			0.431	0.888	0.734	0.727	0.436	0.649	0.741	0.803	0.619	0.929
N x P-K			0.420	0.006	0.797	0.185	0.045	0.186	0.482	0.061	0.058	0.031
<u>MEANS</u>												
Nitrogen												
0 lb/a			30	42	75	77	80	76	81	82	80	69
40			64	86	100	92	113	108	105	106	112	98
80			80	104	117	93	117	122	110	111	127	109
120			78	105	118	91	114	118	95	105	122	105
160			81	113	122	89	118	124	108	110	132	111
200			91	119	126	97	116	128	115	113	138	116
LSD 0.05			10	10	14	9	10	8	13	7	8	7
P_2O_5-K_2O												
0-0 lb/a			56	81	91	79	100	103	90	91	104	89
40-0			76	102	120	96	113	118	107	111	126	108
40-40			79	102	118	95	116	117	109	112	125	108
LSD 0.05			7	7	10	7	7	6	9	5	6	5

*Note: There was no yield data for 1995 because of early freeze damage.

Table 3. Effects of nitrogen and phosphorus fertilizers on soil properties of irrigated corn, Tribune, KS, 2000.

Nitrogen	P_2O_5	pH	OM	CEC	Bray-1 P
- - - lb/a - - -			%	meq/100g	ppm
0	0	7.9	2.0	32.5	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

SOIL FERTILITY RESEARCH
AGRICULTURAL RESEARCH CENTER—HAYS

EFFECTS OF FERTILIZERS AND DEPTH OF SOIL WATER ON CONTINUOUS DRYLAND GRAIN SORGHUM – 31 YEAR SUMMARY

C.A. Thompson

Summary

In the 22.5-inch rainfall area of Kansas, monitoring the depth of soil water before planting continuous dryland sorghum was necessary in order to maximize yields and net return from fertilizer usage. Even though 60 lb N/a maximized yields and net fertilizer return, 20 lb N/a gave the highest return per fertilizer dollar invested. Using low N rates is important only when adequate monies are not available to maximize profit with higher N rates and when depth of soil water is limited. These data show it was cost-effective to apply a low N rate rather than none at all. Fertilizer N was cost effective at 20 lb N/a when soil water depth was 48-inches or more and for 40 and 60 lb N/a when the depth of soil water was 54-inches or deeper.

Introduction

In the traditional fallow areas of Kansas, sorghum producers are cautious about planting continuous grain sorghum because of the possible lack of stored soil water at time of planting. This is a valid concern. However, through various conservation tillage practices, producers are becoming more consistent in storing adequate soil water from the harvest of one crop to the planting of the next.

When managing continuous dryland production, the amount of fertilizer to apply is a concern for sorghum producers. Many producers feel commercial fertilizers applied on continuous dryland cropping will automatically be detrimental to crop production. This paper addresses the effect of the depth of soil water and fertilizer rates on crop production and net return. It is important to show the grain sorghum producer how the application of commercial fertilizers can be cost-effective under continuous dryland conditions.

Procedures

This experiment was started in the fall of 1970. Fertilizer was applied in the fall throughout the 31 years of the study. Both N and P fertilizer were broadcast applied. Nitrogen fertilizer was applied as ammonium nitrate (34% N) and phosphorus as concentrated superphosphate (46% P_2O_5). In most years the soil was dry enough to perform tillage as a ripping operation in the fall directly after fertilizer application. Plots were 12 feet wide and 30 feet long and were replicated 4 times. Sorghum was planted in 12-inch rows at 60,000 seeds/a (Super Thick grain sorghum). A 5/16-inch rod with a 1/2-inch ball bearing welded to the end was pushed into the soil to determine the depth of soil water. The soil was a Crete silty clay loam. Grain was harvested each year from all the plots. In the early years sorghum heads were harvested by hand and then run through a stationary thresher. In the last 10 years, grain was harvested with a plot combine. This study had a randomized block design and was analyzed with SAS using ANOVA. Yield and fertilizer correlations with depth of soil water were also analyzed with SAS.

Results

The summary results from the 31 cropping years are reported in Figures 1 through 4. In Figure 1 each of the fertilizer N rates resulted in significant yield increases. However, phosphorus added to N did not increase yields. This is not surprising because soil P was high. The response to added phosphorus in other studies over the years has been marginal at best even on soils low in available P. Net return from fertilizer additions continued to increase with each increment of added N. Phosphorus fertilizer addition was not cost-effective. Fertilizer costs were nearly linear for all fertilizers applied.

Estimated yield curves (Fig. 2) were calculated from the depth of soil water and yield for each of the N rates. Correlation (R-values) was high for each N rate, indicating a positive effect of depth of soil water on sorghum yields when grown under continuous dryland conditions. As the depth of soil water increased, so did the yield response to added N fertilizer. Fertilizer N at 60 lb N/a had the highest sorghum yields.

Estimated net return curves (Fig. 3) were calculated from the depth of soil water and the net fertilizer return from applied N for each of the N rates. To determine the net return from fertilizer, the estimated net return from each N rate was subtracted from the estimated net return from no fertilizer. There was a very strong correlation between depth of soil water and net return from each N rate. Net returns from added N increased with increasing depth of soil water. Of the three N rates, 60 lb N/a gave the highest net return when depth of soil water was 42-inches or more.

All producers want to obtain the highest return per dollar invested. In Figure 4, ratios of net return from N fertilizer per fertilizer dollar invested are shown. The ratio must be higher than 1 for the fertilizer to be cost-effective. The estimated net return (Fig. 3) from each fertilizer rate was divided by the input N costs. These data show the highest net return per fertilizer dollar invested was from the lowest rate of N (20 lb N/a). Even though the highest overall return from fertilizer came from the highest N rate (Fig. 3), the highest return per dollar invested came from the lowest N rate. When a producer's money for input costs is in short supply, using low N rates is very cost-effective. Also, when depth of soil water is limited, using a low N rate is more cost-effective than higher N rates. These data also show it is better to apply a low N rate rather than none at all. When applying 20 lb N/a it was necessary for the depth of soil water to be 48-inches or deeper. When applying 40 and 60 lb N/a, the depth of soil water needed to be 54-inches or more.

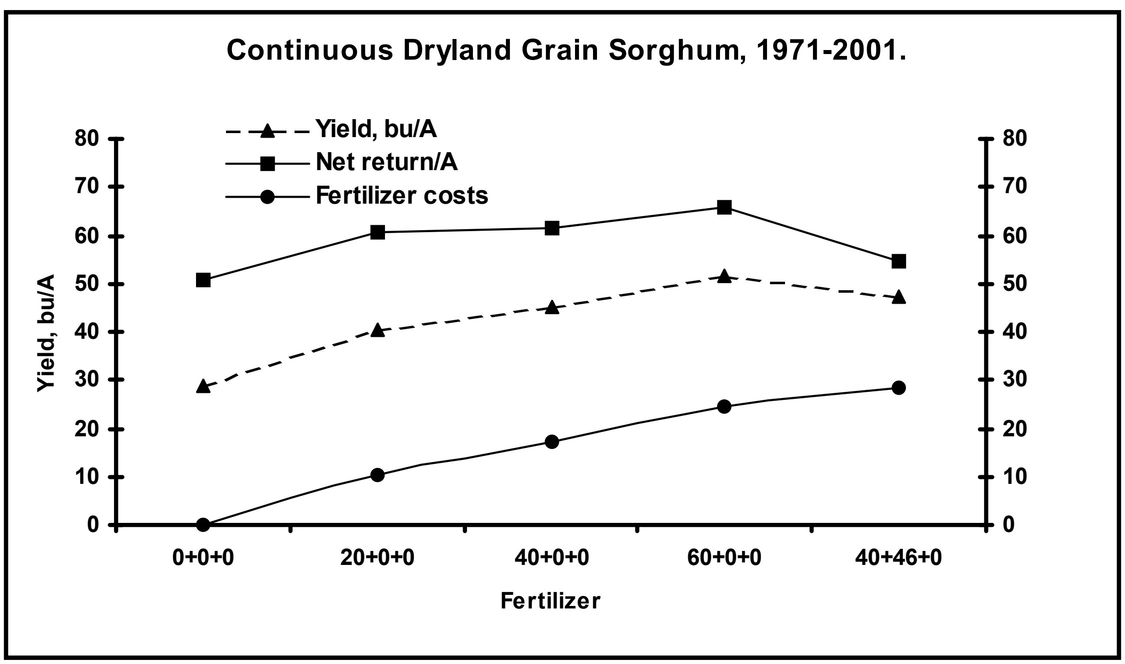

Figure 1. Summary of yield, net return, and fertilizer costs from continuous dryland grain sorghum.

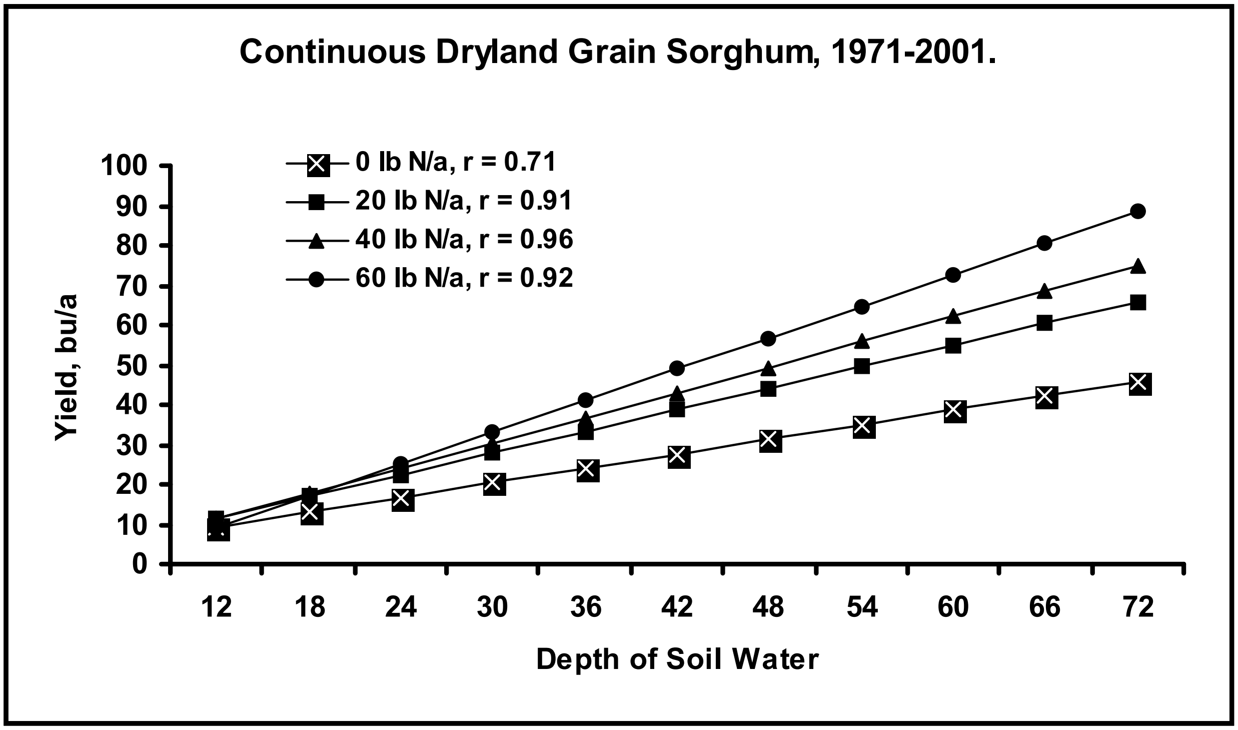

Figure 2. Yield as affected by depth of soil water on continuous dryland grain sorghum.

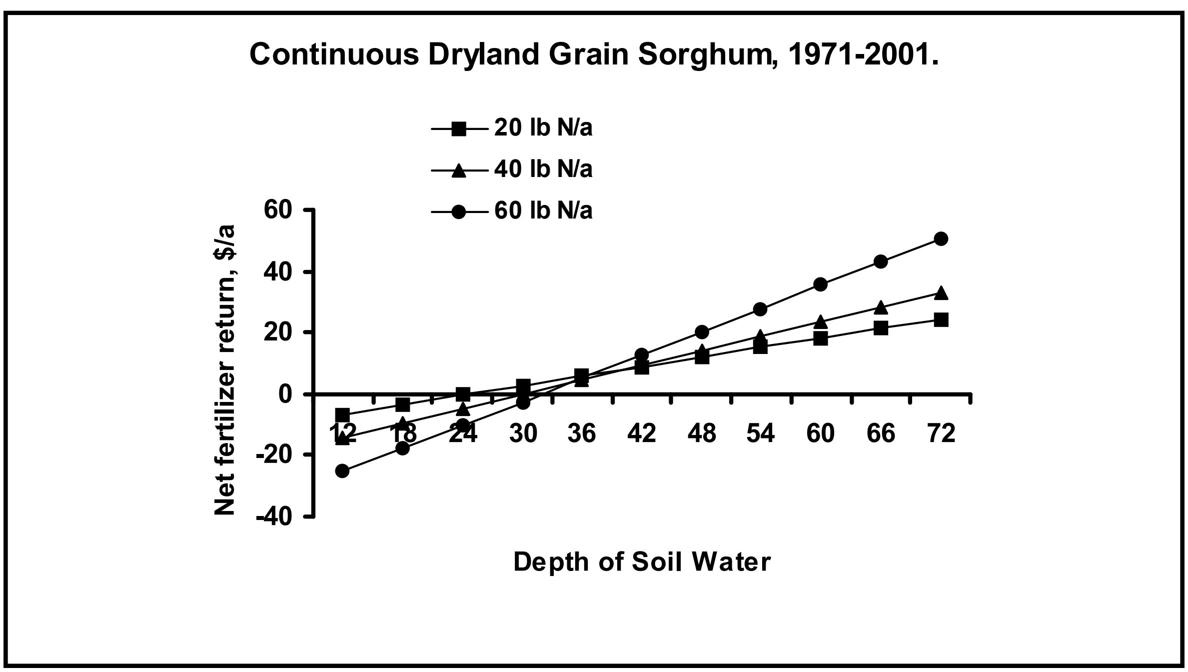

Figure 3. Net fertilizer return as affected by depth of soil water on continuous dryland grain sorghum.

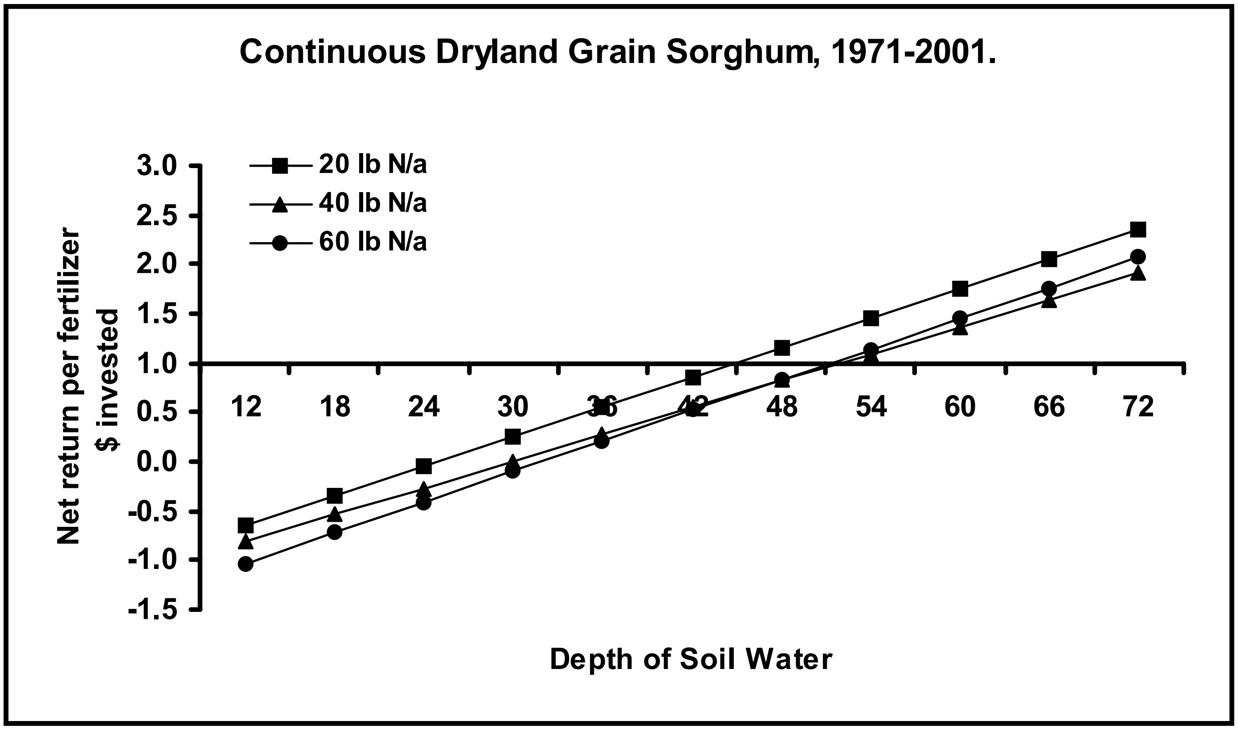

Figure 4. Effect of depth of soil water on net return per fertilizer dollar invested.

SOIL FERTILITY RESEARCH
SOUTHEAST AGRICULTURAL RESEARCH CENTER

EFFECTS OF TIMING OF LIMITED-AMOUNT IRRIGATION AND NITROGEN RATE ON SWEET CORN PLANTED ON TWO DATES

D.W. Sweeney and C.W. Marr

Summary

In 2000, irrigation increased the number of harvestable ears by 19% or more for sweet corn planted in mid-May. Total fresh weight was unaffected by irrigation for the April-planted sweet corn, but irrigation at the R1 growth stage produced more total weight of later-planted sweet corn than with no irrigation.

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. Research 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 consisted of N rates of 40, 80, and 120 lb/a. Sweet corn was planted on April 26 and May 22, 2000. Sweet corn from the first planting date was picked on July 10 and 17, and that from the second planting date was picked on July 27 and August 3, 2000.

Results

The total number of harvestable ears and the total fresh weight was influenced by an interaction between planting date and irrigation scheme (Table 1). In general, there were more harvestable ears from sweet corn planted at the second date than from the first. For sweet corn planted at the first date, splitting the irrigation amount between the V12 and R1 growth stages resulted in greater number of ears than irrigation applied at the R1 stage, but neither were significantly different than no irrigation. However, when planted at the later date, any irrigation scheme resulted in 19% or more harvestable ears than obtained with no irrigation. Total fresh weight of ears from sweet corn planted at the first date was not significantly affected by irrigation scheme. However, from the second date, total fresh weight of sweet corn ears was increased with irrigation, especially for that applied at the R1 growth stage. Although individual ear weight was not affected by an interaction of planting date and irrigation scheme, individual ear weight averaged about 13% greater from sweet corn planted at the second compared with the first date. Nitrogen rate had no effect on total ears, total fresh weight, or individual ear weight.

Table 1. Effects of irrigation scheme and nitrogen rate on sweet corn planted at two dates, Southeast Agricultural Research Center, KS, 2000.

Treatment		Total Ears	Total Fresh Weight	Individual Ear Weight
		no./a	ton/a	g/ear
Planting Date	Irrigation Scheme			
Date 1	None	17700	5.05	259
	V12 (2")	17900	4.79	246
	R1 (2")	15400	4.05	241
	V12-R1 (1" each)	20000	5.00	226
Date 2	None	19400	5.57	258
	V12 (2")	23100	7.41	290
	R1 (2")	26400	8.32	285
	V12-R1 (1" each)	24800	7.07	262
LSD $_{(0.05)}$		3700	1.16	NS†
N Rate, lb/a				
40		20400	5.81	260
80		20900	5.76	249
120		20500	6.15	268
LSD $_{(0.05)}$		NS	NS	NS

† Main effect of planting date on individual ear weight was significant: D1=243 and D2=274 g/ear.

TIMING OF NITROGEN, PHOSPHORUS, AND POTASSIUM FERTILIZATION FOR WHEAT AND DOUBLE-CROPPED SOYBEAN IN REDUCED AND NO-TILL SYSTEMS

D.W. Sweeney

Summary

In 2000, fertilization more than doubled yields. Applying all the nitrogen (N) in the fall increased yields compared to all N applied in the spring. Yield of double-cropped soybean was low and was unaffected by tillage and timing of N or P and K timing.

Introduction

Double-cropping soybean after wheat is practiced by many producers in southeastern Kansas. Typically, phosphorus (P) and potassium (K) fertilizers are applied in the fall prior to wheat planting, with no additional application prior to planting double-cropped soybean. Nitrogen (N) is applied either in the fall or spring or at both times. Moreover, as the acreage of conservation tillage increases, either as reduced- or no-till, management of fertilizer nutrients becomes more crucial. Timing of N, P, and K fertilization may not impact only wheat production but also affect yields of the following double-cropped soybean. The objective of this study was to determine the effects of fall and late winter applications of N, P, and K for wheat followed by double-cropped soybean grown in reduced- and no-tillage systems.

Procedures

The experiment was established in 1997 as a split-plot design with three replications. Whole plots were tillage as either reduced- or no-till. The 3x3 factorial arrangement of the subplots included three N and three P-K fertilizations applied all in the fall, all in late winter, or split evenly between fall and late winter. For each treatment, total applied was 80 lb N/a, 70 lb P_2O_5/a, and 75 lb K_20/a. For reference, a check plot receiving no N, P, or K fertilization was included in each whole plot.

Results

In 2000, wheat yield with no N, P, or K averaged less than 16 bu/a. Applying all the N in the fall produced average yield of 44.7 bu/a, which was greater than yield with all the N applied in the spring, with the 50-50% split N in fall and spring resulting in intermediate yields (Fig. 1). Wheat yield was affected by an interaction between tillage and P-K timing in 2000. Wheat grown with no tillage and fertilized with all the P and K in the fall yielded less than when fertilized with P and K in the spring. In contrast, wheat grown with reduced tillage and fertilized with all the P and K in the fall tended to yield more than split P-K applications or 100% P and K spring-applied, even though the difference was not significant (Fig. 2).

Double-crop soybean yield was low, averaging less than 7 bu/a. Tillage selection and timing of N or P and K fertilization did not significantly affect soybean yields in 2000.

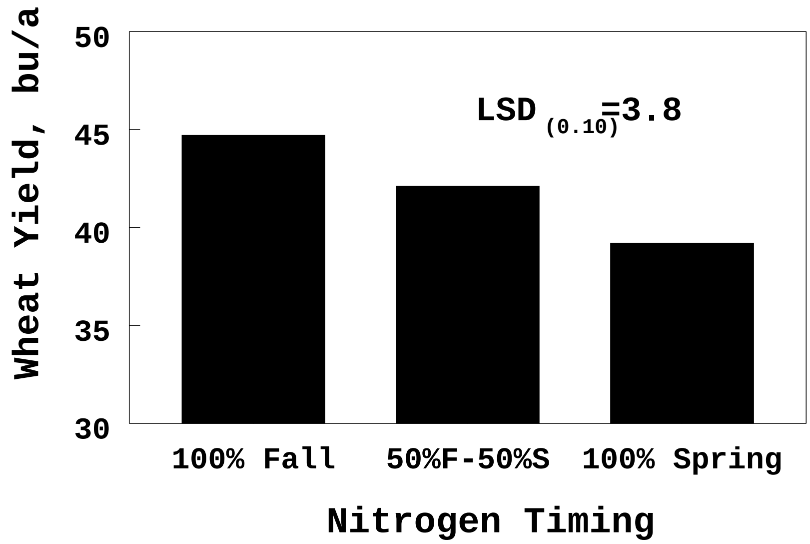

Figure 1. Effects of nitrogen fertilization timing on wheat yield in a continuous wheat — double-cropped soybean rotation, Southeast Agricultural Research Center, 2000.

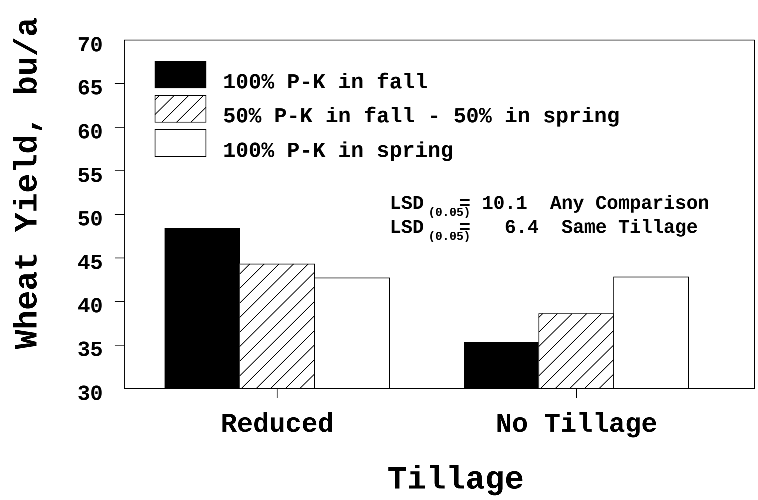

Figure 2. Effects of tillage and timing of P and K fertilization on wheat yield in a continuous wheat—double-cropped soybean rotation, Southeast Agricultural Research Center, 2000.

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

D.W. Sweeney

Summary

In 1999, overall soybean yields were low. Increasing soil phosphorus level increased yield by increasing the number of seeds per plant, but soil potassium level had no effect on soybean yield or yield components. In 2000, drought conditions resulted in low yields and produced unexplainable interactions between phosphorus and potassium fertility 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 and May 30, 2000 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 yields of less than 14 bu/a (data not shown). Increasing soil 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.

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 affected by N application to at least 100 lb N/a. Additional response to higher N rates and timing was variable for the two years. Forage aftermath was increased with increasing N rates up to 150 lb/a. Subsurface applications, especially knifing, often increased yield and crude protein, but appeared to produce more stem weight.

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 and Dec. 6, 1999) and late winter (Feb. 24, 1999 and Mar. 1, 2000). 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 and June 8, 2000 and forage aftermath was harvested on June 14, 1999 and June 12, 2000.

Results

In 1999, late fall application of N at rates up to 200 lb/a resulted in increased clean seed yield (Fig. 3). With late winter application, yield increased with increasing rates to 100 lb N/a but decreased with higher N rates. This likely was associated with the number of panicles/m^2 (Fig. 4). Caryopsis (individual seed) weight and the number of seeds/panicle were unaffected by N management in 1999. In 2000, seed yield was not significantly affected by N fertilization timing, but was affected by N rate (Fig. 3). Similar to 1999, this yield response to N was reflected by an increase in the number of panicles/m^2 (Fig. 4).

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 in both years (Fig. 5). Forage yield exceeded 3 tons/a at the higher N rates but was greater at the low N rates in 2000 than in 1999. Subsurface placement by either knife or spoke resulted in more than 0.5 tons/a additional aftermath forage than broadcast N applications in 1999 (Fig. 6), with no effect due to timing of N fertilization (data not shown). In 2000 broadcast N applications in the late fall tended to produce less than spoke or knife applications (Fig. 6), but the difference was not significant. Likely influenced by nearly an inch of rain the day after application, late winter broadcast N application resulted in nearly 0.5 tons/a more forage than with spoke, whereas knife resulted in intermediate yields.

Averaged across both years, crude protein content was greatest with knife applications followed by spoke and broadcast (Fig. 7). This effect occurred even though yield usually tended to follow the same trend (Fig. 6). The crude protein content averaged low, less than 7% (Fig. 7). Whether the N was applied in late fall or late winter, crude protein tended to decrease with initial increments of fertilizer N (Fig. 7), likely in response to large increases in yield to N rate (Fig. 6). However, when applied in late winter high N rates tended to increase crude protein more than when the N had been applied in the previous late fall (Fig. 7). Although average crude protein was greater with knife applications, leaf to stem ratio tended to be lower with N applications applied in late winter (Fig. 8). This suggests that even though yield and crude protein may often be greater with knife applications, other aspects of forage quality may be reduced.

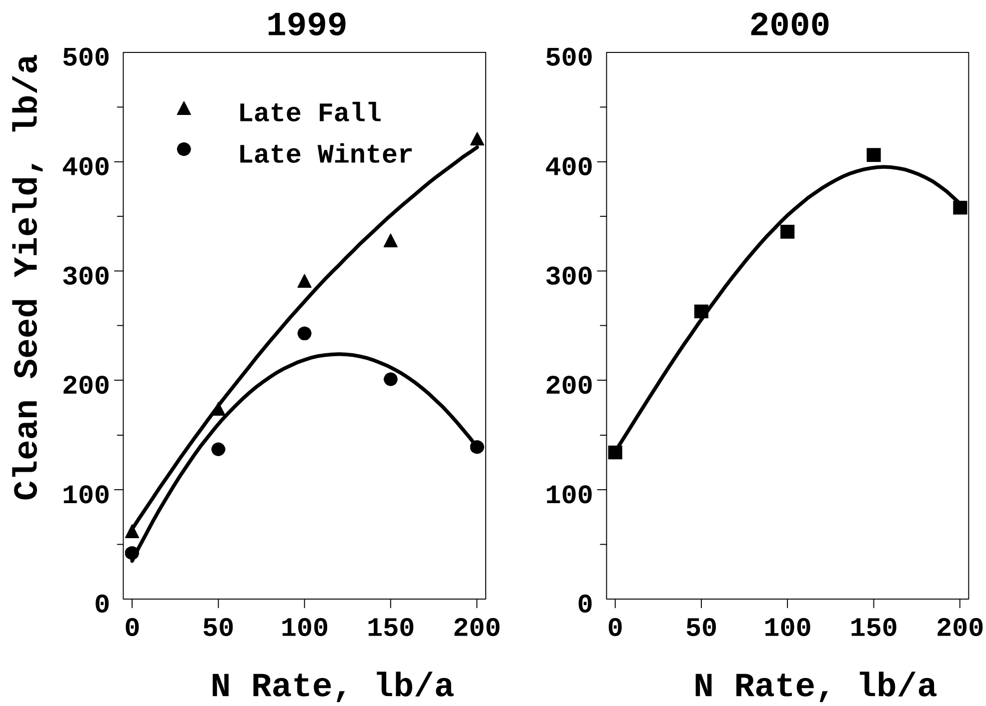

Figure 3. Effects of nitrogen timing and rate on clean seed yield of endophyte-free tall fescue in 1999 and 2000.

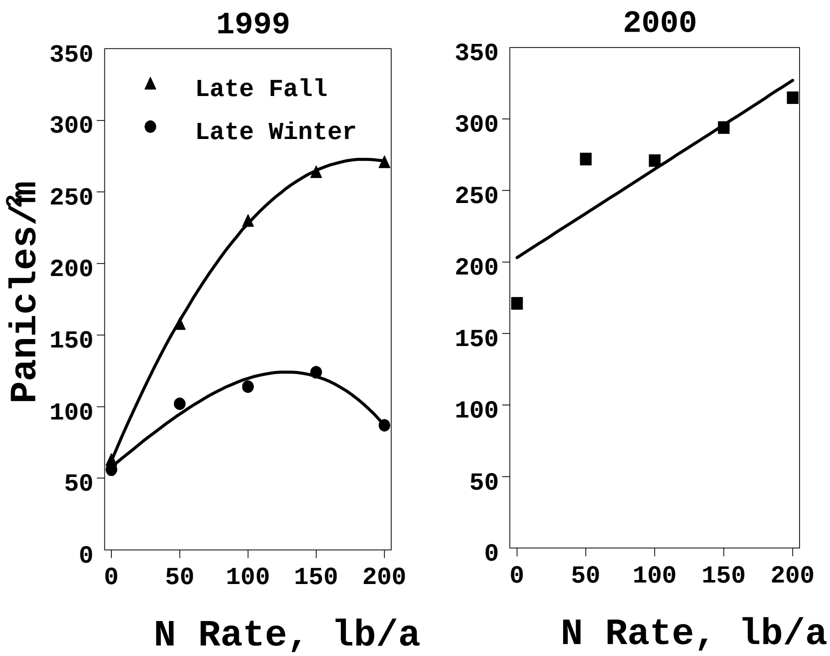

Figure 4. Effects of nitrogen timing and rate on the panicle count of endophyte-free tall fescue in 1999 and 2000.

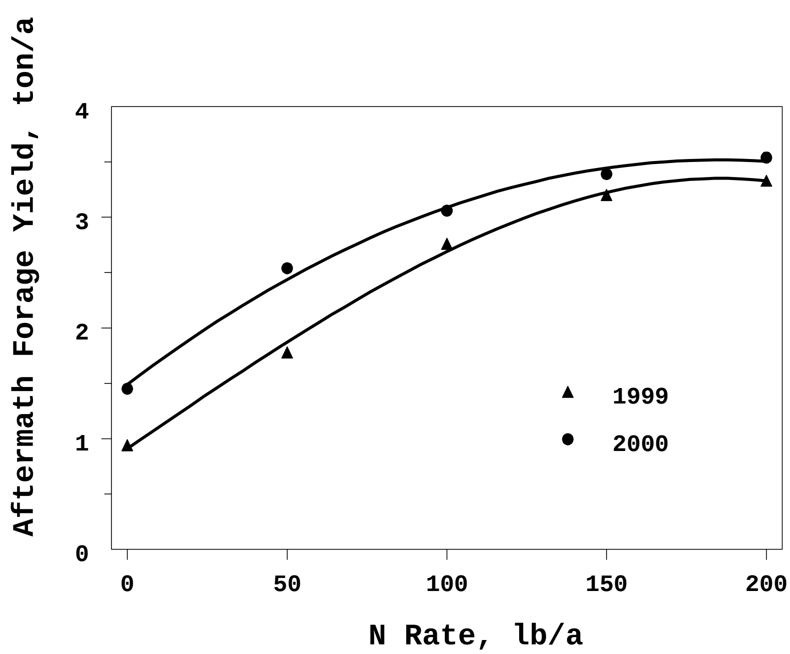

Figure 5. Effects of nitrogen rate on aftermath tall fescue yield following seed harvest in 1999 and 2000.

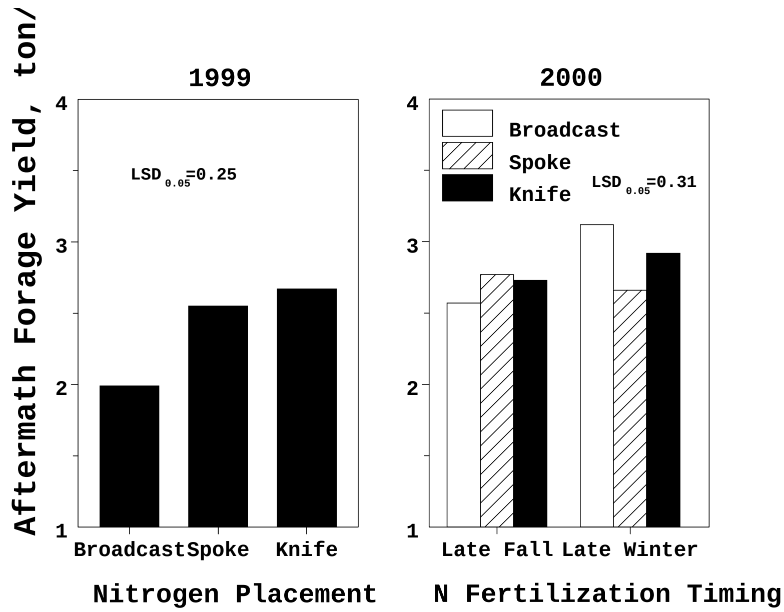

Figure 6. Effects of nitrogen fertilizer placement and timing on aftermath tall fescue yield following seed harvest in 1999 and 2000.

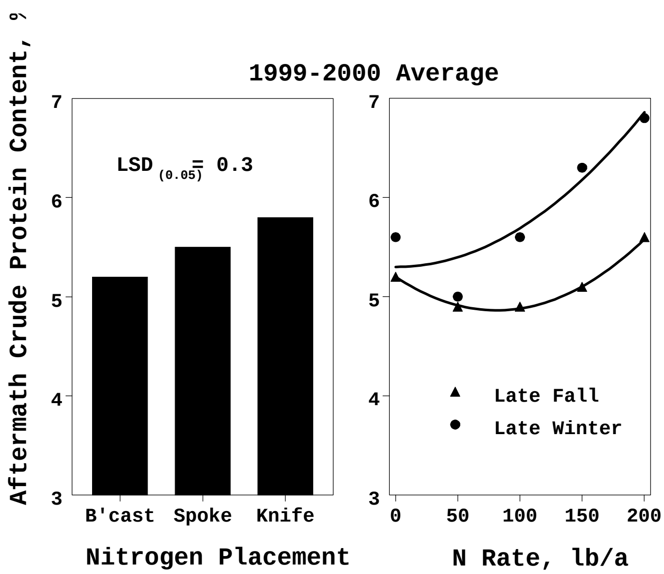

Figure 7. Effects of nitrogen fertilizer placement, rate, and timing on crude protein content of fescue forage following seed harvest.

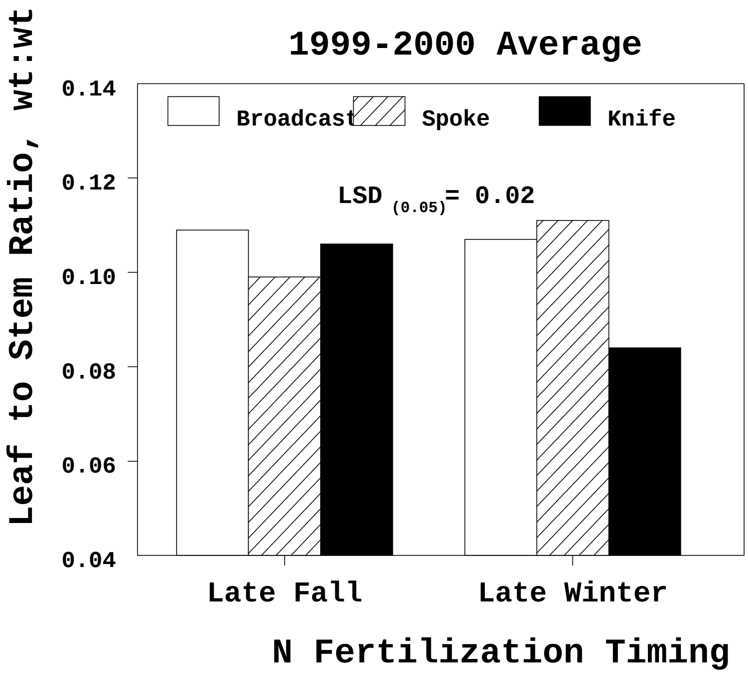

Figure 8. Effects of nitrogen fertilizer timing and placement on leaf to stem ratio (wt:wt basis) of fescue forage following seed harvest.

INTEGRATED AGRICULTURAL MANAGEMENT SYSTEMS: NEOSHO RIVER BASIN SITE

D.W. Sweeney and G.L. Kilgore

Summary

In 2000, runoff volume and nitrate concentrations were greater from no-till than conventional tillage systems. Soluble phosphorus, atrazine, and metolachlor were greater from no-till than conventional tillage systems, especially with the low management option.

Introduction

The quality of our water resources is important. Agricultural practices are perceived to impact surface water quality as non-point source of pollutants. Producers need to use voluntary practices such as Best Management Practices (BMPs) to protect and improve surface water quality in the state. Recent efforts in Kansas are designed to look at large, field-scale integrations of BMPs to determine their effects on losses of sediment, nutrients, and pesticides.

Procedures

The experiment was established on a Parsons silt loam in 1999 at the Greenbush Facility in Crawford County, but was not fully implemented until 2000. The four treatments were: 1) Conventional tillage (spring chisel, disk, field cultivate, plant); Low management: nitrogen (N) and phosphorus (P) broadcast, with incorporation by tillage; and atrazine and metolachor herbicides applied preemerge, 2) Conventional tillage; High management: N and P knifed in, followed by tillage; metolachlor applied preemerge with atrazine applied postemerge, 3) No tillage; Low management: N and P broadcast; atrazine and metolachlor applied preemerge, and 4) No tillage; High management: N and P knifed in; metolachlor applied preemerge with atrazine applied postemerge. For grain sorghum, the total N rate was 120 lb/a and P was 40 lb P_2O_5/a. The background crop in 1999 was soybean. In 2000, grain sorghum was planted May 24.

At the downslope end of each 1-acre plot, a soil berm was constructed to divert surface water flow through a weir. Each weir was instrumented with an ISCO® sampler that recorded flow amounts and collected runoff samples. Water samples were analyzed at the Soil Testing Laboratory for sediment, nutrients, and selected herbicides.

Results

In 2000, from early June through early November, six events occurred where samples and flow were obtained from each treatment. This does not comprise all runoff events during the year because equipment was removed from the field or malfunctioned in some cases. However, the events measured provided comparison data for the management systems tested.

Runoff volume (flow) from no-tillage systems averaged 50 to 150% greater than from conventional tillage systems (Table 2). Nitrate concentrations were two- to three-fold greater from no-tillage systems than conventional systems, resulting in 10 to 20 times more nitrate lost during the six events from no-tillage than conventional systems. Ortho-P in solution was higher in no-tillage with low management in which the P was surface broadcast. Atrazine and metolachlor concentrations were also greater in the no-tillage system with low management. Because of greater flow, the amount of atrazine and metolachlor in runoff from no-till for all runoff events was ten-fold greater than conventional tillage systems. Results may have been affected by construction of ridges to divert runoff water to the collector, therefore, soil loss data collected in 2000 may not correctly represent treatment effects (data not shown). This will be corrected in 2001 by installation of an erosion mat across the water-diversion ridges.

Table 2. Flow amount, nutrients, and herbicides in runoff from integrated agricultural management systems (IAMS): Water Quality Project - Neosho County Site, 2000.

Tillage	Mgt.	Flow	NH_4-N	NO_3-N	Ortho-P	Atrazine	Metolachlor
		Average for six runoff events					
		- ft^3-	--------- ppm ----------		----------------- ppb ---------------------		
Conv.	Low	324	1.00	1.38	188	3.9	3.6
	High	342	1.05	1.89	220	2.1	3.8
No-till	Low	536	0.39	4.77	734	10.0	12.7
	High	793	0.93	4.45	229	5.5	3.1
		Total for six runoff events					
		acre-in	------------------------------ g/a -----------------------------------				
Conv.	Low	0.54	76.1	47	7.7	0.083	0.073
	High	0.57	61.7	76	12.4	0.096	0.117
No-till	Low	0.89	28.8	521	89.8	1.598	1.935
	High	1.31	82.0	1040	27.6	0.956	1.020

† Sediment and related data not reported here may have been affected by erosion of the ridge that was formed to divert water to the weir and collection device.

EFFECTS OF NITROGEN RATE AND PLACEMENT ON EASTERN GAMAGRASS UNDER 1-CUT OR 2-CUT HARVEST SYSTEMS

J.L. Moyer and D.W. Sweeney

Summary

In the year of application (2000), forage yield was increased by 30% from the first 45 lb/a increment of nitrogen (N) applied and by another 21% with the next 45 lb. In 2001, yield was increased with the residual of 90 lb/a of N applied in 2000 by 26% compared to no N, but was not increased by 45 lb/a of N applied in 2000. Knife N application in 2000 at the 90 lb/a rate resulted in 23% higher yields compared to broadcast application at the same rate, and residual effects of the 2000 knife placement yielded 17% more than broadcast in 2001.

Introduction

Eastern gamagrass [*Tripsacum dactyloides* (L.)L.] is a warm-season perennial grass native to the North American tallgrass prairie. It has relatively better forage yield potential and quality than most other warm-season native species. Eastern gamagrass may thus respond well to more intensive management practices, such as added N and more harvests. This study was established to determine the response of eastern gamagrass to N fertilizer rates and placement under 1-cut or 2-cut harvest systems.

Procedures

Established (22-year-old) 'Pete' eastern gamagrass was fertilized with 54 lb P_2O_5/a and 61 lb K_2O/a each year from 1992 to 2000, and burned each spring except 1996. In 2000, nitrogen (urea-ammonium nitrate, 28% N) treatments of 0, 45, or 90 lb/a were applied on May 17 to 8 x 20-ft plots by broadcast or knife (4-inch) placement. Nitrogen was not applied in 2001 so that residual responses could be tested.

Plots were cut with a flail-type harvester in late June and mid August from the 2-cut system, and about 10 July from the 1-cut system. Yields were determined from a 3 x 20-ft strip of each plot, with a subsample taken for moisture determination.

Results

Yields in 2000 were increased ($P<.05$) by 30% with the first 45 lb/a increment of N, and by an additional 21% with the next 45-lb increment (Fig. 9). The residual from application of 90 lb/a of N in 2000 compared to no N resulted in 26% greater ($P<.05$) forage yield in 2001. Also in 2001, there was a 26% higher yield for residual of the 90-lb N rate compared to 45 lb/a of N applied in 2000 for the 2-cut system but not the 1-cut system or overall (data not shown).

Knifing N in 2000 resulted in significant ($P<.05$) yield interactions in 2000 between N rate and N placement factors. Figure 2 illustrates that in 2000, total yield increased ($P<.05$) with each increment of added N, and that knife placement increased yield more than broadcast at the 90 lb/a N rate. In 2001, yield was increased ($P<.05$) by residual effects of 2000 knife placement of N similarly at all N rates (Fig. 10).

The two harvest systems resulted in similar total yields in both years. However, in 2001, there was an interaction between harvest system and the residual from N application treatments; i.e., the 1-cut harvest system responded to the first 45 lb/a of N applied in 2000 with increased ($P<.05$) yield whereas the 2-cut system did not (data not shown).

The results for this year of treatment (2000) and the subsequent year of residual effects (2001) are consistent with earlier results from this study site (see Kansas Fertilizer Research Reports SRP 719 (1995), pp. 49-51; SRP 800 (1998), pp. 55-56; and SRP 847(2000), pp. 49-50). In summarizing this and the other three reports, nitrogen increased yield by 30-60% with the first 45 lb/a increment of N and by an additional 14-45% with the next 45-lb increment. Knife application of 90 lb N/a often increased yield compared to broadcast application at the same rate, particularly in the 2-cut harvest system. The 1-cut harvest system yielded more than the 2-cut system half of the time; otherwise the systems were similar. Residual responses of N placement and especially N rate were obtained the year after treatment on all three occasions, and residual effects were found up to 3 years after treatment.

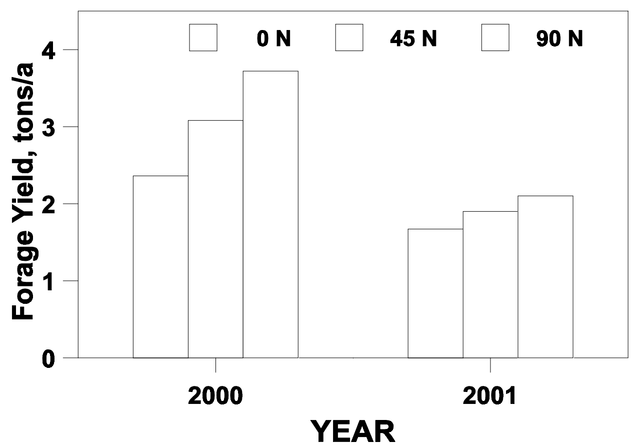

Figure 9. Eastern gamagrass forage yields (12% moisture) for 2000 and 2001 from different N application rates in 2000, Southeast Agricultural Research Center.

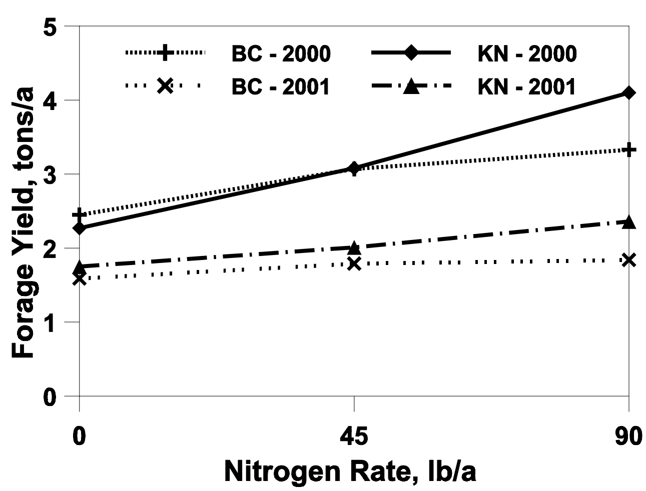

Figure 10. Eastern gamagrass forage yields (12% moisture) for 2000 and 2001 from different N application methods and rates in 2000, Southeast Agricultural Research Center.

EFFECTS OF PREVIOUS CROP, NITROGEN RATE, AND NITROGEN METHOD ON WINTER WHEAT GRAIN YIELD

K.W. Kelley and D.W. Sweeney

Summary

Wheat yields were influenced significantly by previous crop, tillage method, fertilizer nitrogen (N) placement, and N rate. In the first study (Tables 3 and 4), where both reduced- and no-tillage systems were evaluated, grain yields averaged over 5 years were highest for wheat following soybean with reduced tillage and lowest for wheat planted no-till following grain sorghum; however, in 2001, yields varied somewhat from the 5-yr average. Applying fertilizer N (28% UAN) below crop residues with a coulter-knife applicator also significantly increased grain yield compared with broadcast fertilizer N treatments, regardless of previous crop or tillage system. In the second study (Table 5), where only no-tillage was evaluated, wheat yields also were influenced by previous crop, fertilizer N and phosphorus (P) application method, and N rate. Grain yields averaged nearly 52 bu/a following short-season corn and grain sorghum and 65 bu/a following soybean. Averaged over previous crops and N rates, grain yields were highest with knifed N-P applications; intermediate for surface strip banding; and lowest for surface broadcast treatments.

Introduction

In southeastern Kansas, wheat often is planted after a summer crop as a means of crop rotation; however, previous crop, as well as the amount of plant residues remaining after harvest, affects fertilizer nitrogen (N) efficiency. Placement of fertilizer also becomes an important factor, especially for wheat planted no-till into previous crop residues. When fertilizer N, such as urea or liquid urea ammonium nitrate solutions, is surface-applied, there is potential for greater N loss through volatilization and immobilization, particularly when residue levels are high. This research evaluates how the previous crop (corn, grain sorghum, or soybean) affects the utilization of applied N fertilizer by winter wheat. Placement of fertilizer as well as various N rates were evaluated in both reduced- and no-till previous cropping systems.

Procedures

Conventional and No-Tillage
<u>(Tables 3 and 4)</u>

The experiment was a split-plot design with previous crop (grain sorghum and soybean) and tillage method (no-till and reduced) as main plots and a factorial arrangement of N rates (60 and 120 lbs/a) and N placement methods (broadcast and knifed) as subplots. All N treatments were fall-applied and, in reduced tillage, were incorporated with a tandem disk and/or field cultivator prior to wheat planting. Urea ammonium nitrate 28% N solution (UAN) was the N source, except for one comparison treatment where urea was split-applied (fall and late-winter). Knifed N treatments were banded on 15-in. centers with a coulter-knife applicator at a depth of 4 to 6 in. Phosphorus and potassium fertilizer were broadcast applied on all plots prior to planting. Both reduced and no-till plots were planted with a no-till drill.

<u>No-Tillage (Table 5)</u>

The experiment was a split-plot design, in which the main plots were previous crops (corn, grain sorghum, and soybean) and subplots included a factorial arrangement of four N rates (20, 40, 80, and 120 lbs N/a) with three N-P application methods–1) liquid N and P knifed on 15-in. centers at a depth of 4 to 6 in., 2) liquid N and P surface-applied in 15-in. strip bands, and 3) liquid N and P broadcast on soil surface. Phosphorus (P) was applied at a constant rate of 68 lbs P_20_5/a, except for the control plot. Nitrogen source was liquid 28% N and P source was liquid 10-34-0. Potassium fertilizer was broadcast applied to all treatments at a constant rate of 120 lbs K_20/a. All fertilizer was fall-applied prior to planting. Seeding rate was 100 lbs/a.

Results

Conventional and No-Tillage
<u>(Tables 3 and 4)</u>

Wheat yields in 2001 (Table 3) varied somewhat from the average 5-yr grain data (Table 4). In 2001, grain yields were relatively high and differences between previous crop, tillage method, and N fertilizer application method were smaller than for the 5-yr average. However, significant interactions occurred among treatment effects. When wheat followed grain sorghum, grain yields were generally highest where fertilizer N was knifed below crop residues. However, when wheat followed soybean, yields were often higher where fertilizer N was broadcast applied. Rainfall was above normal in the fall of 2000 after wheat planting, which likely moved broadcast N below the soil surface. Also, in 2000, soybean was not harvested for grain because of summer drought conditions. Thus, residual soil N levels were higher than normal, which resulted in significantly greater wheat lodging where fertilizer N was knifed below residues, especially at the higher N rate.

Wheat yields for the 5-yr period (1993, 1995, 1997, 1999, and 2001) were influenced significantly by previous crop, tillage method, N rate, and N placement (Table 4). Yields averaged 7 bu/a higher for wheat following soybean compared to wheat following grain sorghum. Reduced tillage (disking) resulted in slightly higher grain yield than no-till, regardless of previous crop. Fertilizer N placement and N rate also affected grain yields for all previous crop and tillage systems. Grain yields were significantly higher when liquid 28% N was placed below crop residues with a coulter-knife applicator compared with broadcast N treatments, regardless of previous crop or tillage system. Grain yield results suggest that wheat was able to utilize sub-surface knifed N applications more efficiently than fertilizer applied on the soil surface. When wheat followed grain sorghum, the split application (fall and late-winter) of urea, gave higher yields than the preplant broadcast treatment at the same N rate of 120 lbs/a. Where wheat followed grain sorghum, fertilizer N likely was immobilized to a greater extent because of higher residue levels compared to soybean.

<u>No-Tillage (Table 5)</u>

When wheat was planted no-till, yields were influenced significantly by previous crop, N-P application method, and N rate. Grain yields averaged 52 bu/a following short-season corn or grain sorghum and 65 bu/a following soybean. Averaged over previous crops and N rates, grain yields were highest with knifed N-P applications, intermediate for surface strip banding, and lowest for surface broadcast treatments. Grain yields also increased with increasing N rates, except for the knifed application following soybean. When wheat followed soybean, the 80 lb N rate was nearly the same as the 120 lb N rate. However, grain yield differences among previous crops were greater at the lower N rates for all N-P application methods.

Soil samples taken in the fall after harvest and before wheat fertilization showed that residual nitrate-N levels in the top 12 in. of soil were 10 ppm following corn and grain sorghum and 26 ppm following soybean. Ammonium-N levels were similar across all previous crops, averaging slightly less than 20 ppm in the top 12 in. Soil organic matter averaged 2.7% (0 to 6 in.), while soil P level was 20 ppm in the top 6 in. and 5 ppm at the 6 to 12 in. depth.

Although above normal rainfall occurred in the fall after planting, yield results suggest that N losses from leaching or denitrification were minimal at this site, where soil slope prevented ponding of surface water. In this study, previous crop residues did not appear to affect wheat germination or early seedling growth through the process of allelopathy. Thus, wheat yield differences between previous crops and N-P placement methods appear to be primarily related to greater availability of N following soybean, and to immobilization of applied N following higher residue crops, such as grain sorghum and corn. However, effects of previous crop on wheat yields were greatly reduced when fertilizer N (120 lb/a) was knifed below crop residues.

Table 3. Effects of previous crop, tillage method, nitrogen rate, and nitrogen method on hard winter wheat grain yield, Parsons, KS, 2001.

			Wheat Yield After			
			Grain Sorghum		Soybean	
N Rate	N Method	N Source	RT	NT	RT	NT
lb/a			-------------------- bu/a --------------------			
0	---	---	21.3	25.4	54.2	51.2
60	B’cast	UAN	57.8	55.4	64.4	71.1
120	B’cast	UAN	66.8	73.1	57.3	67.6
60	Knife	UAN	64.5	66.2	60.8	66.0
120	Knife	UAN	71.8	69.0	62.6	61.5
120[1]	B’cast	Urea	65.4	70.2	61.5	65.9
Avg.			57.9	59.9	60.1	63.9

Means: (No N and 120 N as urea omitted)	
Grain sorghum	65.6
Soybean	63.9
LSD (0.05)	NS
Reduced tillage	63.2
No-tillage	66.2
LSD (0.05)	NS
B’cast	64.2
Knife	65.3
LSD (0.05)	NS
60 lb N/a	63.3
120 lb N/a	66.2
LSD (0.05)	2.0

[1]60 lb N/a applied in the fall and 60 lb N/a top-dressed in late Feb.
UAN = urea ammonium nitrate 28% N solution.
NT = no tillage, RT = reduced tillage (disk)
Planting date = Oct. 13, 2000; variety = Jagger
All plots received 60 lbs/a P_20_5 and 75 lbs/a K_20.

Table 4. Effects of previous crop, tillage method, nitrogen rate, and nitrogen method on hard winter wheat grain yield, Parsons, KS, 5-yr average.

			Wheat Yield After			
N	N	N	Grain Sorghum		Soybean	
Rate	Method	Source	RT	NT	RT	NT
lb/a			-------------------- bu/a --------------------			
0	---	---	18.8	17.7	34.8	31.3
60	B'cast	UAN	35.2	30.5	45.5	41.8
120	B'cast	UAN	46.3	44.3	52.2	51.5
60	Knife	UAN	41.8	41.4	50.3	49.0
120	Knife	UAN	53.9	51.8	58.8	54.6
120[1]	B'cast	Urea	50.6	46.6	53.8	50.3
Avg.			41.1	38.7	49.2	46.4
Means: (No N and 120 N as urea omitted)						
Grain sorghum				43.2		
Soybean				50.4		
LSD (0.05)				1.0		
Reduced tillage				48.0		
No-tillage				45.6		
LSD (0.05)				1.0		
B'cast				43.4		
Knife				50.2		
LSD (0.05)				0.6		
60 lb N/a				41.9		
120 lb N/a				51.7		
LSD (0.05)				0.6		

[1] 60 lb N/a applied in the fall and 60 lb N/a top-dressed in late Feb.
UAN = urea ammonium nitrate 28% N solution.
NT = no tillage, RT = reduced tillage (disk)
Planting date = October.
Variety = Karl, Karl 92, and Jagger
All plots received 60 lbs/a P_20_5 and 75 lbs/a K_20.

Table 5. Effects of previous crop, nitrogen and phosphorus method, and N rate on hard winter wheat grain yield, Parsons, KS, 2001.

N and P	Fertilizer Rate		Wheat Yield After		
Applic. Method	N	P_2O_5	Corn	Grain Sorghum	Soybean
	----- lbs/a -----		----- bu/a -----		
Knife	20	68	41.5	43.6	58.5
Knife	40	68	52.0	51.0	65.9
Knife	80	68	66.2	65.1	71.4
Knife	120	68	72.3	70.2	69.9
Strip Band	20	68	36.4	38.0	56.6
Strip Band	40	68	45.0	45.9	63.3
Strip Band	80	68	55.1	57.7	69.2
Strip Band	120	68	64.9	67.5	72.5
Broadcast	20	68	36.0	32.9	56.5
Broadcast	40	68	45.1	40.4	61.7
Broadcast	80	68	52.9	55.9	67.6
Broadcast	120	68	61.1	60.3	69.9
Knife Control	0	0	30.8	32.1	55.8
Control	0	0	29.6	27.6	57.4
Means: (controls omitted)			52.4	52.4	65.2
N-P application method					
Knife			58.0	57.5	66.4
Strip Band			50.3	52.3	65.4
Broadcast			48.7	47.4	63.9
LSD (0.05)	(Same crop)		1.7	1.7	1.7
	(Different crop)		2.2	2.2	2.2
N Rate (lb/a)					
20			37.9	38.2	57.2
40			47.4	45.8	63.6
80			58.0	59.5	69.4
120			66.1	66.0	70.7
LSD (0.05)	(Same crop)		2.0	2.0	2.0
	(Different crop)		2.5	2.5	2.5

N source = urea ammonium nitrate 28% N solution; P source = 10-34-0
Planting date = Oct. 24, 1998; variety = Jagger.
All plots received 120 lbs/a of K_2O.

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 2001 growing season was characterized by a much wetter than normal spring and a very hot, dry period from mid-June until late July. Timely rains were received in late July just at heading time and sorghum yields were very good. The overall test average was 111 bu/a. When averaged over all N rates, yields of sorghum grown in rotation with soybean were 19 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 soybean 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 increased with increasing N rate up to 90 lb/a. In soybean rotation, sorghum yields increased with increasing N rate up to 60 lb/a. When averaged over N rate, no-tillage grain sorghum rotated with soybean reached mid-bloom 7 days sooner than continuous grain sorghum. Two knife-applied N sources (anhydrous ammonia and 28% UAN) were evaluated from 1982-1989. No grain sorghum yield differences resulted from N source. The 20-year soybean yield average was 34 bu/a. Soybean yields were not affected by N applied to the previous grain sorghum crop. In 1996, four additional N rates (120, 150, 180, and 210 lb/a) were added to the experiment. When averaged over the period 1996-2001, yields were greater in the rotated system than in continuous sorghum at all levels of N. Addition of N did not compensate for the rotational effect. Yields in the continuous system increased 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 soybean 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 soybean) and N rate (0, 30, 60, and 90 lb/a). In 1982-1989, two N sources were evaluated - anhydrous ammonia and urea-ammonium nitrate solution (28% UAN). 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/foot in 30-in. 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

Although most of the summer was drier than normal, timely rains were received just before heading and yields were very good. When averaged over all N rates, grain sorghum rotated with soybean yielded 19 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 20-year period (1982-2001), soybean yields averaged 34 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 Midbloom 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, 1996-2001.

N Rate	Cropping System	Yield 1996	1997	1998	1999	2000	2001	Avg.
lb/a		----------------	----------------	----------------	bu/a	----------------	----------------	----------------
0	Continuous	92	51	55	73	37	59	61
	Rotated	120	88	87	112	46	75	88
30	Continuous	110	71	75	95	40	75	78
	Rotated	137	108	115	119	62	113	109
60	Continuous	131	110	118	115	68	96	106
	Rotated	164	128	142	127	66	128	126
90	Continuous	143	121	126	125	69	116	117
	Rotated	163	141	144	126	68	129	129
120	Continuous	148	122	128	123	69	117	118
	Rotated	162	144	145	128	65	128	129
150	Continuous	148	120	127	123	69	116	117
	Rotated	162	143	145	129	65	129	129
180	Continuous	148	121	128	126	68	117	118
	Rotated	162	144	145	129	65	129	129
210	Continuous	148	122	128	126	66	116	118
	Rotated	162	145	145	129	64	129	129
System Means								
	Continuous	134	105	111	113	61	101	104
	Rotated	154	130	134	125	63	120	121
N Rate Means								
0		106	70	71	92	42	67	75
30		124	90	95	107	51	94	94
60		148	119	130	121	67	112	116
90		153	131	135	126	69	122	123
120		155	133	137	126	67	123	124
150		155	132	136	126	67	123	123
180		155	133	137	127	67	123	124
210		155	134	137	127	65	123	124
LSD(0.05)		8	6	6	6	8	5	

Table 3. Yield of soybean grown in rotation with grain sorghum, Belleville, KS, 1982-2001.

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

EFFECTS OF STARTER FERTILIZER APPLICATION ON REDUCED- AND NO-TILLAGE GRAIN SORGHUM PRODUCTION

W.B. Gordon and D. A. Whitney

Summary

This experiment was conducted at the North Central Kansas Experiment Field, located near Belleville, on a Crete silt loam soil. Soil test P was in the "high" range. Treatments consisted of tillage systems and starter fertilizer placement and composition. Tillage systems consisted of no-tillage and minimum tillage (spring disc and harrow treatment). Methods of starter fertilizer application included placement 2 in. to the side and 2 in. below the seed at planting (2x2) and dribbled in a band on the soil surface 2 in. beside the seed row. Liquid starter fertilizer treatments consisted of nitrogen (N) and P_2O_5 combinations to provide 15, 30 and 45 lb N/a and 30 lb P_2O_5/a. Starter treatments containing either 30 lb N or 30 lb P_2O_5/a applied alone and a no starter check also were included. In both tillage systems, yields were maximized by application of starter fertilizer containing either 30 or 45 lb N/a with 30 lb P_2O_5/a . In 2001, there were no differences between 2x2 and band dribbled starter fertilizer. In previous years, subsurface placed starter fertilizer had proven to be more efficient than placing fertilizer in a surface band. Rainfall in May and June was much above normal. The ideal soil moisture condition was probably responsible for the improved effectiveness of surface applied starter. When averaged over tillage treatment, starter fertilizer containing 30 lb N and 30 lb P_2O_5/a decreased by more than 13 days the time from emergence to mid-bloom compared to the no-starter check treatment.

Introduction

Conservation-tillage production systems are being used by an increasing number of producers in the central Great Plains because of several inherent advantages. These include reduction of soil erosion losses, increased soil water use-efficiency, and improved soil quality. However, early-season plant growth can be poorer in reduced-tillage systems than in conventional systems. The large amount of surface residue present in a no-tillage system can reduce seed-zone temperatures. Lower than optimum soil temperature can reduce the rate of root growth and P uptake by plants. Starter fertilizers can be applied to place nutrient elements within the rooting zone of young seedlings for better availability, which will hasten maturity and avoid late-season damage by low temperatures. Some experiments that have evaluated crop response to N and P starter fertilizers have demonstrated improved early growth and increased yield and attributed those responses to the P component of the combination. Other studies have indicated that N is the most critical element in the N-P starter on soils not low in P. Many producers do not favor 2x2 placement of starter fertilizer because of high initial cost of application equipment and problems associated with knife applications in high-residue situations. This research is aimed at minimizing fertility problems that arise with reduced-tillage systems thus making conservation tillage more attractive to producers.

Procedures

The experiment was conducted at the North Central Kansas Experiment Field on a Crete silt loam soil. Analysis by the KSU Soil Testing Lab showed that initial soil pH was 6.2, organic mater was 2.2%, Bray P-1 was 42 ppm and exchangeable K was 320 ppm in the top 6 in. of soil. Treatments consisted of two tillage systems (no-tillage and minimum tillage). The minimum tillage treatment received one discing and harrowing operation in the spring 3 weeks prior to planting. Starter fertilizer was placed either 2 in. to the side and 2 in. below the seed at planting (2x2) or dribbled in a band on the soil surface 2 in. beside the seed at planting. Starter fertilizer treatments consisted of N and P_2O_5 combinations giving 15, 30, or 45 lb N/a with

30 lb P_2O_5/a. Treatments consisting of either 30 lb N/a or 30 lb P_2O_5/a applied alone and a no starter check also were included. Starter combinations were made using 10-34-0 and 28% UAN. After planting, knife applications of 28% UAN were made to bring N applied to each plot to a total of 140 lb/a. Grain sorghum (NC+ 7R83) was planted at the rate of 60,000 seed/a on May 22, 2001. At the V6 stage of growth, 20 plants were randomly selected from the 1st or 4th row of each plot and analyzed for dry weight and N and P concentration. At first bloom 20 flag leaves/plot were harvested and analyzed for N and P concentration. Plots were harvested on October 6, 2001.

Results

Although surface dribble applied starter fertilizer had not been as effective as 2x2 placed fertilizer in the previous 2 years of the experiment, there was no difference in starter placement methods in 2001 (Table 4). The very wet spring probably increased the efficiency of the surface banded fertilizer. When averaged over the period 1999-2001, yield of 2x2 placed starter fertilizer was only 6 bu/a greater than the surface dribble treatment. The greatest yields occurred with applications of starter fertilizer containing either 30 or 45 lb N/a with 30 lb P_2O_5/a . All starter treatments increased grain yield over the no-starter check plots. The higher N starters were also the most efficient in reducing the number of days from emergence to mid-bloom. The N alone or the P alone treatments did not yield as well as starters that contained both N and P. The treatment containing only 15 lb N/a with 30 lb P_2O_5/a also was not as effective as starters containing more N. Use of starter fertilizer resulted in greater yields in both tillage systems. All starter fertilizer treatments increased V6-stage whole plant dry matter over the no starter check. The starters containing either 30 or 45 lb/a N with 30 lb/a P_2O_5 resulted in the greatest V-6 whole plant dry matter accumulation. Grain yield, days from emergence to mid-bloom, and V6-stage whole plant dry matter were not affected by tillage system.

Table 4. Tillage system and starter fertilizer placement and composition effects on grain sorghum yield, number of days from emergence to mid-bloom, and V6-stage whole plant dry matter accumulation, Belleville 2001.

Tillage	Placement	Starter N	Starter P_2O_5	Yield 2001	Yield 1999-2001	Days to Mid-bloom	V-6 Dry Matter
		lb/a		------- bu/a-------			lb/a
Reduced		0	0	112	93	66	481
	2x2	0	30	120	101	61	827
		30	0	125	108	60	890
		15	30	129	114	58	870
		30	30	145	124	53	1125
		45	30	145	125	52	1103
	Dribble	0	30	119	100	61	700
		30	0	126	106	60	758
		15	30	133	110	57	910
		30	30	146	116	53	1098
		45	30	148	119	52	1111
No-Tillage		0	0	116	92	67	486
	2x2	0	30	124	107	61	749
		30	0	129	114	58	749
		15	30	137	118	58	950
		30	30	148	129	53	1143
		45	30	150	129	52	1152
	Dribble	0	30	124	101	61	770
		30	0	129	109	60	836
		15	30	137	111	57	952
		30	30	150	119	53	1104
		45	30	149	120	52	1068
Tillage Means	Reduced Till			134	113	57	939
	No-Till			138	116	56	947
	LSD(0.05)			NS		NS	NS
Placement Means	2x2			135	117	57	957
	Dribble			136	111	57	931
	LSD(0.05)			NS		NS	NS
Starter Means	0-30			122	103	61	761
	30-0			127	110	60	808
	15-30			134	113	58	921
	30-30			147	122	53	1118
	45-30			148	123	52	1109
	LSD(0.05)			5		2	56

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 in. to the side and 2 in. below the seed at planting, dribble on the soil surface 2 in. to the side of the seed, and banded over the row on the soil surface) and five starter fertilizer combinations. The starters combined 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 in the experiment. Nitrogen rates were 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 6,600 plants/a compared with the no starter check. Corn yield was 41 bu/a lower when starter fertilizer was applied in-furrow than when applied 2x2. Dribble application of starter fertilizer in a surface band 2 in. 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 the starter treatments that included only 5 or 15 lb N/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. Applications of liquid starter fertilizer 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 coulters in high-residue environments. However, crop 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-till trials 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 in. of soil were 40 and 420 ppm, respectively. The study consisted of four methods of starter fertilizer application (in-furrow with the seed, 2 in. to the side and 2 in. below the seed at planting, dribbled in a narrow band on the soil surface 2 in. to the side of the seed row, and banded over the row on the soil surface). In row-banding, fertilizer was sprayed on the soil surface in a 8 in. band centered on the seed row immediately after planting. Starters 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. Nitrogen as 28% UAN was balanced so all plots received 220 lb/a, regardless of starter treatment. 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 over 6,600 plants/a when compared with the no starter check (Table 5). Corn yield was 41 bu/a lower when starter fertilizer was applied in-furrow with the seed than when applied 2 in. beside and 2 in. below the seed. Dribble application of starter fertilizer in a narrow surface band 2 in. to the side of the seed row resulted in yields equal to the 2x2 applied starter. In this year, surface band application was equal to sub-surface starter placement. 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 V-6 dry matter accumulation was lower in the starter treatment that only included 5 or 15 lb N/a.

Table 5. 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, 2001.

Application Method	Starter	Yield, 2001	Yield, 2000-2001	Population	V-6 Dry Matter
	lb/a	bu/a	bu/a	plants/a	lb/a
	Check 0-0-0	181.2	159.0	31,585	409
In-furrow	5-15-5	187.8	163.7	24,878	414
	15-15-5	187.0	171.7	25,042	430
	30-15-5	185.5	166.3	23,928	397
	45-15-5	185.0	166.4	26,598	409
	60-15-5	179.7	159.2	23,833	348
2x2	5-15-5	210.6	189.9	31,438	585
	15-15-5	211.1	191.4	31,634	654
	30-15-5	237.6	212.5	31,571	742
	45-15-5	236.4	210.6	31,575	753
	60-15-5	236.1	210.5	31,496	745
Dribble 2x	5-15-5	201.8	184.5	31,597	569
	15-15-5	212.5	193.8	31,507	623
	30-15-5	237.5	208.9	31,472	731
	45-15-5	235.5	208.7	31,624	745
	60-15-5	234.2	208.5	31,422	740
Row band	5-15-5	192.9	171.2	31,470	553
	15-15-5	198.5	176.5	31,630	593
	30-15-5	207.9	181.2	31,502	679
	45-15-5	206.6	185.9	31,530	689
	60-15-5	208.4	194.2	31,478	683
<u>Method Means</u>					
In-furrow		185.0	165.5	24,856	400
2x2		226.3	201.5	31,542	696
Dribble 2x		224.3	200.9	31,524	681
Row band		202.8	181.8	31,522	639
LSD (0.05)		11.5		720	21
<u>Starter Means</u>					
5-15-5		198.3	177.4	29,846	530
15-15-5		202.3	183.4	29,953	575
30-15-5		217.1	192.2	29,619	637
45-15-5		215.9	192.9	30,331	649
60-15-5		214.6	193.1	29,557	629
LSD (0.05)		10.9		NS	24

EFFECTS OF 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 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 that 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 the MAP alone at rates up to 90 lb/a. Uncoated 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 have been found to reduce the germination injury problem.

This research was initiated to study the effects on germination and production of grain sorghum of 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 23, 2001 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 therefore 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 2001 growing season was characterized by a very cool, wet spring followed by a hot, dry period from mid-June until mid-July. Timely rains were received in late July and early August resulting in excellent dryland grain sorghum yields. Grain sorghum stands were greatly reduced when un-coated urea was placed in contact with seed as compared to the polymer-coated urea products. 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 field research at North Central in which a 2x2-placed starter band of a 30-30-0 starter rate was significantly greater than 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 in which 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, V4 stage whole plant dry matter, and grain yield of no-tillage grain sorghum at the North Central Kansas Experiment Field, Belleville, KS, 2001.

Starter						
N	P_2O_5	Sources	Balance N	Population	V-4 Dry Matter	Yield
lb/a			lb/a	plants/a	lb/a	bu/a
6	30	MAP	114	48715	359	131
30	30	MAP+CRU I	90	48569	383	142
60	30	MAP+CRU I	60	48206	366	139
90	30	MAP+CRU I	30	47408	335	131
120	30	MAP+CRU I	0	45738	278	122
30	30	MAP+CRU II	90	47916	379	141
60	30	MAP+CRU II	60	48061	359	138
90	30	MAP+CRU II	30	46754	335	137
120	30	MAP+CRU II	0	45447	296	126
30	30	MAP+Urea	90	25918	149	120
60	30	MAP+Urea	60	25047	97	106
90	30	MAP+Urea	30	23595	89	101
120	30	MAP+Urea	0	22070	76	94
60	30	MAP+CRU I	0	47915	370	134
60	30	MAP+CRU II	0	47771	371	136
60	0	CRU I	60	48206	367	133
60	0	CRU II	60	48642	383	131
60	0	Urea	60	24611	125	115
0	30	0-0-46	120	48497	286	127
0	0	Check	0	48569	183	92
0	0	Check	120	48279	192	118
LSD(0.5)				1557	54	8

SOIL FERTILITY RESEARCH
HARVEY COUNTY EXPERIMENT FIELD

EFFECTS OF NITROGEN RATE AND SEEDING RATE ON NO-TILL WINTER WHEAT AFTER GRAIN SORGHUM

M.M. Claassen

Summary

Wheat following sorghum that had been fertilized with 120 lb/a of nitrogen (N) yielded an average of 2 bu/a more than wheat following sorghum that had received only 60 lb/a of N. The favorable residual effect of higher sorghum N rate was larger at low wheat N rates, but decreased to zero with 120 lb/a of N. Yields increased significantly with each 40 lb/a increment of fertilizer N. When averaged across seeding rates, highest yields of 60 bu/a were obtained with 120 lb/a of N. Plant height and plant N concentration also increased with N rate, while grain test weight improved only slightly at the highest N level. Wheat yields tended to be highest when seeded at 90 or 120 lb/a. A significant interaction occurred between seeding rate and N rate effects on yield, with a larger yield response to seeding rate as N rate increased.

Introduction

Rotation of winter wheat with row crops provides diversification that can aid in the control of diseases and weeds, as well as improve the overall productivity of cropping systems in areas where wheat commonly has been grown. Grain sorghum often is a preferred row crop in these areas because of its drought tolerance. However, sorghum residue may have a detrimental effect on wheat because of allelopathic substances released during decomposition. Research has indicated that negative effects of sorghum on wheat can be overcome by increasing the amount of N fertilizer, as well as the wheat seeding rate. This experiment was established to study wheat responses to these factors and to the residual from N rates on the preceding sorghum crop.

Procedures

The experiment site was located on a Geary silt loam soil with pH 6.4, 2.4% organic matter, 20 lb/a of available phosphorus (P), and 493 lb/a of exchangeable potassium. Grain sorghum had been grown continuously on the site for several years before the initiation of this experiment in 1998. A split-plot design was utilized with main plots of 60 and 120 lb/a N rates on the preceding sorghum crop and subplots of 0, 40, 80, and 120 lb/a of N on wheat in a factorial combination with seeding rates of 60, 90, and 120 lb/a. In this second cycle of the sorghum/wheat rotation with its treatment variables, Pioneer 8500 grain sorghum was planted in 30-in. rows on May 10 and harvested on September 4, 2000. Soil was sampled to a depth of 2 ft for residual N shortly after sorghum harvest. Nitrogen rates were applied as ammonium nitrate on September 21. Wheat planting was delayed initially by extremely dry soil conditions and subsequently by mid-October rains. Variety 2137 was planted on October 20, 2000, into undisturbed sorghum stubble with a no-till drill equipped with double-disk openers on 8- in. spacing. P_2O_5 at 37 lb/a was banded in the seed furrow. Whole-plant wheat samples were collected at bloom stage for determination of N and P concentrations. Wheat was harvested on June 18, 2001. Grain subsamples were analyzed for N content.

Results

In the preceding sorghum crop, stands were approximately 35,500 plants/a, and yields, across previous wheat N rates and seeding rates, averaged 106 and 124 bu/a with 60 and 120 lb/a of N, respectively. Soil nitrate N (0 to 2 ft) after sorghum was low and differed little between treatments, averaging less than 7 lb/a following these N rates.

Rainfall totaled 2.32 in. between N fertilizer application and wheat planting, and an additional 6.43 in. fell during the first 4 weeks after planting. Stand establishment was good, but cold temperatures in November greatly limited wheat development before winter dormancy. Winter precipitation was somewhat above normal in January, well above average in February, but below normal during the other winter months. Mean temperatures were sharply below normal in November and December and, to a lesser extent, colder than usual in February and March. May temperatures were near normal, but the other spring months were cooler than usual. The spring period was dryer than usual, except for June. Favorable temperatures and moisture substantially benefitted wheat during grain filling.

Despite little measured difference in residual soil nitrate N following N rates on sorghum, a small residual effect of those treatments was seen in the succeeding wheat crop (Table 1). When averaged over wheat N rates and seeding rates, the high versus low sorghum N rate significantly increased wheat whole-plant nutrient content by 0.04% N and yield by 2 bu/a. These effects were significant at the 12% probability level. A significant interaction between sorghum N rate and wheat N rate occurred in wheat yield, plant height, and grain protein. Following 60 lb/a of N on sorghum, wheat yields increased more with N rate than following 120 lb/a of N. However, yields converged at the highest rates of fertilizer on wheat. Plant heights increased with N rate, but with zero fertilizer N, plant height was greater following 120 lb/a of N than after 60 lb/a of N on sorghum. With zero fertilizer N, grain protein was higher after 60 lb/a versus 120 lb/a N on sorghum, but the highest protein level occurred with 120 lb/a of N following 120 lb/a of N on the preceding crop. No significant interactions occurred between sorghum N rate and wheat seeding rate.

N rate significantly affected each wheat response variable measured. Yields increased with each 40 lb/a increment of fertilizer. Overall average yields of 60 bu/a were obtained with 120 lb/a of N. Plant height and plant N concentration also increased with N rate. Test weight increased slightly with N rate. Plant P concentration was highest at the zero N rate, reflecting the dilution effect of greater plant growth that resulted from fertilizer application. Grain protein decreased at intermediate N rates, but increased with 120 lb/a of N.

Seeding rate main effect was significant, increasing wheat yield by an average of 2 bu/a and increasing test weight slightly. However, average plant N concentrations and grain protein decreased somewhat with increasing seeding rate. A significant interaction between wheat N rate and seeding rate occurred in grain yield, test weight, and plant N. Yields did not respond to seeding rate at low N rates, but reached a maximum of 61 bu/a with 90 or 120 lb/a of seed and 120 lb/a of N. Higher seeding rates tended to increase test weight slightly, more so at the zero N rate. Plant N levels decreased with increasing seeding rate except at the highest N rate.

Table 1. Effects of nitrogen and seeding rate on no-till winter wheat after grain sorghum, Hesston, KS, 2001.

Sorghum N Rate[1]	Wheat N Rate	Seeding Rate	Yield	Bushel Wt	Plant Ht	Plant N[2]	Plant P[2]	Grain Protein[3]
--------------------lb/a--------------------			bu/a	lb	inch	------------------%------------------		
60	0	60	14.2	60.9	18	1.17	0.29	10.1
		90	13.6	61.3	17	1.10	0.27	10.1
		120	13.2	61.8	16	1.03	0.27	9.9
	40	60	35.3	61.6	24	1.14	0.21	9.3
		90	34.1	61.8	24	1.09	0.21	9.2
		120	37.7	61.7	25	1.07	0.19	9.0
	80	60	52.0	62.0	26	1.43	0.18	9.7
		90	54.5	61.9	27	1.28	0.18	9.4
		120	54.7	62.0	27	1.18	0.17	9.4
	120	60	57.0	61.8	27	1.40	0.18	10.1
		90	60.8	61.8	28	1.43	0.18	10.1
		120	62.0	61.8	29	1.53	0.16	10.0
120	0	60	18.1	61.0	19	1.12	0.26	10.1
		90	18.1	61.3	19	1.09	0.24	9.9
		120	18.1	61.8	19	1.07	0.24	9.6
	40	60	37.5	61.8	24	1.17	0.20	9.4
		90	40.0	61.9	25	1.15	0.19	9.1
		120	38.7	61.9	24	1.16	0.19	9.1
	80	60	52.3	62.0	27	1.43	0.18	9.8
		90	55.3	62.0	27	1.35	0.17	9.7
		120	56.6	62.2	27	1.19	0.17	9.4
	120	60	56.3	61.4	28	1.61	0.18	10.6
		90	60.5	61.8	27	1.50	0.17	10.6
		120	60.9	61.5	28	1.48	0.17	10.6
LSD .05	Means at same Sor. N		2.9	0.32	1.4	0.14	0.021	0.36
	Means at diff. Sor. N		3.8	0.37	1.7	0.15	0.032	0.41
Means: Sorghum N Rate								
60			40.8	61.7	24	1.24	0.21	9.7
120			42.7	61.7	24	1.28	0.20	9.8
LSD .05			NS	NS	NS	NS	NS	NS
LSD .15			1.8	NS	NS	0.04	NS	NS
	N Rate							
	0		15.9	61.3	18	1.10	0.26	9.9
	40		37.2	61.8	24	1.13	0.20	9.2
	80		54.2	62.0	27	1.31	0.18	9.6
	120		59.6	61.7	28	1.49	0.17	10.3
	LSD .05		1.2	0.13	0.6	0.06	0.009	0.15
		Seed Rate						
		60	40.3	61.6	24	1.31	0.21	9.9
		90	42.1	61.7	24	1.25	0.20	9.8
		120	42.7	61.8	24	1.21	0.20	9.6
		LSD .05	1.0	0.11	NS	0.05	0.008	0.13

[1] N applied to preceding sorghum crop.
[2] Whole-plant nutrient levels at bloom stage.
[3] Protein calculated as %N x 5.7.

EFFECTS OF TERMINATION METHOD OF HAIRY VETCH WINTER COVER CROP AND NITROGEN RATE ON GRAIN SORGHUM

M.M. Claassen

Summary

Nitrogen response of sorghum grown in the third cycle of a vetch-sorghum-wheat rotation was compared with that of sorghum in a sorghum-wheat rotation at nitrogen (N) rates of 0 to 90 lb/a. Vetch was terminated by tillage (disking) or herbicides (no-till). Cold temperatures severely limited vetch fall development, but favorable spring conditions resulted in ample growth and average yields of 1.42 ton/a of dry matter by mid-May. The potential amount of N to be mineralized for use by the sorghum crop was 103 lb/a. On average, sorghum leaf N concentration was near a maximum with an N rate of 30 lb/a. 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. In sorghum without a cover crop, yield response to fertilizer was limited to the lowest N rates. However, no yield increase occurred with increasing N rate in sorghum after vetch. Vetch termination method had no affect on sorghum yield. The average vetch contribution to sorghum grain production was equivalent to 43 lb/a of fertilizer N.

Introduction

Interest in the use of legume winter cover crops has been rekindled by concerns for soil and water conservation, dependency on commercial fertilizer, and maintenance of soil quality. Hairy vetch is a good candidate for the cover crop role, because it can be established in the fall when water use is reduced, it has winterhardiness, and it can fix substantial N. This experiment was conducted to investigate the effects of hairy vetch and N fertilizer rates on the supply of N to the succeeding grain sorghum crop, as well as to assess sorghum yield response when the vetch is terminated by tillage versus by herbicides.

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 after vetch had been terminated, and the comparison again was made with sorghum in annual rotation with wheat alone. Wheat was planted without tillage into sorghum shortly after harvest and later top-dressed with the same N rates that had been applied to the preceding sorghum crop. After wheat harvest, volunteer wheat and weeds were controlled with Roundup Ultra. The third cycle of these treatment variables was initiated on October 4, 2000 with no-till planting of hairy vetch plots at 25 lb/a in 8-in. rows with a grain drill equipped with double-disk openers. 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 + 0.25 pt/a). Weeds were controlled with tillage in plots without hairy vetch.

Vetch forage yield was determined by harvesting a 1 sq m area from each plot on May 9, 2000. 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, treated with Concep III safener and Gaucho insecticide, was planted at approximately 42,000 seeds/a on June 15. Weeds were controlled with a preemergence application of Lasso + AAtrex 4L (2.5 qt + 1 pt/a). Grain sorghum was combine harvested on October 11.

Results

Dry soil delayed vetch emergence. Subsequently, early cold temperatures severely limited vetch fall development, which provided only 17% ground cover by late November. However, favorable spring conditions resulted in ample vetch growth and average yields of 1.42 ton/a of dry matter at early bloom stage near mid-May. N content was 3.65%, so that the average potential amount of N to be mineralized for use by the sorghum crop was 103 lb/a (Table 2).

Disking to terminate hairy vetch growth did not adversely affect soil moisture at the surface because of subsequent rains. Stand establishment was excellent. No-till sorghum after vetch averaged 1,000 plants/a less than sorghum after disked vetch or no vetch. High temperatures and limited rainfall combined to produce considerable drought stress.

Sorghum leaf N concentration tended to be near a maximum with a N rate of 30 lb/a. 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. Grain sorghum maturity (days to half bloom) increased very slightly in no-till sorghum after vetch versus the other systems. The number of heads per plant reflected the absence of treatment effects and tillering. In sorghum without a cover crop, yield response to fertilizer was limited to the lowest N rates. However, no yield increase occurred with increasing N rate in sorghum after vetch. 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. Neither cover crop nor N rate affected grain test weight.

Table 2. Effects of hairy vetch cover crop, termination method, and nitrogen rate on grain sorghum after wheat, Hesston, KS, 2001.

Cover Crop/ Termination	N Rate[1]	Vetch Yield[2] Forage	Vetch Yield[2] N	Grain Sorghum: Grain Yield	Bushel Wt	Stand	Half[3] Bloom	Heads/ Plant	Leaf N[4]
	lb/a	ton/a	lb	bu/a	lb	1000's/a	days	no.	%
None	0	--	--	83.0	58.8	39.2	54	1.0	2.55
	30	--	--	95.7	59.6	38.4	54	1.0	2.80
	60	--	--	101.7	59.8	37.8	54	1.0	2.83
	90	--	--	101.5	59.9	38.6	53	1.0	2.82
LSD .10				11.8	0.58	NS	NS	NS	0.18
Vetch/Disk	0	1.42	107	100.9	59.4	38.9	54	1.0	2.71
	30	1.30	101	96.3	58.9	38.5	55	1.0	2.79
	60	1.46	108	100.0	59.6	39.1	54	1.0	2.86
	90	1.42	96	99.0	58.7	38.8	54	1.0	2.70
LSD .10		----	----	NS	NS	NS	0.90	NS	NS
Vetch/No-till	0	1.50	106	97.2	59.5	37.5	54	1.0	2.72
	30	1.47	100	101.9	59.6	37.5	54	1.1	2.82
	60	1.50	109	99.6	59.4	37.0	55	1.1	2.89
	90	1.31	99	93.6	58.9	38.5	55	1.0	2.84
LSD .10		----	----	NS	NS	NS	NS	NS	NS
LSD .05 across systems		NS	NS	NS	NS	1.63	0.98	NS	0.23
LSD .10 across systems		NS	NS	NS	NS	----	----	NS	---
Means: Cover Crop/ Termination									
None		--	--	95.6	59.5	38.5	54	1.0	2.75
Vetch/Disk		1.40	103	99.1	59.1	38.8	54	1.0	2.76
Vetch/No-till		1.44	104	98.1	59.4	37.6	55	1.0	2.81
LSD .05		NS	NS	NS	NS	0.82	0.49	NS	NS
N Rate									
0		1.46	106	93.9	59.2	38.5	54	1.0	2.66
30		1.38	101	98.0	59.3	38.1	54	1.0	2.80
60		1.48	108	100.4	59.6	37.9	54	1.0	2.86
90		1.36	97	98.0	59.2	38.6	54	1.0	2.79
LSD .05		NS	NS	NS	NS	NS	NS	NS	0.13

[1] N applied as 34-0-0 on June 14, 2000.
[2] Oven dry weight and N content on May 9, 2000.
[3] Days from planting (June 15, 2001) 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 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. Both hairy vetch and N rate significantly increased wheat yield. At 0 lb/a of fertilizer N, the residual effect of hairy vetch increased wheat yields by 27 and 23 bu/a in disk and no-till systems, respectively. These residual vetch benefits were equivalent to 47 and 40 lb/a of fertilizer N, respectively. In wheat after sorghum without vetch, each 30 lb/a increment of fertilizer N significantly increased yield. The trend suggested that yields had not exceeded the maximum at 90 lb/a of fertilizer N. In wheat after vetch-sorghum, yields at 60 and 90 lb/a of N 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 1995. Sorghum was grown in 1996 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-in. rows into sorghum stubble in the fall of 1996. In the third cycle of the rotation, hairy vetch plots were seeded at 24 lb/a in 8-in. rows on October 8, 1999. One set of vetch plots was terminated by disking on May 8. 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).

Vetch forage yield was determined by harvesting a 1 sq m area from each plot on May 8, 2000. Nitrogen fertilizer treatments were broadcast as ammonium nitrate on May 24. 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-in. rows at approximately 42,000 seeds/a on June 7, 2000. Weeds were controlled with a preemergence application of Dual II + AAtrex 90 DF (1 qt/a + 0.55 lb/a). Grain sorghum was combine harvested on September 26. Fertilizer N was broadcast as 34-0-0 on October 4, 2000, at rates equal to those applied to the prior sorghum crop. Variety 2137 winter wheat was no-till planted in 8-in. rows into sorghum stubble on October 20 at 120 lb/a with 39 lb/a of P_2O_5 fertilizer banded in the furrow. Wheat was harvested on June 18, 2001.

Results

Hairy vetch terminated near mid-May, 2000, produced an average of 1.97 ton/a of dry matter, yielding 105 lb/a of N potentially available to the sorghum that followed (Table 3). In terms of sorghum leaf N levels, the apparent N contribution by vetch was equivalent to approximately 57 lb/a and >120 lb/a of fertilizer N in no-till and disked plots, respectively. However, in the absence of fertilizer N, sorghum after vetch produced yields not differing significantly from sorghum with no preceding cover crop. And, when averaged over N rates, yields of sorghum after disked vetch were 7 bu/a lower than either no-till sorghum after vetch or sorghum without a cover crop.

Residual vetch effect increased wheat

plant height at 0 and 30 lb/a of N but not at higher N rates. Averaged across N rates, vetch treatments increased wheat plant N and grain protein. These increases were most notable at 90 lb/a of N. At 0 lb/a of fertilizer N, the residual effect of hairy vetch increased wheat yields by 27 and 23 bu/a in disk and no-till systems, respectively. These residual vetch benefits were equivalent to 47 and 40 lb/a of fertilizer N, respectively. Averaged over N rates, hairy vetch in these systems accounted for yield increases of 15 and 12 bu/a. In wheat after sorghum without vetch, each 30 lb/a increment of fertilizer N significantly increased yield. The trend suggested that yields had not exceeded the maximum at 90 lb/a of fertilizer N. In wheat after vetch-sorghum, yields also increased with increasing fertilizer N, but failed to differ significantly between rates of 60 and 90 lb/a of N.

Table 3. Residual effects of hairy vetch cover crop, termination method, and nitrogen rate on no-till wheat after grain sorghum, Hesston, KS, 2001.

Cover Crop/ Termination[1]	N Rate[2]	Vetch Yield[3] Forage	Vetch Yield[3] N	Sorghum Yield 2000	Wheat Yield	Wheat Bushel Wt	Wheat Plant Ht	Wheat Plant N[4]	Wheat Grain N[5]
	lb/a	ton/a	lb	bu/a	bu/a	lb	in.	%	%
None	0	--	--	76.1	12.0	62.2	17	0.94	10.0
	30	--	--	82.0	28.3	62.3	22	1.05	9.2
	60	--	--	86.0	46.2	62.2	26	1.07	9.1
	90	--	--	89.3	54.2	61.8	27	1.21	9.5
Vetch/Disk	0	2.19	109	73.8	38.7	62.8	24	1.13	10.1
	30	1.96	110	77.4	48.1	62.0	26	1.05	9.7
	60	2.05	104	79.9	54.6	61.7	27	1.26	10.4
	90	1.76	94	75.6	58.9	60.7	27	1.55	10.8
Vetch/No-till	0	2.26	116	82.2	35.2	63.0	23	1.14	9.9
	30	1.91	108	80.6	45.0	62.5	26	1.08	9.7
	60	1.84	98	85.5	52.0	62.1	27	1.28	10.1
	90	1.80	101	84.0	54.6	61.5	28	1.59	11.0
LSD .05		0.41	NS	9.5	5.5	0.52	1.9	0.25	0.69
Means: Cover Crop/ Termination									
None		----	----	83.3	35.2	62.1	23	1.07	9.5
Vetch/Disk		1.99	104	76.7	50.1	61.8	26	1.24	10.3
Vetch/No-till		1.95	106	83.1	46.7	62.3	26	1.27	10.2
LSD .05		NS	NS	4.7	2.8	0.26	0.9	0.12	0.34
N Rate									
0		2.23	112	77.3	28.7	62.7	21	1.07	10.0
30		1.94	109	80.0	40.5	62.3	25	1.06	9.6
60		1.94	101	83.8	51.0	62.0	27	1.20	9.9
90		1.78	98	83.0	55.9	61.3	27	1.45	10.4
LSD .05		0.29	NS	NS	3.2	0.30	1.1	0.14	0.40

[1] Hairy vetch planted on October 8, 1999, and terminated in the following spring.
[2] N applied as 34-0-0 on May 24, 2000 for sorghum and on October 4, 2000 for wheat.
[3] Oven dry weight and N content just prior to termination.
[4] Whole-plant N concentration at early heading.
[5] Protein calculated as %N x 5.7.

SOIL FERTILITY RESEARCH
KANSAS RIVER VALLEY EXPERIMENT FIELD

MACRONUTRIENT FERTILITY ON IRRIGATED CORN IN A CORN-SOYBEAN ROTATION

L.D. Maddux

Summary

A corn-soybean cropping sequence was evaluated from 1983 - 2001 (corn planted in odd years) for the effects of N, P, and K fertilization. Corn yield increased with increasing N rates up to 160 lbs N/a. A significant yield increase to P fertilization was observed in only 1 year. An average 6 bu/a corn yield increase was observed from 1983-95 with K fertilization.

Introduction

A study was initiated in 1972 at the 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 lbs/a of available P and 312 lbs/a of exchangeable K in the top 6 in. of the soil profile. Rates of P were from 50 and 100 lbs P_2O_5/a from 1972 - 1975 and 30 and 60 lbs P_2O_5/a from 1976 - 2001, except in 1997 when a starter of 120 lbs/a of 10-34-0 (12 lbs N/a + 41 lbs P_2O_5/a) was applied to all plots (also applied to soybean in 1998). Rates of K were 100 lbs K_2O/a (1972 - 1975), 60 lbs K_2O/a (1976 to 1995), and 150 lbs K_2O/a (1997 - 2001). N Rates included a factorial arrangement of 0, 40, and 160 lbs of preplant N/a (with single treatments of 80 and 240 lbs N/a). The 40 lbs N/a rate was changed to 120 lbs 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).

Corn hybrids planted were BoJac 603 - 1983, Pioneer 3377 - 1985, 1987, 1989; Jacques 7820 - 1991 and 1993; Mycogen 7250CB - 1995; DeKalb 626 - 1997, 1999; and Golden Harvest 2547 in 2001. Corn was planted in mid-April. Herbicides were applied preplant, incorporated each year. The plots were cultivated, furrowed, and furrow irrigated as needed. A plot combine was used for harvesting.

Results

Average corn yields for the 13-year period from 1983 through 1995 (7-years) and yields for 1997, 1999, and 2001 are shown in Table 1. A good N response was obtained with 160 lbs N/a. Fertilization at 240 lbs N/a did not significantly increase corn yield. In 1997, corn yield with 120 lbs N/a was equal to that with 160 lbs N/a and only 6 and 4 bu/a less in 1999 and 2001, respectively. Corn yield showed a significant response to P fertilization only in 1985 and 1993 (yearly data not shown) while the 7-year average resulted in no significant difference in yield. K fertilization showed a significant yield increase in 1985, 1989, and 1993 (yearly data not shown) and the 7-year average showed a 6 bu/a yield increase. No P response was observed in 1997, when starter fertilizer was applied to all plots, nor in 1999 or 2000, after the 2 years of starter application. No significant response to K fertilization was observed in 1997, 1999, or 2001, although there was a trend to increased yield with K fertilization in 1999 and 2001.

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

Fertilizer Applied[1]			Corn Yield			
N	P_2O_5[2]	K_2O	1983 - 1995	1997	1999	2001
----lbs/a----			---- bu/a ----			
0	0	0	87	93	88	119
0	0	60/150	86	95	106	123
0	30	0	93	101	115	124
0	30	60/150	86	87	90	115
0	60	0	84	86	76	110
0	60	60/150	92	89	79	115
40/120	0	0	129	200	202	183
40/120	0	60/150	126	181	195	173
40/120	30	0	123	189	188	168
40/120	30	60/150	138	208	181	192
40/120	60	0	117	195	159	183
40/120	60	60/150	132	190	213	182
160	0	0	171	203	171	171
160	0	60/150	177	177	206	168
160	30	0	168	184	189	174
160	30	60/150	181	205	209	190
160	60	0	167	191	199	205
160	60	60/150	178	204	203	198
80	30	60/150	151	187	177	167
240	30	60/150	182	206	219	192
LSD(.05)			15	27	46	26
Nitrogen Means:						
0			88	92	92	118
40/120			127	194	190	180
160			174	194	196	184
LSD(.05)			8	19	19	13
Phosphorus Means:						
	0		129	158	161	156
	30		131	162	162	160
	60		128	159	155	166
LSD(.05)			NS	NS	NS	NS
Potassium Means:						
		0	127	160	154	160
		60/150	133	159	165	162
LSD(.05)			6	NS	NS	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 & 1998 (corn & soybean). N & K treatments were applied to corn in 1997.

EFFECT OF PLACEMENT OF STARTER FERTILIZERS ON SOYBEAN

L.D. Maddux, D.A. Whitney, 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. 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 near Powhattan on a dryland Grundy silty clay loam site previously cropped to soybean. Soil pH was 6.4, organic matter content 3.2%, and P test level 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 1.6%, and P test level 21 ppm.

Nine 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 & 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 May 16 at Rossville and May 23 at Powhattan. Stine 4200-2 and Taylor 394RR soybean varieties were planted at 144,000 seeds/a in 30-inch rows at Rossville and Powhattan, respectively. Trifoliate leaf and grain samples were collected for nutrient analyses. The Rossville site was sprinkler irrigated as needed. The plots were harvested using a plot combine on October 26 at Rossville and October 12 at Powhattan.

Results

No significant differences in grain yield were found at either location (Table 2).

Table 2. Effects of nitrogen and phosphorus placement on soybean yield, northeast KS, 2001.

Treatment[1]	Placement	Yield: Rossville	Yield: Powhattan
		------------bu/a-----------	
Check	---	52.9	39.0
8.8-30-0	2x2	45.4	39.5
30-30-0	2x2	50.5	41.9
10-34-0, 2 gpa	In Furrow	52.8	38.9
10-34-0, 4 gpa	In Furrow	52.4	38.3
8.8-0-0	2x2	47.5	37.5
30-0-0	2x2	50.2	37.8
30-30-0	Broadcast	50.5	37.5
0-30-0	Broadcast	48.6	35.7
LSD(0.05)		NS	NS

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

SOIL FERTILITY RESEARCH
EAST CENTRAL EXPERIMENT FIELD

INTEGRATED AGRICULTURAL MANAGEMENT SYSTEMS TO IMPROVE THE QUALITY OF KANSAS SURFACE WATERS

K.A. Janssen and G.M. Pierzynski

Summary

The results of this study show that no-till can significantly reduce soil erosion and sediment in runoff water. However, if fertilizer and herbicides are surface applied, runoff losses of these crop inputs will be increased compared to when they are incorporated by tillage.

Therefore, an important BMP (best management practice) for balancing cropland contaminant losses in no-till will be subsurface application of P fertilizer. This could be in the form of pre-plant deep banding (which was used here), 2x2 inch band placement of fertilizer with the planter, or some combination of these.

Steps to reduce herbicide losses will also be necessary when using no-till. This might be partially accomplished by timing of the herbicide applications when the potential for runoff is less (fall and early spring applications compared to planting-time applications).

Farming operations that use tillage also must be improved. Every effort should be taken to minimize soil erosion. Use of structures (terraces) and grass waterways are a given. Also, use of tillage implements that leave more crop residue cover on the soil surface, but still allow for fertilizer and herbicide incorporation would be beneficial.

Ultimately, the farming practices that are most friendly for a watershed may depend on what the problems are in the watershed. If the problem is predominantly soil erosion and sediment losses, then the use of no-till would be beneficial. If the problem is elevated levels of phosphorus and herbicides, then cropping practices that allow for incorporation or injection of these crop inputs would be desirable. If all three contaminates (sediment, nutrients, and herbicides) are problems in the watershed, or no one contaminant is a problem, then a combination of tillage practices (no-till on the most highly erosive land and tilled systems on the least erosive fields) may actually provide the most balanced control of cropland runoff contaminants.

Introduction

The Kansas Department of Health and Environment is developing Total Maximum Daily Loads (TMDLs) for various contaminants in Kansas streams and water bodies. The contaminants of most concern are sediment, nutrients, pesticides, and fecal coliform bacteria. The implementation of TMDLs will require information on runoff losses associated with different agricultural land uses and the impact of different agricultural management practices on contaminant loading.

Cropland systems that greatly reduce tillage and maintain 30% or more crop residue cover after planting have been shown to significantly reduce soil erosion and sediment in runoff. Among the conservation tillage systems, the no-till system is the most effective. This is because it incorporates very little crop residue and loosens the least amount of soil at the surface.

Tillage/planting systems that significantly reduce tillage, however, provide little opportunity for incorporating fertilizer, manure, and herbicides. When surface applied, these materials enrich the near surface soil zone and increase runoff losses.

Consequently, a more comprehensive management strategy other than just tillage reduction is needed. A system of cropping practices is needed incorporating all best management practices (BMPs) for controlling all cropland runoff contaminates. We refer to such a strategy as “Integrated Agricultural Management Systems.”

The purpose of this study was to evaluate, on a field-scale basis, different combinations of tillage, fertilizer, and herbicide management practices for balanced control of all cropland runoff contaminants.

Procedures

Five locations in Kansas were selected for this project. This article presents information and data for the Marais des Cygnes River Basin site located in Franklin Co. near Ottawa, Kansas. This location represents the slowly permeable soils of the east-central part of Kansas with 38-40 inches rainfall per year. The field selected for this study was approximately 10 acres in size, had a slope of 2-5 percent, and had near parallel terraces. Soils in the field were a mixture of Eram-Lebo with some Dennis-Bates complex (Argiudolls, Hapludolls and Paleudolls). Bray 1 P soil test was 13 ppm, which according to K-State recommendations is a low to medium soil test. The tillage, fertilizer, and herbicide treatment combinations evaluated 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. The crops grown were grain sorghum and soybean planted 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/a ai) and Dual (metolachlor 1.25 lb/a ai) herbicides were applied for weed control in grain sorghum. For soybean, Roundup Ultra (glyphostate 1 lb/a ai) and metolachlor (1.25 lb/a ai) herbicides were applied.

Runoff from natural rainfall was collected by instrumentation of each of the between terraced treatment areas with weirs and automated ISCO samplers. The runoff water was analyzed for sediment, nutrient, and herbicide losses.

Results

Rainfall and Runoff

Rainfall amounts for the dates in which we collected runoff totaled 9.46 inches in 1998, 8.02 inches in 1999, and 5.00 inches in 2000. Averaged across all runoff collection dates and years, the amount of rainwater that ran off was 49% with the no-till system and 29% with the chisel-disk-field cultivate system (Figures 1, 2 and 3). Part of the reason that runoff was greater in no-till than in the chisel-disk-field cultivate system was that each time the soil was tilled in the chisel-disk-field cultivate system, it loosened and dried the soil, which then increased the soil's capacity to infiltrate and absorb rainwater.

Soil Erosion and Sediment Losses

Averaged across all of the runoff collection dates and years, the amount of soil loss in the runoff water was three times greater for the chisel-disk-field cultivate system than for no-till (Figures 4, 5 and 6). Soil losses did not always parallel runoff losses. Differences in rainfall intensity and timing of individual rainfall events, differences in surface soil conditions because of tillage, and differences in the amount of canopy cover at the time the rainfall occurred, also influenced soil losses.

Nutrient and Herbicide Losses

Soluble P, atrazine, and metolachlor concentrations in the runoff water were highest with surface applications in no-till (Figures 7, through 13). Incorporation of fertilizer and herbicides with tillage decreased losses. Highest concentrations of soluble P and herbicides in runoff occurred during the first couple of runoff events after application. Much of the initial losses appeared to be direct losses before being absorbed by the soil.

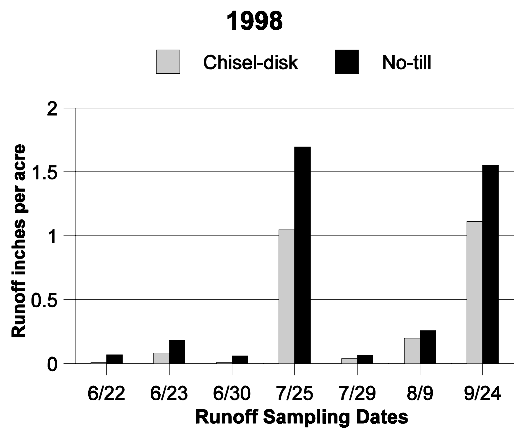

Figure 1. Tillage effects on volume of runoff, 1998.

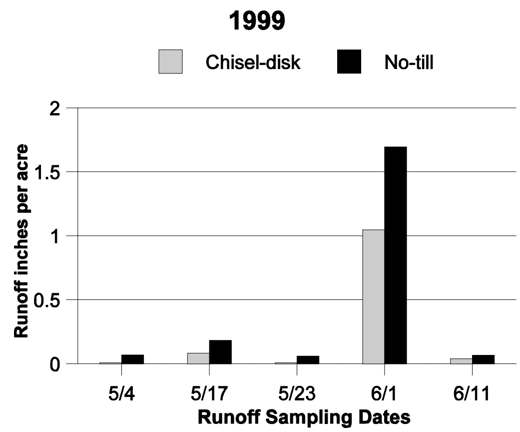

Figure 2. Tillage effects on volume of runoff, 1999.

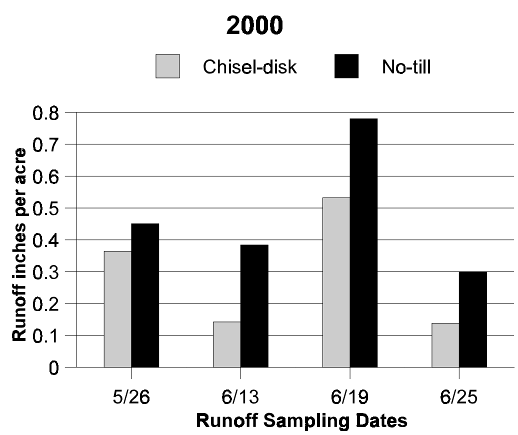

Figure 3. Tillage effects on volume of runoff, 2000.

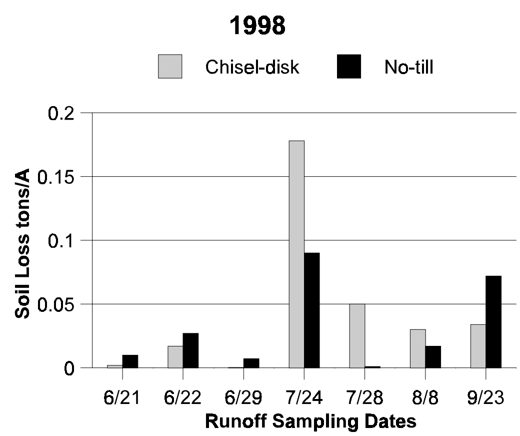

Figure 4. Tillage effects on sediment losses in runoff, 1998.

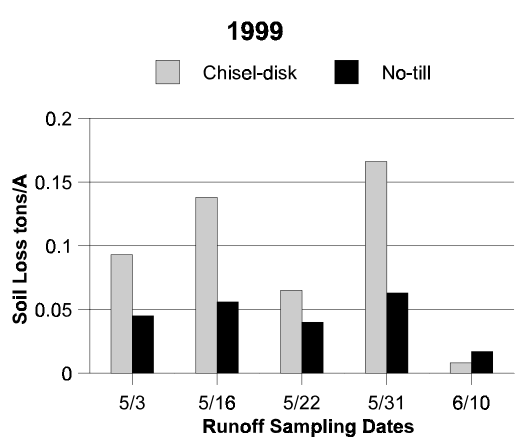

Figure 5. Tillage effects on sediment losses in runoff, 1999.

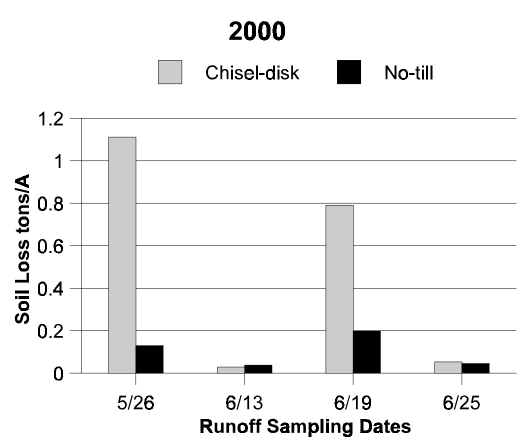

Figure 6. Tillage effects on sediment losses in runoff, 2000.

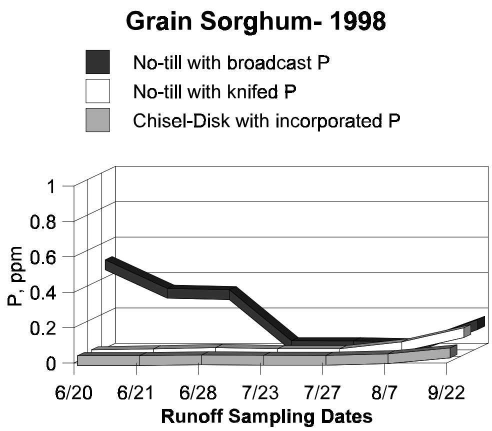

Figure 7. Effects of tillage and P fertilizer placement on soluble P concentrations in runoff, 1998.

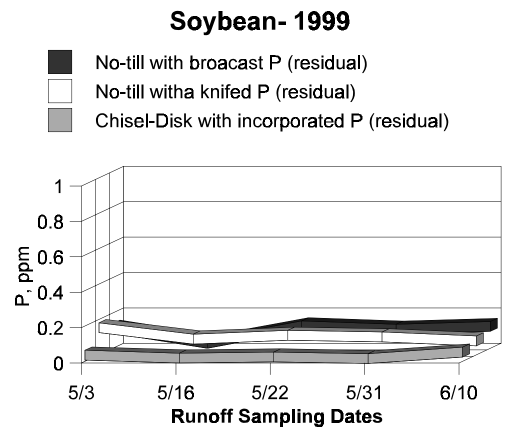

Figure 8. Effects of tillage and residual from P fertilizer placement on soluble P concentrations in runoff, 1999.

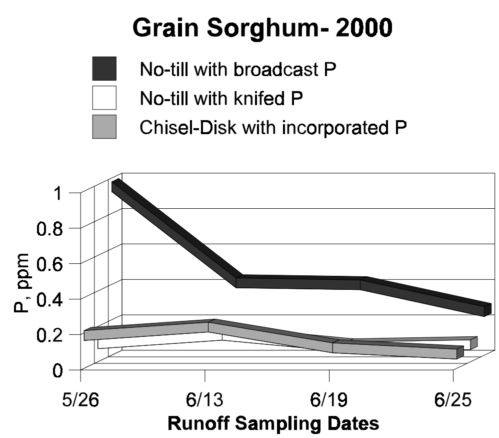

Figure 9. Effects of tillage and P fertilizer placement on soluble P concentrations in runoff, 2000.

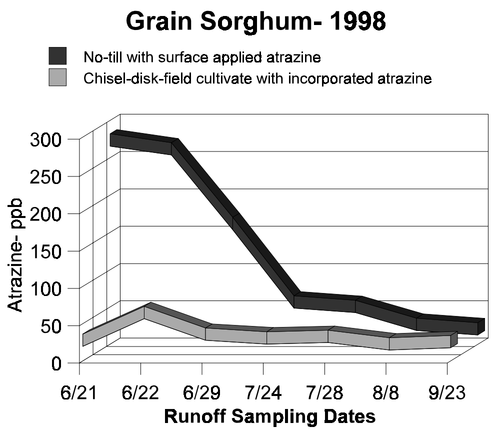

Figure 10. Effects of tillage and atrazine placement on atrazine concentrations in runoff, 1998.

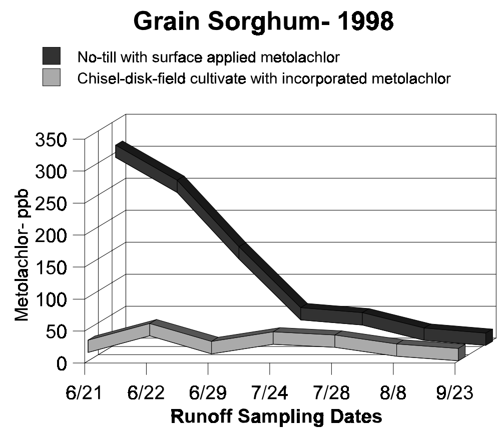

Figure 11. Effects of tillage and metolachlor placement on metolachlor concentrations in runoff, 1998.

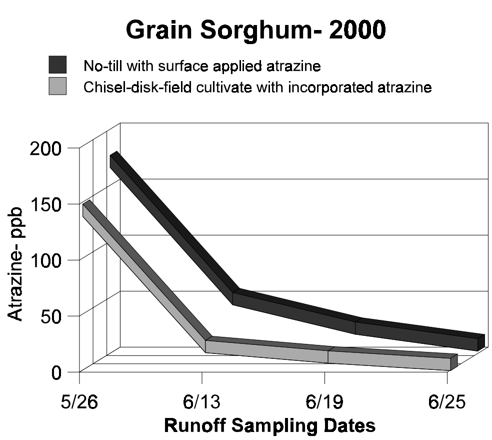

Figure 12. Effects of tillage and atrazine placement on atrazine concentration in runoff, 2000.

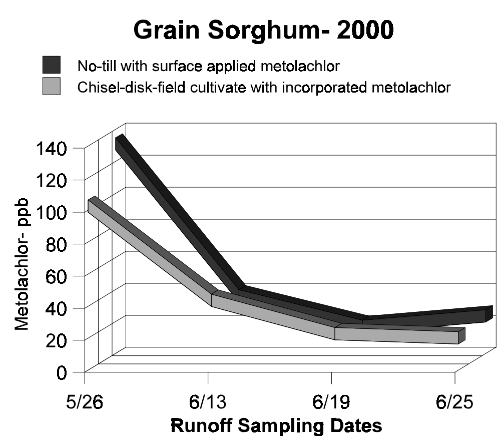

Figure 13. Effects of tillage and metolachlor placement on metolachlor concentration in runoff, 2000.

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

STARTER FERTILIZER MANAGEMENT FOR NO-TILL CORN PRODUCTION

B.J. Niehues, R.E. Lamond, and C.J. Olsen

Summary

Because of the interest in, and importance of, the use of starter fertilizers in no-till corn production systems, research was initiated to evaluate rates of nitrogen (N) in starter fertilizers placed in direct seed contact, dribbled over the row, or in a 2x2 configuration. The use of starter fertilizer containing N, phosphorus (P), and potassium (K) significantly increased corn grain yields compared to an N-only program. The application of more than 20 lb N/a in starter fertilizer placed in-furrow did not increase yields further and reduced plant populations. Current recommendations suggest that no more than 10 lb/a of N + K_2O should be placed in direct seed contact. Over-the-row applications did increase yields, and plant populations were not reduced compared to those with the in-furrow placement. Application of 30 to 120 lb N/a in a 2x2 starter band increased yields without affecting plant populations. Results indicate that either over-the-row or a 2x2 placement should be used if the starter fertilizer contains more than 10 lb/a of N. The addition of 10 lb sulfur/a in the starter fertilizer has consistently increased yields in this work.

Introduction

The use of starter fertilizers applied during the planting operation has proven to be an extremely effective way to provide needed P, K, and micronutrients in conservation-tillage production systems. Most starter fertilizers also contain small amounts of N. Because of the recognized potential inefficiency of surface-applied N in these heavy-residue production systems, interest has increased in applying more of the total N program in the starter fertilizer. However, applying more than 10 lb N/a in a starter in direct seed contact increases the risk of germination damage and poor stands. Fertilizer additives are now available that may reduce the risk of germination problems, possibly allowing higher rates of N to be applied in direct seed contact. Alternatively, using a 2x2 starter placement allows higher rates of N to be applied as part of a starter fertilizer.

This research was initiated to evaluate starter fertilizer management in a no-till production system, including placement and use of higher N rates.

Procedures

The study was conducted at the North Agronomy Farm (Manhattan, dryland) to evaluate direct seed contact, over–the–row, and 2x2 placements of starter fertilizer. In the direct seed contact and over-the-row studies, N rates were 10, 20, 40, and 50 lb N/a. In the 2x2 studies, N rates of 30, 60, 90, and 120 lb/a were evaluated in a starter fertilizer containing P and K placed 2 in. below and 2 in. to the side of the seed. Total N was balanced on all treatments at 150 lb/a, as broadcast ammonium nitrate. Corn was no-till planted on April 14.

Plant populations and V-6 dry matter yields were determined, and leaf samples were taken at V-6 and tassel stages to determine N, P, K, and sulfur (S) concentrations. Grain yields, grain moisture, and grain protein levels were determined.

Results

Grain yields were good to excellent in 2000 despite hot dry weather and only average in 2001 due to a June 18 hailstorm and dry conditions at pollination (Tables 1 and 2). Soil test P and K levels were adequate in this field. The use of starter fertilizer either in direct seed contact, dribbled over the row, or in a 2x2 placement increased yields compared to broadcast N only (Tables 1-2). Increasing N rates with direct contact did not increase yields, and final stand counts were reduced significantly at the 40 and 50 lb N/a rates. Effects of too much N in direct seed contact are worse in dry seedbeds. Current recommendations suggest no more than 10 lb/a of N plus K_2O should be placed in direct seed contact. A higher rate of N can be dribbled over the row without a risk of stand reduction, while still producing high yields.

With the 2x2 starter placement, applying either 30, 60, 90, or 120 lb N/a increased yields over the no-starter treatment. The 2x2 placement allows the flexibility of increasing N rates in a starter fertilizer without the risk of emergence problems encountered with in-furrow placement of starters. The inclusion of 10 lb S/a in the starter consistently increased early-season growth and grain yields.

Table 1. Evaluation of starter fertilizer formulation and placement on no-till dryland corn, North Agronomy Farm, Manhattan, KS.

B'cast	Starter Fertilizer				Plant Population		V-6 Dry Wt.		Grain Yield	
N[1]	N	P_2O_5	K_2O	Placement	2000	2001	2000	2001	2000	2001
lb/a	- - lb/a - -				1000 plants/a		- - lb/a - -		- - bu/a - -	
150	0	0	0	--	20.7	24.8	163	247	105	72
140	10	15	5	In-furrow	19.7	23.5	210	294	127	82
130	20	15	5	In-furrow	19.7	24.5	163	333	122	83
110	40	15	5	In-furrow	17.3	21.6	173	281	127	90
100	50	15	5	In-furrow	15.9	16.3	120	307	111	76
140	10	15	5	Over Row	20.2	24.3	209	452	133	96
130	20	15	5	Over Row	20.7	24.5	214	384	133	92
110	40	15	5	Over Row	19.2	24.8	173	367	126	93
100	50	15	5	Over Row	20.5	25.1	161	341	128	89
LSD(0.10)					2.8	2.9	NS	65	21	11
Mean Values:										
Starter	10				20.0	23.9	209	373	130	89
N	20				20.2	24.5	189	358	127	88
	40				18.3	23.2	173	324	127	91
	50				18.2	20.7	141	324	119	82
LSD (0.10)					NS	1.8	38	NS	NS	NS
Placement		In-furrow			18.2	21.5	166	304	121	83
		Over Row			20.2	24.7	189	386	130	92
LSD (0.10)					1.5	1.3	NS	35	NS	6

[1] Broadcast N applied as ammonium nitrate after planting

Table 2. Evaluation of starter fertilizer placed 2x2 on no-till dryland corn, North Agronomy Farm, Manhattan, KS.

B'cast	Starter Fertilizer[2]				Plant Population		V-6 Dry Wt.		Grain Yield	
N[1]	N	P_2O_5	K_2O	S	2000	2001	2000	2001	2000	2001
lb/a	- - - - - lb/a - - - - -				1000 plants/a		- - - lb/a - - -		- - - bu/a - - -	
150	0	0	0	0	20.7	23.7	163	247	105	72
120	30	30	10	0	17.9	22.7	209	316	119	86
120	30	30	10	10	18.0	23.7	201	499	132	91
90	60	30	10	0	20.1	23.2	152	316	120	83
60	90	30	10	0	20.8	22.5	178	301	142	85
30	120	30	10	0	20.3	22.7	121	308	128	88
LSD(0.10)					1.5	NS	NS	91	15	6

[1] Broadcast N applied as ammonium nitrate after planting
[2] Starter was placed 2 inches below and 2 inches to the side of seed row at planting

EFFECTS OF NITROGEN RATES AND SOURCES ON NO-TILL CORN

R.E. Lamond, V.L. Martin, W.B. Gordon, and C.J. Olsen

Summary

The poor performance of surface-applied urea-containing fertilizers in no-till corn production systems likely is due to nitrogen (N) loss by volatilization as the urea is hydrolyzed. Earlier work in Kansas has shown that the urease inhibitor NBPT (sold under the trade name AgrotaiN) is effective in improving the performance of such fertilizers. This research was continued in 2001 to evaluate experimental N fertilizers (UCAN-21 and CR-43) surface broadcast on no-till corn. UCAN-21 is a mixture of 2/3 urea-ammonium nitrate (UAN) solution and 1/3 liquid calcium nitrate. The CR-43 material is a polymer-coated urea. The polymer coating makes the urea a slow-release N source. Results from this dryland corn site indicate that UCAN-21, CR-43 and UAN all performed similarly when surface broadcast under no-till conditions.

Introduction

Urea-containing fertilizers are subject to N loss through volatilization when surface applied without incorporation, particularly if heavy residue is present. Volatilization potential is usually high when N fertilizers are applied close to corn planting dates. The use of urease inhibitors applied with urea-containing fertilizers can reduce volatilization. AgrotaiN, a commercially available urease inhibitor, was proven effective in earlier work. Previous work in Texas had indicated that applying calcium (Ca) with urea also may reduce volatilization potential. The objective of this research was to compare an experimental N fertilizer (UCAN-21), which contains Ca, to UAN and CR-43 when surface applied in no-till corn. The CR-43 is a polymer–coated urea.

Procedures

Studies were conducted at the North Agronomy Farm in 2000 and 2001 using no-till production systems. Nitrogen rates (50, 100, 150 lb/a) were surface broadcast just after corn planting as either UAN, CR-43, or UCAN-21. A no-N treatment was included.

Whole-plant samples were taken at the V6 stage to measure early-season growth, and samples were retained for N analysis and calculation of early-season N uptake. Leaf samples were taken at tassel for N analysis. Grain yields were determined, and samples were retained for protein analysis.

Results

Grain yields were average both years. Visual responses to N were apparent shortly after emergence at the North Agronomy Farm. Nitrogen rates up to 150 lb N/a significantly increased corn yields (Table 3). Nitrogen also consistently increased leaf N.

All N sources performed similarly in both 2000 and 2001. The UCAN-21 and CR-43 produced slightly higher yields in 2000, but in 2001 no differences in grain yields were noted among N sources. Significant rainfall occurred shortly after application in 2001, which would reduce volatilization loss potential.

Table 3. Effects of nitrogen rates and sources on no-till corn, North Agronomy Farm, Manhattan, KS, 2000-2001.

		2000		2001	
N Rate	N Source	Tassel N	Grain Yield	Tassle N	Grain Yield
lb/a		%	bu/a	%	bu/a
0	--	1.58	34	2.25	34
50	UAN	1.81	72	2.48	64
100	UAN	2.29	104	2.67	66
150	UAN	2.66	133	2.72	81
50	CR-43	2.03	83	2.64	56
100	CR-43	2.50	114	2.70	69
150	CR-43	2.49	132	2.77	72
50	UCAN-21	1.87	82	2.56	52
100	UCAN-21	2.37	109	2.56	70
150	UCAN-21	2.51	129	2.80	77
LSD (0.10)		0.23	16	0.15	15
Mean Values:					
N	50	1.90	79	2.55	58
Rate	100	2.39	109	2.64	68
	150	2.55	131	2.77	77
LSD (0.10)		0.14	9	0.08	9
N	UAN	2.25	103	2.62	70
Source	CR-43	2.34	110	2.71	66
	UCAN-21	2.25	106	2.64	66
LSD (0.10)		NS	NS	NS	NS

EFFECTS OF NITROGEN MANAGEMENT AND TILLAGE ON GRAIN SORGHUM

R.E. Lamond, D.A. Whitney, G.M. Pierzynski, and C.J. Olsen

Summary

Since 1982, the 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, and 120 lbs 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 an N source and was replaced by CR-43, 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. Results in 2001 indicate that no-till and conventional tillage performed similarly. Nitrogen sources performed similarly in conventional tillage and no-till in 2001. Significant rainfall shortly after fertilizer application likely reduced the potential for N volatilization losses from urea. Yields were down in 2001 due to a hailstorm and dry conditions, but yields and grain protein were increased dramatically by N application.

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 CR-43, 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 CR-43. All materials were surface broadcast. The two tillage methods used 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 in 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), leaf sampling, and harvesting of grain sorghum were done on May 25, July 13, and October 3, respectively.

Results

Results are summarized in Table 4. Grain yield and leaf N were increased significantly by N application up to 120 lbs. All N sources performed similarly in conventional till and no-till. Apparently, N loss via volatilization was insignificant in 2001. Conventional-tillage yields were slightly lower than no-till yields in 2001, but differences were not statistically significant. In addition, 20-year average yields show no difference between no-till and conventional tillage on the silty clay loam soil at this site.

Table 4. Effects of nitrogen management and tillage on continuous grain sorghum, North Agronomy Farm, Manhattan, KS, 2001.

N Rate	N Source	Tillage	Boot N	Grain Yield
lb/a			%	bu/a
0	--	No-till	1.73	41
30	Am. nit.	No-till	1.77	57
60	Am. nit.	No-till	1.91	76
120	Am. nit.	No-till	2.17	70
30	Urea	No-till	1.93	56
60	Urea	No-till	2.00	71
120	Urea	No-till	2.29	67
30	CR-43	No-till	2.02	64
60	CR-43	No-till	1.91	73
120	CR-43	No-till	2.14	66
0	--	Conventional	1.69	44
30	Am. nit.	Conventional	1.79	58
60	Am. nit.	Conventional	1.86	69
120	Am. nit.	Conventional	2.36	69
30	Urea	Conventional	1.73	59
60	Urea	Conventional	1.98	60
120	Urea	Conventional	2.28	61
30	CR-43	Conventional	1.94	58
60	CR-43	Conventional	2.24	73
120	CR-43	Conventional	2.49	68
	LSD (0.10)		0.18	11
Mean Values:				
N	30		1.86	58
Rate	60		1.98	70
	120		2.29	66
	LSD (0.10)		0.10	6
N	Am. nit.		1.98	67
Source	Urea		2.03	63
	CR-43		2.12	66
	LSD (0.10)		NS	NS
Tillage	No-till		2.02	66
	Conventional		2.07	64
	LSD (0.10)		NS	NS

CHLORIDE FERTILIZATION FOR CORN AND GRAIN SORGHUM

R.E. Lamond, K. Rector, and C.J. Olsen

Summary

Recent research in Kansas has shown that wheat often responds to chloride (Cl) fertilization. In some cases, Cl fertilization has slowed the progression of leaf diseases on wheat. In other cases, Cl responses occurred where soil Cl levels were low, indicating that some Kansas soils may be deficient in Cl. In light of consistent wheat response to Cl, work was continued in 2001 to evaluate Cl fertilization on dryland corn and grain sorghum. Results indicate that Cl fertilization often can increase corn and grain sorghum yields and leaf tissue Cl concentrations, particularly on soils testing less than 20 lb Cl/a. Yield responses were most consistent when leaf Cl concentrations of the check treatments were below 0.10 - 0.15%.

Procedures

Chloride rates (0, 10, 20 lb/a) and sources (KCl and $CaCl_2$) were evaluated on corn and grain sorghum at sites in Osage and Marion counties. Nitrogen was balanced on all treatments. All fertilizer materials were broadcast just after planting. Leaf samples were taken at tassel/boot stages for Cl analysis. Grain yields were determined and samples retained for protein analysis.

Results

Yields in 2001 were average to excellent at all locations. Yields and leaf tissue Cl concentrations are summarized in Table 5. Significant yield increases were noted at three of four sites, although not all Cl treatments produced significant yield increases. Chloride fertilization significantly increased leaf tissue Cl concentrations at all sites. Both Cl sources performed similarly. Because of these positive results, this work will be continued in 2002.

Results to date suggest that performing a Cl soil test is advisable in areas where no Cl has been applied. If soil Cl levels are below 20 lb/a, consistent responses by corn and grain sorghum to Cl fertilizer are likely.

Table 5. Effects of chloride fertilization on corn and grain sorghum, 2001.

		Marion County*				Osage County**			
Cl	Cl	Site A		Site B		Site A		Site B	
Rate	Source	Yield	Boot Cl	Yield	Boot Cl	Yield	Tassel Cl	Yield	Boot Cl
lb/a		bu/a	%	bu/a	%	bu/a	%	bu/a	%
0	--	117	.28	92	.15	79	.26	88	.09
10	KCl	126	.67	119	.43	82	.40	89	.38
20	KCl	131	.82	133	.49	79	.46	96	.50
10	$CaCl_2$	129	.68	107	.49	82	.40	95	.45
20	$CaCl_2$	129	.72	121	.53	81	.45	94	.46
LSD (0.10)		11	.15	21	.06	NS	.04	6	.06
Mean Values:									
Cl	10	127	.67	113	.46	81	.40	92	.41
Rate	20	130	.77	126	.51	81	.45	95	.48
LSD (0.10)		NS	.10	NS	.04	NS	.03	NS	.04
Cl	KCl	129	.74	125	.46	81	.43	92	.44
Source	$CaCl_2$	130	.70	114	.51	81	.42	94	.45
LSD (0.10)		NS	NS	NS	.04	NS	NS	NS	NS
Soil test Cl, ppm		8		6		17		4	

* Site A and B grain sorghum,
** Site A corn, site B grain sorghum

EVALUATION OF PHOSPHORUS MATERIALS ON CORN

R.E. Lamond and C.B. Godsey

Summary

Mono-ammonium phosphate (MAP), diammonium phosphate (DAP), and several experimental phosphorus (P) fertilizers were compared on a medium P soil with dryland corn as the test crop. All P fertilizers were placed in a band close to the seed row at planting. Grain yields were excellent at this dryland site in 2001 and the application of P on this medium–testing soil increased yields. All P fertilizer materials performed similarly.

Introduction

The availability of new corn hybrids with better ability to tolerate heat and drought has increased yield potentials under dryland conditions. Better hybrids and changes in the farm program have resulted in significant increases in dryland corn acreage in Kansas. This research was initiated to evaluate P fertilizer materials and rates of application on a medium P soil in dryland corn production.

Procedures

Phosphorus rates (0, 20, 40 lb P_2O_5/a) and sources (Exp. 1, Exp. 2, MAP, Exp. MAP, DAP, Exp. DAP) were evaluated on dryland corn in Osage County. All P materials were banded near the seed row at planting. Nitrogen (N) was balanced on all treatments. Whole plant samples were taken at V-6 stage and leaf samples were analyzed for N and P. Grain yields were determined at 15.5% moisture.

Results

Corn grain yields at this dryland site in 2001 were excellent (Table 6). Even though the site had a medium soil P test, the application of P increased grain yields, although not all P treatments resulted in significant yield increases. Early-season (V-6) and tassel N and P concentrations were not affected by P fertilization. All P sources performed similarly at this site.

Results suggest that more P soil test correlation work may be needed with the availability of better dryland corn genetics with higher yield potential. This work will be continued in 2002.

Table 6. Evaluation of P fertilizers on corn, Osage Co., KS, 2001.

P_2O_5 Rate	P Source	V-6 N	V-6 P	Tassel N	Tassel P	Grain Yield
lb/a		- - - - - % - - - - -		- - - - % - - - -		bu/a
0	- - -	3.46	.25	2.90	.28	104
0	Exp. 1	3.47	.26	3.02	.31	142
20	MAP	3.47	.26	2.84	.31	134
40	MAP	3.63	.30	3.00	.30	135
20	Exp. MAP	3.69	.28	3.19	.31	134
40	Exp. MAP	3.66	.29	3.06	.32	146
20	DAP	3.42	.25	2.98	.31	136
40	DAP	3.56	.27	3.01	.30	143
20	Exp. DAP	3.68	.28	2.85	.31	129
40	Exp. DAP	3.65	.27	2.92	.30	129
20	Exp. 2	3.59	.26	2.83	.29	134
40	Exp. 2	3.50	.25	2.90	.29	134
LSD (0.10)		NS	NS	NS	NS	27
Mean Values:						
P	20	3.57	.27	2.94	.31	133
Rate	40	3.60	.28	2.98	.30	138
LSD (0.10)		NS	NS	NS	NS	NS
P	MAP	3.55	.28	2.92	.30	135
Source	Exp. MAP	3.68	.29	3.12	.32	140
	DAP	3.49	.26	3.00	.31	140
	Exp. DAP	3.67	.27	2.89	.31	129
	Exp. 2	3.55	.26	2.87	.29	134
LSD (0.10)		NS	NS	NS	NS	NS

THE EFFECTS OF TILLAGE AND NITROGEN SOURCE ON SOIL ORGANIC MATTER AND RESULTING CORN YIELD

M. Mikha, R.E. Lamond, and C.W. Rice

Summary

Residuals of two different nitrogen (N) sources; solid beef manure and fertilizer (NH_4NO_3); and two different N rates (150 and 75 lb N/a) under two tillage practices (no-tillage (NT) and conservation tillage (CT)), were investigated on a Kennebec silt loam soil (fine silty, mixed, mesic cumulic Hapludoll) at the North Agronomy Farm, Manhattan KS. Corn yield was measured after 5 and 10 years of N application (manure and fertilizer) followed by 7 (R_7) and 2 (R_2) years of no applied N. Relative yield with R_7 treatments was calculated to assess the contribution of residual N to corn yield. Corn yield was significantly ($p < 0.05$) affected by N source (manure vs. fertilizer), N rate (high vs. low), and years of application (R_2 vs.R_7). Corn yield was significantly greater in applied fertilizer compared with residual fertilizer. Corn yield was not significantly different between the two rates of N applied. Relative yield was significantly affected by N source (manure vs. fertilizer). Manure improves soil organic N so that corn yield is sustained even 2 and 7 years after terminating application.

Introduction

In most cropping systems, N is derived from (i) mineralization of soil organic N, (ii) decomposition and mineralization of N returned in crop residues, and (iii) N added as fertilizer or manures. The N availability to the crop is greatly influenced by the degree and type of tillage. Many studies suggested that higher levels of fertilizer N are often required for no-tillage than plowed soils. Previous studies have shown that manure can be more effective in increasing corn yield than fertilizer. Nitrogen mineralization from crop residue and manure can contribute to a crop's N requirement, which may reduce future fertilizer needs.

Procedures

The field experiment was conduced at Kansas State University, North Agronomy Farm, Manhattan Kansas, from 1990 to 2001. The soil is a moderately well drained Kennebec silt loam (fine silty, mixed, mesic cumulic Hapludoll). The experiments were established in 1990 with two tillage treatments, conservation tillage (CT, chisel-disk) and no-tillage (NT); two N-sources (manure and fertilizer) applied at two rates, 75 and 150 lb N/a . In 1995, treatments were split into applied N source and no further N after 5 years of application. The treatments were arranged in a completely randomized split plot design with four replications. In 2000, 10 years after the start of the experiment, the applied N treatments were terminated. The fertilizer treatments were arranged in a completely randomized split-split plot design with four replications. The manure (solid beef manure) and fertilizer (NH_4NO_3) were applied in spring of each year by the time of corn (hybrid Pioneer Brand 3379) planting.

Relative yield for residual treatments (R_7) were calculated by dividing residual N (high manure, high fertilizer and control) by applied fertilizer from 1995 to 2001.

Results

Tillage and manure are two management practices that can affect the level of soil organic matter and thus the supply of nutrients. After 10 years, soil organic C and N were greater with no-tillage and manure (Fig. 1). This increase in organic N should provide a greater source of nutrients. The potential for mineralizable N was significantly greater with manure but was not significantly affected by tillage (Fig 2).

Since soil organic matter and potentially mineralizable N have increased, N supply for corn production should also increase. Thus, after 5 and 10 years fertilizer and manure applications were stopped to determine the N supplying capacity of the soil to support corn production. Across all the treatments (Table 7), corn yield was significantly affected by N source, N rate, and time since previous N application (P #0.05). Corn yield was not significantly affected by tillage. Corn yield was significantly greater with manure compared with fertilizer ($p < 0.05$). Corn yield from the higher N application rate was significantly greater ($p < 0.05$) than the low N rate. Across the residual treatments, high manure had a significantly greater effect on corn yield than fertilizer N (high N and low N). Across all the tillage and N sources, relative yield was significantly affected by N source except for 1997. Relative yield was significantly higher for previous applications of manure compared with fertilizer and no N, especially with no-tillage (Fig. 3A). The effect of manure on relative yield at CT (Fig. 3B) was pronounced only in 3-years through the study period (1995-2001). In general, relative yield decreased from 1995 to 2001, but was still higher than no N for 10 years. This indicates that after 7 years of residual N, the soil was still capable of providing some of the N for the crop. Mineralization can be highly affected by environmental conditions such as soil temperature and moisture. Therefore, using relative yield assesses the contribution of residual N mineralized for plant growth.

Recommended applications of manure increase the levels of soil organic matter and the potential for N supply to a crop. After 5 and 10 years, sufficient N was mineralized from the soil to sustain crop yields equivalent to annual applications of commercial fertilizer. Recommended annual applications of commercial fertilizer is sufficient to support that year's corn production but does not increase soil organic matter. Two years after fertilizers were stopped, the N supply and corn yields were similar to no N application for 10 years. No-tillage enhanced the increase in soil organic matter, and as a result sustained corn yields, particularly in combination with manure. Thus, manure can improve soil nutrient status while improving productivity through slow release of nutrients required (mineralization) for plant growth.

Table 7. Effects of tillage, nitrogen source, and nitrogen application on corn grain yield, Manhattan, KS, 2001.

Tillage Treatment	N Source	N Rate	Yield: Residual$_2$[!]	Residual$_7$[2]	Applied[3]
		lb/a	------------------------------- bu/a		-------------------------
No tillage	Control	0	26	26	------------
	Manure	150	47	42	----------
		75	44	29	----------
	Fertilizer	150	37	30	69
		75	33	27	66
Tillage	Control	0	27	27	----------
	Manure	150	48	41	----------
		75	49	26	----------
	Fertilizer	150	37	34	74
		75	37	26	62

Manure and Fertilizer (Residual$_2$ *vs* Residual$_7$)		Fertilizer (Applied *vs* Residual$_2$ *vs* Residual$_7$)	
Tillage*Application*N Source*N Rate	NS		
Tillage*Application*N Rate	NS	Tillage*Application*N Rate	NS
Tillage	NS		NS
<u>Mean Values:</u>			
No tillage	36		44
Conventional Tillage	38		45
Application	0.04*		0.0001*
<u>Mean Values:</u>			
Applied	-----		68 a
Residual$_2$	42 a		36 b
Residual$_7$	33 b		29 b
N Source	0.0001*		--------
<u>Mean Values:</u>			
Manure	42 a		--------
Fertilizer	33 b		--------
No nitrogen	26 c		--------
N Rate	0.027*		NS
<u>Mean Values:</u>			
High rate	39 a		47
Low rate	35 b		42
<u>Mean Values</u>			
High manure	44 a		-------
Low manure	39 ab		--------
High fertilizer	35 bc		71
Low fertilizer	31 c		64

* Significant at $P<0.05$ NS = Not significant
[1] Represents 2 years of residual N
[2] Represents 7 years of residual N
[3] Represents 10 years of continuous applied N
High rate (150 lb N/a) Low rate (75 N lb/a)
No letter indicates no significant differences

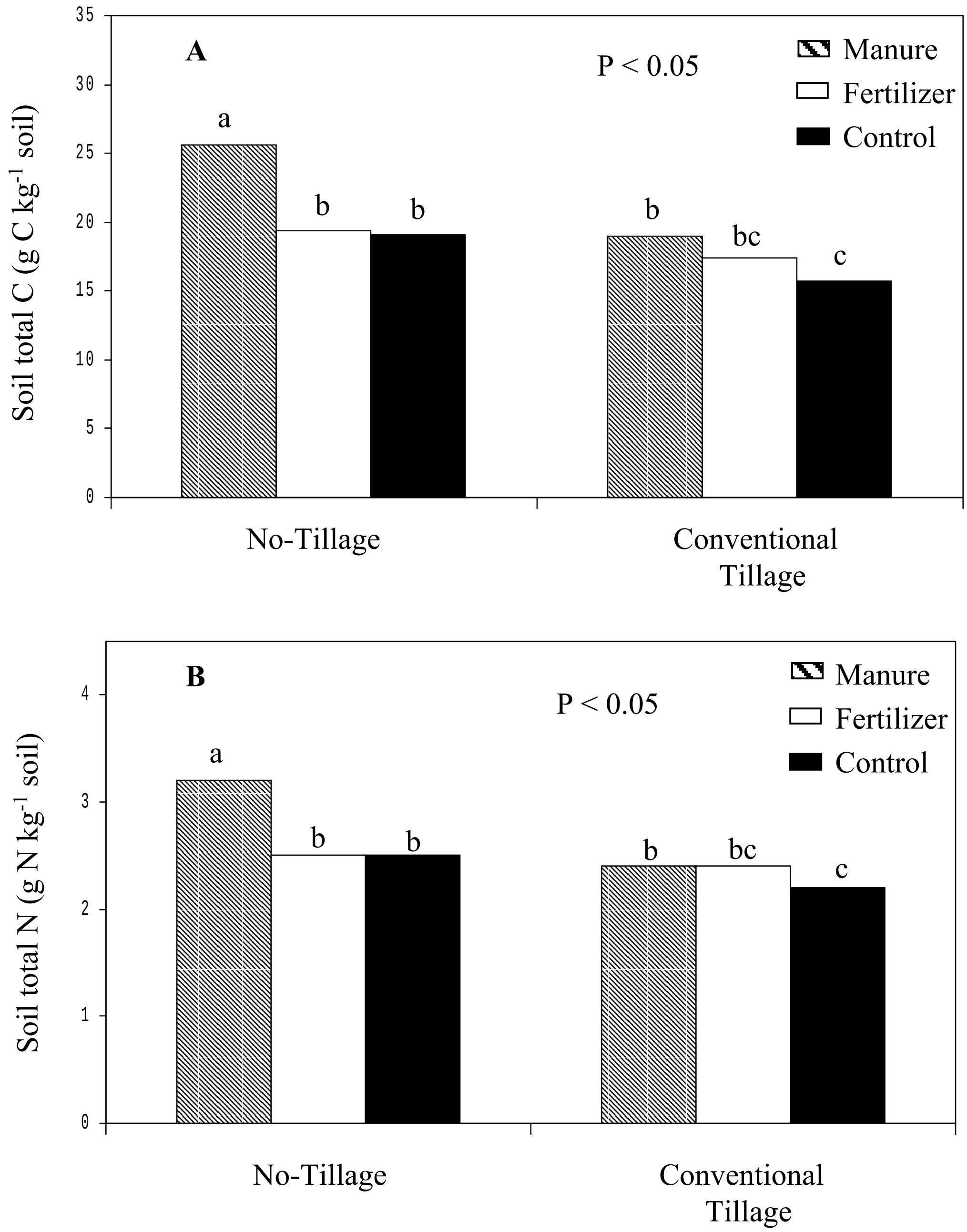

Figure 1: Soil total C and N. A represents soil total C; and B represents soil total N

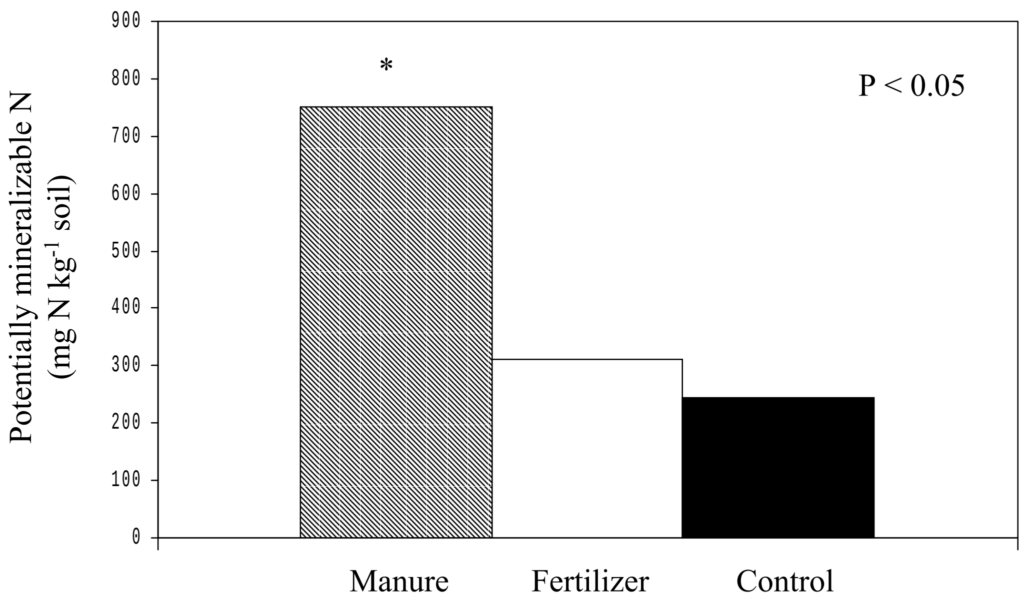

Figure 2: Potentially mineralizable N.

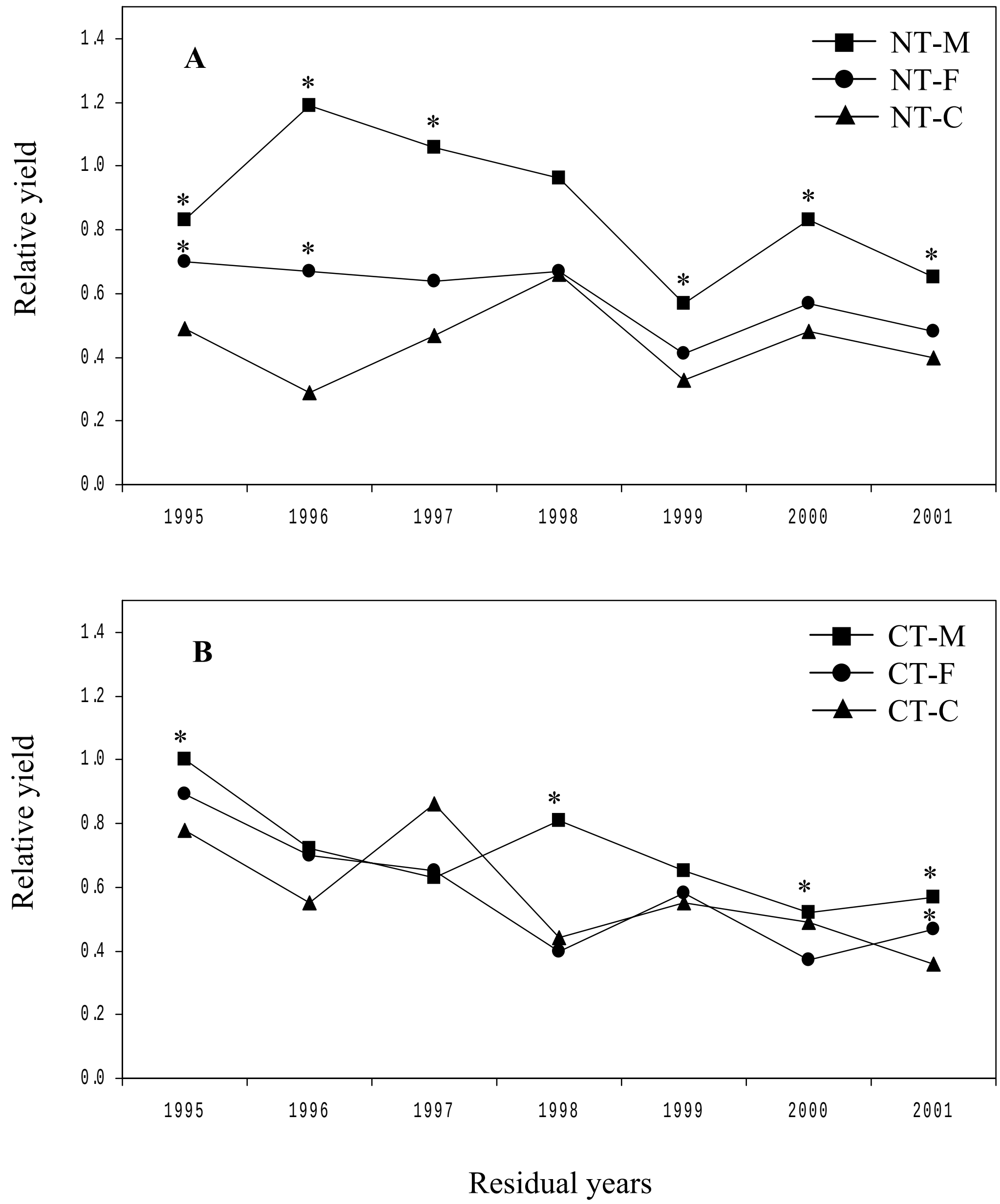

Figure 3: Residual corn yield after 5 years of N application.
A represents no-tillage treatments; B represents conventional tillage treatments
* Significantly different ($p < 0.05$)

EFFECTS OF LIME APPLICATION ON 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 initial 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 from lime application in these no-tillage systems. Movement of the lime may have been limited by lack of precipitation. Soybean grain yields also 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. Past research has shown that surface applied N in no-tillage systems often leads to a decrease in soil pH, which in turn leads to elevated Al concentrations in the soil. In the past, most lime recommendations and lime application research have focused on thorough incorporation of the 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 were established. These included four rates of Ag Lime (0, 1000, 1000 annually for four years, 2000, and 4000 lb ECC Ag lime/a); and one rate of Pell-Lime (1000 and 1000 annually for four years lb ECC Pell-Lime/a). All treatments were one-time applications except the two treatments indicated above that will be applied annually for four years. Applications were first 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 2001 at one inch increments to a depth of six inches and analyzed for pH. Soybean was harvested from each site in 2001.

Results

Soil pH from samples collected in 2001 from Site A and B are listed in Table 8 and 9. Selected contrasts indicated lime application significantly increased soil pH in the top inch of soil at both sites (Pr>F = 0.01 for site A, Pr>F = 0.06 for site B). Specifically, soil pH increased by an average of 0.4 at both sites with the addition of lime. The only treatment difference observed was at site A. Soil pH increased significantly in the top inch with the addition of 2000 and 4000 lb ECC Ag Lime/a when compared to the other treatments at site A (Table 8 and 9). The neutralizing capability and movement of the lime may have been limited by the lack of precipitation during 2000 and 2001.

Grain yield was calculated for 2000 and 2001 (Table 10). In 2001, yields were below normal because of 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.

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

Table 8. Observed soil pH at Site A, Spring 2001.

	Treatments							
		Ag Lime (lb ECC/a)				Pell-Lime (lb ECC/a)		
Depth	Control	1000	1000 (ann.- 4 yrs)	2000	4000	1000	1000 (ann. - 4 yrs)	LSD (0.10)
- in -	pH							
0-1	5.7	5.9	6.1	6.3	6.3	6.0	6.0	0.2
1-2	5.9	5.9	6.0	6.0	6.0	5.9	6.0	NS
2-3	6.0	5.9	6.0	6.0	6.0	5.9	6.0	NS
3-4	6.0	6.0	6.0	6.0	5.9	5.9	5.9	NS
4-5	6.0	6.0	6.0	6.0	6.0	5.9	6.0	NS
5-6	6.1	6.0	6.1	6.1	6.2	6.0	6.1	NS

Table 9. Observed soil pH at Site B, Spring 2001.

	Treatments							
		Ag Lime (lb ECC/a)				Pell-Lime (lb ECC/a)		
Depth	Control	1000	1000 (ann.- 4 yrs)	2000	4000	1000	1000 (ann. - 4 yrs)	LSD (0.10)
- in -	pH							
0-1	5.4	5.6	5.5	5.8	5.9	5.8	5.8	NS
1-2	5.3	5.2	5.1	5.2	5.3	5.2	5.2	NS
2-3	5.2	5.0	5.1	5.1	5.2	5.1	5.1	NS
3-4	5.2	5.0	5.1	5.2	5.2	5.1	5.1	NS
4-5	5.3	5.1	5.3	5.3	5.2	5.1	5.1	NS
5-6	5.3	5.4	5.4	5.4	5.3	5.3	5.3	NS

Table 10. Grain yield in 2000 and 2001.

Treatment	2000 Site A	2000 Site B*	2001 Site A	2001 Site B
	- - - - - - - - - - - -	bu/a	- - - - - - - - - - - -	
0	19	126	4	19
1000 ECC (1-time) Ag Lime	24	115	4	20
1000 ECC (1-time) Pell-Lime	20	124	5	19
1000 ECC Ag Lime annually for 4 years	26	136	5	19
1000 ECC Pell-Lime annually for 4 years	20	121	5	19
2000 ECC (1-time)	22	128	4	19
4000 ECC (1-time)	28	127	3	19
LSD (0.10)	NS	NS	NS	NS

*All grain yields are for soybean except for Site B in 2000, where sorghum was the crop harvested.

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