KANSAS FERTILIZER RESEARCH 2003

Report of Progress 921

Kansas State University
Agricultural Experiment Station
and Cooperative Extension Service

INTRODUCTION

The 2003 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 Kansas 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 various firms who contributed time, effort, land, machinery, materials, and laboratory analyses. Without their support, much of the work reported here would not have been possible.

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Cover photo provided by Chad Godsey, KSU Soil Testing Laboratory

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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)

2002	Manhattan	S.W. KS RES-EXT. CTR Tribune	S.E. KS EXP. STA. Parsons	E. CEN EXP. FLD. Ottawa	HARVY CTY EXP. FLD Hesston S
August	2.93	1.43	3.22	1.93	2.50
September	3.03	1.30	3.62	1.20	1.75
October	5.59	3.59	1.36	4.61	6.62
November	0.39	0.11	0.50	0.31	0.41
December	0.01	0.07	1.36	0.07	0.50
Total 2002	27.45	10.01	34.23	28.46	30.36
Dept. Normal	-6.37	-5.95	-5.79	-10.75	-2.56
2003					
January	0.30	0.07	0.30	0.36	0.09
February	1.10	0.73	1.49	2.36	1.41
March	1.67	1.19	3.89	1.01	2.98
April	4.24	1.44	4.82	4.29	4.47
May	2.77	3.35	5.40	4.09	4.76
June	7.85	6.25	4.78	5.40	2.85
July	2.60	0.60	2.39	1.38	0.55
August	5.03	1.08	6.23	5.14	4.78
September	3.22	0.92	3.51	7.44	4.55

2002	N. CEN EXP. FLD. Belleville	KANSAS RV VALLEY EXP. FLD.	S. CEN. EXP. FLD. Hutchinson	FT. HAYS EXP. STN. Hays
August	2.58	3.26	6.04	4.02
September	1.33	1.59	0.83	1.32
October	5.33	3.65	6.62	3.03
November	0.14	0.15	0.38	0.07
December	0.01	0.05	0.68	0.03
Total 2002	19.94	20.39	30.87	17.43
Dept. Normal	-10.95	-17.65	0.55	-5.20
2003				
January	0.26	0.52	0.04	0.01
February	0.98	1.02	1.51	0.42
March	1.46	0.78	4.51	2.19
April	2.73	4.86	3.55	3.74
May	3.44	2.38	3.50	2.31
June	8.61	2.96	3.21	4.50
July	0.27	0.52	0.50	0.01
August	5.71	6.17	5.15	2.99
September	6.70	1.95	1.83	6.46

WHEAT FERTILIZATION STUDIES
KANSAS STATE UNIVERSITY - DEPARTMENT OF AGRONOMY

EFFECTS OF PHOSPHORUS SOURCES ON WINTER WHEAT

D.F. Leikam, J.R. Massey, J.C. Herman, and R.E. Lamond

Summary

The results of this study suggest differences in performance among several phosphorus (P) sources that were evaluated for wheat production. While these differences were not significant at the commonly used 5 or 10% confidence levels, they were significant at the 14% level. Similar studies will be conducted on the 2004 wheat crop.

Introduction

Common Kansas fertilizer sources of P includes diammonium phosphate (DAP, 18-46-0), monoammonium phosphate (MAP, 11-52-0) and liquid ammonium polyphosphate (APP, 10-34-0). Results from previous research have shown these fertilizers to be equally effective on soils deficient in phosphorus. Fertilizer manufacturers continually evaluate new products for agronomic effectiveness, better physical characteristics, and/or improved manufacturing processes. Four experimental products from Cargill were evaluated for agronomic performance in winter wheat production.

Procedures

This study was conducted at a single location in Osage County. Soil samples from the surface six inches indicated 19 ppm Bray P-1, a soil pH of 6.8, soil organic matter content of 2.9% and available sulfate-S level of 9 ppm.

Four experimental fertilizer materials were evaluated. These products varied in nitrogen (N), phosphorus (P), and sulfur (S) content and were applied at rates providing 30 lb P_2O_5/a. Common MAP was used as a check treatment and included at rates of 30 and 60 lb P_2O_5/a, both with and without additional ammonium sulfate as a sulfur source. Preplant N applications were balanced at 23 lb N/a as urea for all treatments. All fertilizer was applied after soybean harvest on November 25, 2002, and incorporated. Wheat was seeded on November 27, 2002.

Results

The results are summarized in Table 1. Wheat yields from two of the experimental materials (S15 and ACT 32) tended to be higher than others, including MAP, at P application rates of 30 lb P_2O_5/a. The other two materials (ACT 31B and ACT 29) performed similarly to MAP at equal P application rates. MAP applied at a rate of 60 lb P_2O_5/a produced similar results to S15 and ACT 32 at 30 lb P_2O_5/a. While these differences were not statistically significant at the 10% level, they were significantly different at the 14% level.

Leaf tissue P content was similar for all P fertilizer products applied alone. Interestingly, including ammonium sulfate at a rate of 13 lb S/a with MAP increased leaf tissue P content as compared to MAP alone.

While the results of this study indicate potential differences among various P sources, more studies are needed to evaluate these materials. Additional studies on wheat will be conducted in Kansas for the 2004 crop, while studies on additional crops will be conducted in other states.

Table 1. Phosphorus source effects on wheat grain yield and p uptake, Osage Co. KS, 2003.

Product(s)	N	P_2O_5	S	Yield	Grain P_2O_5	Leaf P
	- - - - - - - - -	lb/a - - - - - - - -		bu/a	- - - - - - %	- - - - - - -
Check	23	0	0	51.4	0.39	0.36
S15	23	30	13	62.6	0.44	0.38
ACT 32	23	30	9	65.2	0.48	0.39
ACT 31B	23	30	8	54.2	0.42	0.36
ACT 29	23	30	0	55.0	0.49	0.38
MAP	23	30	0	54.0	0.49	0.39
MAP + Amm. Sul.	23	30	13	58.6	0.43	0.43
MAP	23	60	0	65.2	0.45	0.39
MAP + Amm. Sul.	23	60	13	61.0	0.40	0.43
LSD (0.05)				NS	0.04	NS
Significance Level				0.14	0.01	--

GRASS FERTILIZATION STUDIES
KANSAS STATE UNIVERSITY - DEPARTMENT OF AGRONOMY

BROMEGRASS FERTILIZATION STUDIES

R.E. Lamond, H.C. George, D.V. Key, and C.B. Godsey

Summary

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

Introduction

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

Procedures

<u>Miami County</u>

Studies were initiated in 2003 at three sites in Miami County to evaluate N, P, K, and S fertilization. Sites were low to medium in P and K. At two sites, a variable time of P application was evaluated, with P applied either in September or February. All N, K and S were topdressed in February. The bromegrass was harvested in late May at all sites. Forage samples were retained for analyses.

<u>Nemaha County</u>

A study was initiated to evaluate time of N application, N source, and P and S fertilization on brome. Urea or ammonium nitrate were applied in either November or April, with and without P. A split N application was also evaluated. The study was harvested in early June and forage samples retained for protein analysis.

Results

<u>Miami County</u>

The 2003 results are summarized in Tables 1 and 2. Forage yields were average to good at all locations, and yields were consistently increased by N application at all sites. Nitrogen fertilization also significantly increased forage protein levels. Phosphorus fertilization increased brome forage yields, particularly at sites with low soil P tests. Although P applied in September tended to produce slightly higher yields than February application, the differences were not statistically significant. At the sites with soil P levels less than 10 ppm, the addition of 30 lbs P_2O_5/a produced an additional 1070 lb/a of forage. On soils with low P levels, the inclusion of phosphorus in the fertilization program is essential for optimum forage production.

The addition of S fertilizer produced an additional 1200 lb/a of forage. 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 (less than 10 ppm).

<u>Nemaha County</u>

The 2003 results of this work are summarized in Table 3. An excellent response to N was noted, however time of N application had minimal impact on yield. In general, N applied in April produced higher forage protein than N applied in November. Phosphorus fertilization had little effect on forage yield, but this was not unexpected with the 19 ppm P soil test. These studies will be continued in 2004.

Table 1. Nutrient management on bromegrass, Miami Co., KS, 2003.

					Forage					
				Time of P	South			North		
N	P	K	S[1]	Application	Yield	Prot.	P	Yield	Prot.	P
- - - - - lb/a - - - - -					lb/a	- - - % - - -		lb/a	- - - % - - -	
0	0	0	0	---	2610	9.9	.12	2300	9.1	.21
0	30	0	0	Sept.	3140	10.6	.19	2650	9.8	.26
0	30	0	0	Feb.	3320	10.3	.19	2550	9.8	.25
45	0	0	0	---	2720	12.8	.13	4520	10.4	.21
45	30	0	0	Sept.	5210	11.6	.17	5690	10.1	.23
45	30	0	0	Feb.	4540	11.6	.20	5220	9.6	.24
90	0	0	0	---	3720	14.1	.14	6140	13.6	.23
90	30	0	0	Sept.	5880	14.2	.20	6610	12.7	.22
90	30	0	0	Feb.	5320	14.1	.20	6790	11.8	.26
90	30	30	0	Feb.	6050	12.6	.19	6630	11.0	.26
90	30	0	10	Feb.	6520	12.9	.18	6470	11.8	.26
90	30	30	10	Feb.	5860	13.4	.18	6210	11.7	.26
LSD (0.10)					920	2.2	.03	930	1.5	.04
Mean Values										
N	0				3020	10.3	.17	2500	9.6	.24
Rate	45				4160	12.0	.17	5140	10.1	.23
lb/ac	90				4970	14.1	.18	6510	12.7	.24
LSD (0.10)					570	1.4	NS	430	0.9	NS
P Rate	0			---	3020	12.3	.13	4320	11.1	.22
lb/ac	30			Sept.	4740	12.1	.19	4980	10.9	.24
	30			Feb.	4390	12.1	.20	4850	10.4	.25
LSD (0.10)					570	NS	.02	430	NS	.03
Bray P-1 Soil Test, ppm					3			9		

[1] All N, K, S applied in February.

Table 2. Nitrogen, phosphorus, potassium and sulfur on bromegrass, Miami Co., KS, 2003.

				East			
				Forage			
N	P	K	S	Yield	Prot.	P	K
				lb/a	- - - - - - - - % - - - - - - - -		
0	0	0	0	2380	8.6	.24	1.87
90	0	0	0	7730	9.8	.23	1.62
90	30	0	0	7500	10.5	.26	1.62
90	0	30	0	6500	10.4	.23	1.96
90	30	30	0	7950	10.2	.24	1.89
90	30	30	10	7120	10.7	.25	1.85
90	30	60	10	7240	10.8	.24	1.93
	LSD (.10)			1070	1.3	NS	.20
Soil Test P, K (ppm)				P (25 ppm)		K (122 ppm)	

Table 3. Nutrient management on bromegrass, Nemaha Co., KS, 2003.

N	P_2O_5	S	Time of N Application	Time of P Application	Time of S Application	Forage Yield	Forage Prot.
	lb/a					lb/a	%
0	0	0	--	--	--	3470	6.3
8.5	40	0	Sept.	Sept.	--	4020	7.0
0	0	10	--	--	Sept.	5310	6.5
90	0	0	Nov. (Urea)	--	--	7540	7.3
90	0	0	Nov. (Am. Nit.)	--	--	8890	7.1
90	0	0	Apr. (Urea)	--	--	8410	9.9
90	0	0	Apr. (Am. Nit.)	--	--	9150	8.7
98.5	40	0	Nov. (Urea)	Sept.	--	8250	7.2
98.5	40	10	Nov. (Urea)	Sept.	Sept.	8130	7.2
98.5	40	0	Nov. (Am. Nit.)	Sept.	--	8150	8.6
98.5	40	10	Nov. (Am. Nit.)	Sept.	Sept.	8440	7.9
90	0	0	30 Sept, 60 Nov. (Urea)	--	--	8800	6.7
90	0	0	30 Sept, 60 Nov. (Am. Nit.)	--	--	9380	7.3
98.5	40	0	30 Sept, 60 Nov. (Urea)	Sept.	--	8240	6.7
98.5	40	0	30 Sept, 60 Nov. (Am. Nit.)	Sept.	--	9040	7.9
98.5	40	0	Apr. (Urea)	Apr.	--	9100	8.1
98.5	40	0	Apr. (Am. Nit.)	Apr.	--	8900	9.7
LSD (.10)						1270	1.4
Bray P-1 Soil Test, ppm						19	

SOIL FERTILITY RESEARCH
SOUTHWEST RESEARCH - EXTENSION CENTER

NITROGEN AND PHOSPHORUS FERTILIZATION OF IRRIGATED CORN

A.J. Schlegel

Summary

Long-term research shows that phosphorus (P) and nitrogen (N) fertilizer must be applied to optimize production of irrigated corn in western Kansas. In 2003, N and P applied alone increased yields about 60 and 15 bu/a, respectively; however when applied together yields increased up to 120 bu/a. Averaged across the past 10 years, corn yields were increased more than 100 bu/a by N and P fertilization. Application of 80 lb N/a (with P) was sufficient to produce >90% of maximum yield in 2003, this was less than the 10-year average of 120 lb N/a. Phosphorus increased corn yields up to 70 bu/a when applied with at least 120 lb N/a. Application of 80 lb P_2O_5/a increased yields 4 to 7 bu/a compared to 40 lb P_2O_5/a when applied with at least 120 lb N/a.

Introduction

This study was initiated in 1961 to determine responses of continuous corn and grain sorghum grown under flood irrigation to N, P, and K fertilization. The study was 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 was discontinued in 1992 and replaced with a higher P rate.

Procedures

Initial fertilizer treatments in 1961 were N rates of 0, 40, 80, 120, 160, and 200 lb N/a without P and K; with 40 lb P_2O_5/a and zero K; and with 40 lb P_2O_5/a and 40 lb K_2O/a. In 1992, the treatments were changed, with the K variable being replaced by a higher rate of P (80 lb P_2O_5/a). All fertilizers were broadcast by hand in the spring and incorporated before planting. The soil is a Ulysses silt loam. The corn hybrid was Pioneer 3379 (1992-94), Pioneer 3225 (1995-97), Pioneer 3395IR (1998), Pioneer 33A14 (2000), Pioneer 33R93 (2001 and 2002), and Dekalb C60-12 (2003) planted at about 32,000 seeds/a in late April or early May. Hail damaged the 2002 crop and destroyed the 1999 crop. The corn was irrigated to minimize water stress. Furrow irrigation was used through 2000 and sprinkler irrigation since 2001. The center two rows of each plot were machine harvested after physiological maturity. Grain yields were adjusted to 15.5% moisture.

Results

Corn yields in 2003 were higher than the 10-year average (Table 1). Nitrogen alone increased yields up to 62 bu/a while P alone increased yields about 15 bu/a. However, N and P applied together increased corn yields up to 120 bu/a. Only 80 lb N/a was required to obtain more than 90% of maximum yields compared to the 10-year average of 120 lb N/a. Since the 2002 crop was damaged by hail, residual N may have contributed to the higher yields at lower N rates in 2003. Corn yields were 3 bu/a greater with 80 than with 40 lb P_2O_5/a, compared to the 10-year average of 5 bu/a.

Table 1. Effect of nitrogen and phosphorus fertilizers on irrigated corn, Tribune, KS, 1994-2003.

		Grain Yield									
Nitrogen	P_2O_5	1994	1995	1996	1997	1998*	2000	2001	2002	2003	Mean
- - - - lb/a - - - -		- bu/a -									
0	0	47	22	58	66	49	131	54	39	79	60
0	40	43	27	64	79	55	152	43	43	95	67
0	80	48	26	73	83	55	153	48	44	93	69
40	0	66	34	87	86	76	150	71	47	107	80
40	40	104	68	111	111	107	195	127	69	147	115
40	80	105	65	106	114	95	202	129	76	150	116
80	0	66	34	95	130	95	149	75	53	122	91
80	40	129	94	164	153	155	205	169	81	188	149
80	80	127	93	159	155	149	211	182	84	186	150
120	0	70	39	97	105	92	143	56	50	122	86
120	40	147	100	185	173	180	204	177	78	194	160
120	80	154	111	183	162	179	224	191	85	200	165
160	0	78	44	103	108	101	154	76	50	127	93
160	40	162	103	185	169	186	203	186	80	190	163
160	80	167	100	195	187	185	214	188	85	197	169
200	0	80	62	110	110	130	165	130	67	141	110
200	40	171	106	180	185	188	207	177	79	197	166
200	80	174	109	190	193	197	218	194	95	201	174
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	0.007	0.001	0.001
N x P		0.001	0.001	0.001	0.001	0.001	0.008	0.001	0.133	0.001	0.001
MEANS											
N, lb/a	0	46	25	65	76	53	145	48	42	89	66
	40	92	56	102	104	93	182	109	64	135	104
	80	107	74	139	146	133	188	142	73	165	130
	120	124	83	155	147	150	190	142	71	172	137
	160	136	82	161	155	157	190	150	71	172	142
	200	142	92	160	163	172	197	167	80	180	150
	LSD 0.05	13	7	10	12	11	10	15	8	9	6
P_2O_5, lb/a	0	68	39	92	101	91	149	77	51	116	87
	40	126	83	148	145	145	194	147	72	168	136
	80	129	84	151	149	143	204	155	78	171	141
	LSD 0.05	9	5	7	9	7	7	10	6	6	4

*Note: There was no yield data for 1999 because of hail damage. Hail reduced yields in 2002.

SOIL FERTILITY RESEARCH
AGRICULTURAL RESEARCH CENTER - HAYS

LONG-TERM EFFECTS OF TILLAGE SYSTEMS AND NITROGEN FERTILIZER IN A WHEAT-SORGHUM-FALLOW CROP ROTATION

C.A. Thompson

Summary

Average sorghum yields (1975-2002) from a wheat-sorghum-fallow (WSF) rotation under clean-till (CT) and reduced-till (RT) systems were significantly higher than yields from no-till (NT). Because CT soils tend to have more erosion and the yield difference between CT and RT was nonsignificant, RT is recommended on this nearly level Harney silt loam soil. Furthermore, on a year by year basis, sorghum yields on RT tended to be consistently higher than CT or NT systems. On a year by year basis (1975-2003) wheat yields from a wheat-sorghum-fallow rotation under CT soils were consistently higher than RT and NT soils. This was also true on the 29-year average. Because the average yield difference between CT and RT was only 0.6 bu/a and the soil erosion potential on CT is higher than RT, the RT system is recommended on this nearly level soil.

Both crops responded well to each increasing nitrogen (N) fertilizer rate applied. Over the years, sorghum and wheat yields from 60 lb N/a were significantly higher than from lower N rates. This implies that 60 lb N/a may not have been high enough to maximize yields. The highest yield difference between N rates was with the first 20 lb N/a.

Introduction

Farmers strive to be good stewards of the land while attempting to reap financial rewards. The two can go hand in hand and stewardship is a must for the future of the agricultural community and of the nation. The cost/price squeeze has forced most farmers to become better managers of their farming enterprise. The results of this long-term study should aid farmers to alter their management program in choosing the optimum tillage system and rate of nitrogen fertilizer to apply on wheat and sorghum on high fertility, nearly level silt loam soils.

Procedures

This paper reports the findings from 1975 when nitrogen rates were changed to 0, 20, 40, and 60 lb N/a. Nitrogen fertilizer (using ammonium nitrate) was broadcast applied in the previous fall for June sorghum planting and in August before September wheat planting. In this wheat-sorghum-fallow (WSF) rotation each phase of the cropping system was included each year.

Tillage plots were 67 X 100 feet and each fertilizer treatment was 11 X 67 feet. Tillage systems were CT, RT, and NT. The study was established on a nearly level high fertility Harney silt loam soil. Each of the 12 treatments was included in every phase of the crop rotation each year.

CT plots employed residue-incorporating tillage tools (disc, one-way, mulch treader). RT plots used residue-saving tillage tools (V-blade, sweeps, rod-weeder). Three to four tillage operations were performed between harvest and planting on CT and RT systems. Only herbicides were used on NT plots throughout the duration of the study. To accomplish effective weed control, herbicide selection remained flexible. The primary sorghum herbicides for all tillage systems included propazine, atrazine, cyanazine, and metolachlor applied at labeled rates. Herbicides for wheat included chlorsulfuron and 2,4-D. In addition NT plots during the fallow period received contact (paraquat) or translocated (glyphosate + 2,4-D) herbicides. Herbicides and tillage operations were performed in a timely fashion in all tillage systems. This resulted in adequate weed control in the CT and RT systems. Despite multiple herbicide applications during the fallow period, weed control in the NT plots was poor (less than 50% control) because of the persistence of the two perennial grasses, tumblegrass [Schedonnardus paniculltus (Nutt.) Trel.] and tumber windmillgrass (Chloris verticillata Nutt.). These two weeds are a common problem in this geographical area.

This study used adapted wheat varieties and sorghum hybrids. Row spacing for both crops was 12 inches. Crops were harvested by hand (80 sq ft/subplot) from 1975 to 1985, and with a plot combine (600 sq ft/subplot) from 1986 to 2003. Data were analyzed with the statistical software package SAS. ANOVA was used to determine treatment differences (P<.05).

Results

Although average differences between tillage systems were insignificant, sorghum yields (1975-2002) favored CT and RT systems over NT (Table 1). This yield difference becomes more important when the increased input costs on NT are considered. Because CT soils tend to have more erosion and average yield differences between CT and RT was insignificant, RT is the recommended tillage system for this nearly level Harney silt loam soil. On a year by year basis, sorghum yields on RT tended to be consistently higher than CT or NT systems.

Yearly (1975-2003) wheat yields from CT soils were consistently higher than RT and NT soils. This was also true of the 29-year average (Table 2). Because the average yield difference between CT and RT was only 0.6 bu/a and the soil erosion potential on CT is higher than RT, the RT system is recommended on this nearly level soil.

Grain sorghum and winter wheat responded well to each increasing N fertilizer rate applied. Over the years, sorghum and wheat yields from 60 lb N/a were significantly higher than with lower N rates. This implies that 60 lb N/a may not have been high enough to maximize yields. Yield difference between N rates was highest with the first 20 lb N/a. Therefore, the return per fertilizer dollar input was highest for both crops with 20 lb N/a.

Fewer years showed an interaction between tillage systems and nitrogen fertilizer rates on sorghum than on wheat. This was not surprising because wheat not only goes through a longer growing season, but experiences more changes in weather conditions than sorghum.

Table 1. Effects of tillage system and nitrogen fertilizer on grain sorghum yields in a wheat-sorghum-fallow crop rotation on a nearly level Harney silt loam soil, KSU Agricultural Research Center-Hays, KS, 1975 to 2003.

Tillage System	N Rate[1]	Yield 1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
	lb/a	bu/a														
Clean-till	0	45.3	47.7	63.1	47.5	57.7	43.1	72.0	51.1	12.0	23.6	84.4	98.1	62.8	65.9	26.3
	20	45.5	50.5	76.0	52.6	59.7	45.9	84.0	69.1	18.5	28.6	107.3	101.4	65.3	72.0	43.0
	40	49.3	49.1	82.2	45.7	64.6	53.2	95.1	66.8	20.1	30.2	118.1	104.9	71.3	72.8	47.4
	60	53.0	55.6	83.4	46.4	63.3	52.6	111.0	65.0	20.5	30.5	93.3	112.9	74.7	78.3	47.0
Reduced-till	0	46.6	43.3	68.6	52.4	59.1	41.2	72.2	66.0	15.4	28.3	71.8	84.7	63.6	60.8	35.9
	20	50.7	53.9	78.1	48.5	66.7	43.9	83.5	72.9	20.1	29.3	103.3	101.5	73.3	64.0	45.7
	40	57.0	53.9	90.1	47.6	77.7	47.1	107.9	69.1	17.1	30.7	119.9	105.5	79.1	75.3	49.9
	60	56.6	52.2	86.7	49.2	74.8	47.4	114.3	65.8	25.3	31.9	103.5	112.4	83.5	74.4	46.4
No-till	0	38.0	49.3	65.4	38.2	48.7	19.2	80.0	64.2	14.4	18,7	65.0	97.2	52.9	63.1	45.0
	20	38.6	53.3	78.5	36.6	56.6	30.0	88.6	75.7	12.9	24.7	105.1	101.4	55.2	71.3	58.5
	40	45.9	62.3	87.8	33.8	67.2	37.6	101.6	71.2	13.5	25.3	114.9	110.6	55.8	80.4	58.5
	60	55.6	54.9	85.7	33.4	71.8	42.0	110.4	71.0	14.4	26.7	124.3	102.5	56.6	87.1	56.0
Tillage System Averages																
Clean-till		48.3	50.7	76.2	48.1	61.3	48.7	90.5	63.0	17.8	28.2	100.8	104.3	68.5	72.2	40.9
Reduced-till		52.7	50.8	80.9	49.4	69.6	44.9	94.5	68.4	19.5	30.0	99.6	101.0	74.9	68.6	44.4
No-till		44.5	54.9	79.4	35.5	61.1	32.2	95.1	70.7	13.8	23.8	102.3	102.9	55.1	75.5	54.5
Nitrogen Rate Averages																
	0	43.3	46.7	65.7	46.0	55.1	34.5	74.7	60.4	13.9	23.5	73.7	93.4	59.7	63.3	35.7
	20	44.9	52.5	77.5	45.9	61.0	39.9	85.4	72.6	17.2	27.5	105.2	101.4	64.6	69.1	49.0
	40	50.7	55.1	86.7	42.3	69.8	46.0	101.5	69.2	16.9	28.7	117.6	107.0	68.7	76.1	51.9
	60	55.0	54.2	85.3	43.0	70.0	47.3	111.9	67.3	20.1	29.7	107.0	109.3	71.6	79.9	49.8
LSD (P<.05)																
Tillage		NS	NS	NS	5.4	4.6	4.3	NS	6.3	0.8	1.6	NS	NS	2.4	3.6	5.2
Nitrogen Rate		7.8	NS	4.9	NS	5.3	4.9	5.2	7.3	1.0	1.9	17.7	8.7	2.8	4.2	6.0
T x N		NS	NS	NS	NS	NS	NS	NS	NS	1.7	NS	NS	NS	4.8	NS	NS

[1] Nitrogen as ammonium nitrate (34-0-0).

Table 1. (con't.) Effects of tillage system and nitrogen fertilizer on grain sorghum yields in a wheat-sorghum-fallow crop rotation on a nearly level Harney silt loam soil, KSU Agricultural Research Center-Hays, KS, 1975 to 2003 .

Tillage	N	Yield													28-Yr
System	Rate[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Avg.
	lb/a	bu/a													bu/a
Clean-till	0	52.5	43.9	84.6	38.0	44.0	41.6	68.7	56.7	45.6	60.5	44.8	72.9	61.7	54.1
	20	60.0	42.4	96.2	53.0	48.1	52.1	84.9	68.3	65.6	85.2	51.1	75.3	84.5	63.8
	40	51.4	46.0	104.7	57.0	53.2	66.8	89.2	73.8	79.9	92.3	56.2	77.4	80.6	68.2
	60	57.7	53.2	108.8	72.0	57.7	66.0	93.3	77.8	85.3	98.8	60.5	83.2	78.2	70.7
Reduced-till	0	48.0	43.8	85.6	24.7	36.6	36.1	67.5	46.1	41.8	59.7	47.4	70.4	65.8	52.9
	20	59.6	44.3	94.8	30.4	45.7	45.3	82.0	61.4	60.5	93.6	50.0	68.7	89.3	62.5
	40	67.1	53.9	103.8	39.8	56.7	51.9	94.5	71.3	70.7	92.4	55.0	69.6	96.8	69.7
	60	65.1	54.2	104.5	52.3	59.5	60.3	102.4	75.5	81.8	95.9	59.9	70.5	93.3	71.4
No-till	0	38.5	39.3	65.4	37.5	27.1	37.1	64.6	34.2	60.8	75.4	35.4	57.4	61.2	49.7
	20	51.9	43.7	80.0	49.8	39.6	52.7	85.6	55.4	79.3	89.4	51.1	56.5	75.8	60.6
	40	55.1	49.7	91.0	53.6	49.2	53.8	100.7	70.7	85.7	93.6	55.2	66.1	82.3	66.9
	60	60.5	49.9	93.0	63.9	63.8	62.4	107.1	80.9	84.3	99.9	60.2	66.8	90.5	70.5
Tillage System Averages															
Clean-till		57.9	46.4	98.6	55.0	50.8	56.6	84.0	69.2	69.1	84.2	53.1	77.2	76.2	64.2
Reduced-till		60.0	49.1	97.2	36.8	49.6	48.4	86.6	63.6	63.7	82.9	53.1	69.8	86.3	64.1
No-till		51.5	45.6	82.3	51.2	44.9	51.5	89.5	60.3	77.5	89.6	50.5	61.7	77.4	62.0
Nitrogen Rate Averages															
	0	46.3	42.3	78.5	33.4	35.9	38.3	66.9	45.6	49.4	65.2	42.5	66.9	62.9	52.3
	20	47.2	43.5	90.3	44.8	44.5	50.0	84.1	61.7	68.5	86.1	50.7	66.8	83.2	62.3
	40	61.2	49.8	99.8	50.1	53.0	57.5	94.8	72.0	78.8	92.7	55.5	71.0	86.6	68.3
	60	61.1	52.4	102.1	62.8	60.3	62.9	100.9	78.1	83.8	98.2	60.2	73.5	87.3	70.9
LSD (P<.05)															
Tillage		2.7	1.3	4.9	4.2	0.8	1.3	0.9	3.3	2.3	4.6	NS	1.7	6.2	1.1
Nitrogen Rate		3.1	1.5	5.6	4.9	0.9	1.4	1.0	3.9	2.6	5.3	5.0	1.9	7.1	1.3
T x N		5.3	2.6	NS	NS	1.5	2.5	1.7	6.7	4.5	NS	NS	3.3	NS	NS

[1] Nitrogen fertilizer as ammonium nitrate (34-0-0).

Table 2. Effects of tillage system and nitrogen fertilizer on wheat yields in a wheat-sorghum-fallow crop rotation on a nearly level Harney silt loam soil, KSU Agricultural Research Center-Hays, KS, 1975 to 2003.

Tillage System	N Rate[1]	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
		Yield															
	lb/a	- bu/a -															
Clean-till	0	30.4	30.6	25.9	24.0	35.2	31.1	21.6	28.6	31.5	15.5	27.6	18.9	40.2	41.0	13.5	39.4
	20	33.0	40.4	34.4	24.9	38.3	42.9	30.6	34.1	38.6	23.4	30.4	21.9	56.3	46.1	16.0	51.5
	40	40.2	45.8	37.0	25.8	41.1	42.1	33.0	35.9	43.1	27.5	31.0	25.9	64.4	49.9	18.5	58.2
	60	40.7	46.1	38.4	26.0	42.9	44.0	33.0	37.1	44.1	30.6	31.6	26.6	67.1	52.8	20.9	60.6
Reduced-till	0	28.7	24.9	24.0	24.4	35.7	31.4	18.4	31.3	32.3	13.3	27.5	25.4	41.0	33.1	13.3	39.7
	20	35.0	34.9	30.4	27.8	38.5	37.1	24.2	35.0	39.5	22.9	30.5	28.9	55.3	37.5	15.6	48.2
	40	40.0	38.3	38.8	28.3	39.6	42.9	27.8	37.1	43.0	25.9	29.9	30.7	63.0	40.4	17.4	53.9
	60	42.5	42.5	40.9	28.9	41.1	41.1	29.6	38.1	45.2	27.8	25.7	26.7	68.1	42.1	20.7	58.4
No-till	0	28.5	21.1	18.1	25.1	24.2	29.3	18.9	27.3	35.7	14.7	27.4	22.2	30.1	29.1	12.2	33.0
	20	36.0	29.8	25.3	30.2	29.7	33.4	21.1	34.2	40.7	23.6	30.8	24.7	45.8	33.0	14.1	41.8
	40	43.7	39.6	28.0	30.2	31.3	40.0	24.6	37.1	39.3	28.8	29.6	26.7	51.6	34.4	17.3	45.0
	60	43.6	41.9	29.2	29.8	33.3	42.2	25.6	39.1	39.9	33.8	29.5	25.2	57.4	40.4	21.0	54.5
Tillage System Averages																	
Clean-till		36.1	40.7	33.9	25.2	39.4	40.0	29.5	33.9	39.3	24.3	30.1	23.3	57.0	47.4	17.2	52.4
Reduced-till		36.5	35.2	33.5	27.3	38.7	38.1	25.0	34.4	40.0	22.5	28.4	27.9	56.8	38.3	16.7	50.1
No-till		38.0	33.1	25.1	28.8	29.6	36.2	22.6	35.4	38.9	25.2	29.3	24.7	46.2	34.2	16.1	43.6
Nitrogen Rate Averages																	
	0	29.2	25.6	22.7	24.5	31.7	30.6	19.7	29.1	33.1	14.5	27.5	22.1	37.1	34.4	13.0	37.4
	20	34.7	35.0	30.0	27.6	35.5	37.8	25.3	34.4	39.6	23.3	30.5	25.2	52.5	38.8	15.2	47.2
	40	41.3	41.2	34.6	28.1	37.3	41.7	28.5	36.7	41.8	27.4	30.2	27.7	59.7	41.6	17.7	52.4
	60	42.3	43.5	36.2	28.2	39.1	42.4	29.4	38.1	43.1	30.7	28.9	26.2	64.2	45.1	20.8	57.9
LSD (P<.05)																	
Tillage		1.7	1.3	1.2	1.0	1.1	1.5	1.1	0.2	2.2	1.2	0.8	1.2	2.4	1.2	0.7	1.6
Nitrogen Rate		2.0	1.5	1.4	1.1	1.2	1.7	1.3	0.2	2.5	1.4	0.9	1.3	2.7	1.4	0.8	1.9
T x N		NS	2.7	2.4	NS	2.2	3.0	2.3	0.4	4.4	NS	1.5	2.3	NS	NS	NS	3.3

[1] Nitrogen as ammonium nitrate (34-0-0).

Table 2. (con't.) Effects of tillage system and nitrogen fertilizer on wheat yields in a wheat-sorghum-fallow crop rotation on a nearly level Harney silt loam soil, KSU Agricultural Research Center-Hays, KS, 1975 to 2003 .

Tillage System	N Rate[1]	Yield 1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	29-Yr Avg.
	lb/a	bu/a													bu/a
Clean-till	0	27.4	30.2	44.4	20.6	17.3	20.1	25.1	20.1	17.9	23.5	27.0	33.1	34.2	27.4
	20	33.6	35.6	54.0	31.8	24.8	26.7	36.4	26.7	30.9	34.6	30.0	47.8	50.0	35.4
	40	34.1	37.0	58.5	39.3	28.6	28.3	44.2	31.6	44.3	43.6	30.6	52.9	53.3	39.5
	60	36.6	36.0	59.4	39.1	29.3	28.9	48.2	32.8	53.9	45.9	32.8	53.1	55.4	41.2
Reduced-till	0	30.4	31.1	42.5	19.6	15.4	17.0	24.9	14.3	22.8	22.4	26.5	33.7	36.3	26.9
	20	38.5	37.4	53.2	28.6	25.1	21.8	32.2	25.1	34.9	34.9	32.3	45.3	51.1	34.5
	40	37.6	37.9	60.0	34.1	30.8	22.7	42.2	33.4	49.2	43.5	33.9	52.3	50.7	38.8
	60	40.2	34.6	61.4	35.3	36.1	24.6	45.0	34.8	56.6	47.8	34.8	55.3	52.5	40.6
No-till	0	18.4	28.6	24.8	16.5	8.0	12.1	17.6	10.8	24.0	23.2	21.9	28.3	25.8	22.7
	20	30.3	34.6	35.9	26.3	19.4	19.4	26.1	23.5	38.0	38.1	27.2	39.1	38.1	30.7
	40	34.6	35.0	47.9	34.1	23.8	22.8	37.1	30.4	51.0	46.9	29.1	48.4	45.5	35.6
	60	40.3	36.8	54.3	39.3	28.5	25.0	43.1	34.0	55.2	52.5	35.5	53.0	53.7	39.2
Tillage System Averages															
Clean-till		32.9	34.7	54.1	32.7	25.0	26.0	38.4	27.8	36.7	36.9	30.1	46.7	48.2	35.8
Reduced-till		36.6	35.2	54.3	29.4	26.8	21.5	36.1	26.9	40.9	37.2	31.9	46.6	47.6	35.2
No-till		30.9	33.7	40.7	29.0	20.1	19.8	31.0	24.7	42.1	40.2	28.4	42.2	40.7	32.0
Nitrogen Rate Averages															
	0	25.4	29.9	37.2	18.9	13.9	16.4	22.5	15.1	21.5	23.0	25.1	31.7	32.1	25.7
	20	34.1	35.8	47.7	28.9	23.1	22.6	31.5	25.1	34.6	35.9	29.8	44.1	46.4	33.5
	40	35.4	36.6	55.5	35.8	27.7	24.6	41.2	31.8	48.2	44.7	31.2	51.2	49.8	38.0
	60	39.0	35.8	58.4	37.9	31.3	26.2	45.4	33.8	55.2	48.7	34.4	53.8	53.8	40.3
LSD (P<.05)															
Tillage		1.7	0.5	0.6	0.5	0.9	0.7	1.3	1.2	3.0	2.0	1.3	1.8	1.6	0.3
Nitrogen Rate		1.9	0.6	0.7	0.6	1.0	0.8	1.5	1.3	3.5	2.3	1.4	2.0	1.9	0.4
T x N		3.3	1.0	1.2	1.0	1.7	1.3	2.6	2.3	NS	NS	2.5	NS	3.2	0.6

[1] Nitrogen as ammonium nitrate (34-0-0).

LONG-TERM EFFECTS OF TILLAGE SYSTEMS AND NITROGEN FERTILIZER ON WINTER WHEAT AND GRAIN SORGHUM ON A SLOPING CRETE SILTY CLAY LOAM SOIL

C.A. Thompson

Summary

Over the years on this sloping high fertility Crete silty clay loam soil, sorghum and wheat grown in a wheat-sorghum-fallow (W-S-F) rotation under reduced-till (RT) resulted in higher yields than under clean-till (CT) and no-till (NT). In most years under RT, 60 lb/a of nitrogen (N) had the highest yields but may not be cost effective over 40 lb N/a. In order to reduce soil erosion through wind and water, keeping residue on the soil surface through a RT or NT tillage system is advised, providing it is cost effective.

Introduction

The effect of tillage systems and fertilizers has been documented separately. This paper includes both practices in one study. Because of the increasing cost/price squeeze, it is imperative that growers use the most cost effective farming methods possible to sustain a profitable enterprise. This study was evaluated on sloping soil, typical of many of the Kansas cropland acres.

Procedures

This study was established on a Crete silty clay loam soil in 1974 with the first crop harvest in 1975. In the last 30 years, annual precipitation has averaged 22.7 inches. Current high yielding wheat varieties and sorghum hybrids were used throughout the duration of the study. Row spacing was 12 inches for both crops. In this W-S-F rotation, each phase of the cropping system was included each year. Tillage systems included CT, RT, and NT. CT used tillage tools that incorporated the crop residue into the soil. RT used residue conserving tillage tools. NT was maintained with herbicides only. Nitrogen fertilizer as ammonium nitrate was surface applied in August for wheat and in November for sorghum at 0, 20, 40, and 60 lb N/a for each crop. Data were analyzed with statistical software package SAS. Treatments were replicated four times.

Results

Grain Sorghum

In most of the 28 years, sorghum under the RT tillage system in a WSF rotation had as high or higher yields than when under CT and NT (Table 3). Although 60 lb N/a resulted in the highest yield under RT, cost effectiveness may not exceed 40 lb N/a. Although this soil had a 2% slope, soil fertility was high.

Winter Wheat

In most of the 29 years, wheat yields in a W-S-F rotation were as high or higher under the RT tillage system than under CT and NT (Table 4). Under RT 60 lb N/a produced the highest yield in most years. However, the average yield may not have been enough to be cost effective over 40 lb N/a. In other studies, soils high in soil fertility failed to respond to NT tillage system.

Table 3. Yields of grain sorghum as influenced by tillage system and rate of nitrogen fertilizer in a wheat-sorghum-fallow cropping system on a 2% slope on a Crete silty clay loam soil, KSU Agricultural Research Center - Hays, KS, 1975 - 2003.

Tillage	N	Yield														
System	Rate[1]	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
	lb/a	bu/a														
Clean-till	0	51.6	17.1	93.5	12.1	54.1	25.3	48.2	11.2	5.3	55.8	67.9	76.4	83.3	43.6	60.7
Clean-till	20	52.5	36.0	105.0	13.8	61.9	27.5	47.6	27.3	15.3	50.1	68.9	82.4	79.0	50.7	45.8
Clean-till	40	49.0	22.1	113.4	13.3	57.2	29.4	65.7	36.5	30.4	52.5	68.5	74.3	88.9	57.5	36.5
Clean-till	60	53.7	30.0	107.8	13.0	57.4	33.6	65.4	21.9	27.9	52.5	73.7	73.8	94.3	56.1	22.2
Reduced-till	0	50.3	29.5	95.3	13.3	55.4	23.4	64.5	52.1	18.5	56.7	64.4	76.7	93.1	51.6	70.8
Reduced-till	20	46.3	28.9	105.4	13.0	61.6	29.6	57.9	59.8	16.4	65.9	80.6	88.6	99.1	69.5	68.0
Reduced-till	40	48.1	40.7	107.5	12.1	85.6	32.8	60.7	64.3	17.7	70.8	94.7	85.8	103.7	74.8	74.3
Reduced-till	60	45.8	35.3	114.4	12.6	78.2	34.9	62.1	70.0	23.2	83.4	77.3	74.8	103.2	88.8	70.8
No-till	0	29.2	35.3	77.4	2.7	53.7	13.0	75.6	59.4	19.5	43.7	73.9	68.7	43.3	36.0	67.5
No-till	20	40.0	46.8	87.7	2.9	60.7	24.5	75.2	71.5	20.9	56.4	80.3	65.5	56.0	47.4	70.5
No-till	40	33.4	49.6	105.4	4.0	74.1	13.1	87.5	71.9	23.1	57.0	79.2	69.2	61.6	64.2	77.3
No-till	60	34.1	48.8	112.4	3.5	80.1	14.2	105.9	58.7	13.0	65.3	81.4	68.7	71.5	71.2	73.8
Tillage System Averages																
Clean-till		51.7	26.3	104.9	13.0	57.6	28.9	56.7	24.2	19.7	52.7	69.7	76.7	86.3	50.5	41.3
Reduced-till		47.6	33.6	105.6	12.7	70.2	30.2	61.2	61.5	18.9	69.2	79.2	81.5	99.8	71.2	71.0
No-till		34.2	45.1	95.7	3.3	67.1	16.2	86.0	65.3	19.1	55.6	78.7	68.0	58.1	54.7	72.3
Nitrogen Rate Averages																
	0	43.7	27.3	88.7	9.3	54.4	20.5	62.7	40.9	14.4	52.0	68.7	73.9	73.2	43.7	66.3
	20	46.3	37.2	99.4	9.9	61.4	27.2	60.2	52.8	17.5	57.5	76.6	78.8	78.0	55.9	62.7
	40	43.5	37.5	108.8	9.8	72.3	25.1	71.3	57.6	23.7	60.1	80.8	76.4	84.7	63.5	61.4
	60	44.5	38.0	111.5	9.7	71.9	27.6	77.8	50.2	21.4	67.0	77.4	72.4	89.7	72.0	55.6
LSD (P<.05)																
Tillage		3.9	5.4	2.9	0.5	5.2	1.8	4.3	8.4	NS	1.8	3.2	5.2	4.4	6.3	1.3
Nitrogen Rate		NS	6.3	3.4	NS	6.0	2.0	4.9	9.7	1.7	2.1	3.7	NS	5.1	7.3	1.5
T X N		NS	NS	5.6	0.9	10.0	3.4	8.2	NS	2.8	3.5	6.1	NS	8.4	NS	2.4

[1] Nitrogen as ammonium nitrate (34-0-0).

Table 3. (con't.) Yields of grain sorghum as influenced by tillage system and rate of nitrogen fertilizer in a wheat-sorghum-fallow cropping system on a 2% slope on a Crete silty clay loam soil, KSU Agricultural Research Center - Hays, 1975 - 2003.

Tillage	N	Yield													28-Yr
System	Rate[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Avg.
	lb/a	- bu/a -													bu/a
Clean-till	0	60.3	51.3	97.5	42.5	37.0	31.3	90.4	49.7	29.3	72.2	43.3	59.5	37.1	50.3
Clean-till	20	39.4	53.7	105.9	49.8	40.1	37.8	97.0	55.2	41.7	91.9	55.0	67.3	39.1	54.9
Clean-till	40	38.1	47.5	105.3	53.9	47.4	47.3	108.5	78.3	56.0	94.5	63.1	71.2	29.0	58.2
Clean-till	60	38.1	45.7	98.3	62.5	49.8	42.0	96.7	82.5	61.4	97.6	73.7	75.1	27.4	58.3
Reduced-till	0	72.1	78.8	91.3	42.3	45.7	31.8	85.8	49.0	32.5	76.0	58.0	57.4	56.6	56.9
Reduced-till	20	63.6	79.4	104.4	59.4	50.4	35.9	101.6	61.2	45.9	92.5	65.8	65.6	64.6	63.6
Reduced-till	40	59.8	86.9	108.1	65.8	54.0	51.9	112.8	74.6	58.9	105.2	71.6	72.9	65.0	70.0
Reduced-till	60	57.4	91.6	118.0	71.7	54.7	53.0	110.8	85.8	67.9	112.1	79.2	80.3	62.6	72.1
No-till	0	57.4	63.5	83.6	21.4	13.3	29.7	70.0	41.7	35.7	78.7	32.3	55.0	34.1	47.0
No-till	20	61.9	65.9	91.2	44.5	36.1	33.8	98.2	55.8	51.2	86.9	49.8	60.7	34.3	56.3
No-till	40	69.0	76.0	103.8	53.5	46.1	41.4	110.8	78.7	53.2	90.8	55.4	68.6	43.1	62.9
No-till	60	75.0	79.9	103.1	55.5	48.1	42.7	107.3	81.2	55.8	101.2	63.2	79.9	42.3	65.6
Tillage System Averages															
Clean-till		44.0	49.5	101.8	52.2	43.6	39.6	98.1	66.4	47.1	89.0	58.8	68.3	33.1	55.4
Reduced-till		63.2	84.2	105.4	59.8	57.2	43.1	102.8	67.7	51.3	96.4	68.6	69.0	62.2	65.7
No-till		65.8	71.3	95.4	43.7	35.9	36.9	96.6	64.4	49.0	89.4	50.2	66.0	38.4	57.9
Nitrogen Rate Averages															
	0	63.2	64.6	90.8	35.4	32.0	30.9	82.0	46.8	32.5	75.6	44.5	57.3	42.6	51.4
	20	54.9	66.4	100.5	51.2	42.2	35.8	98.9	57.4	46.3	90.4	56.9	64.5	46.0	58.3
	40	55.6	70.1	105.7	57.7	49.2	46.9	110.7	77.2	56.0	96.8	63.3	70.9	45.7	63.7
	60	56.8	72.4	106.5	63.2	50.9	45.9	104.9	83.1	61.7	103.6	72.0	78.4	44.1	65.4
LSD (P<.05)															
Tillage		1.7	1.9	1.0	1.1	1.3	0.7	1.2	1.4	2.6	5.5	3.4	NS	1.9	0.7
Nitrogen Rate		2.0	2.2	1.2	1.2	1.5	0.8	1.3	1.7	3.0	6.3	4.0	3.1	2.2	0.9
T X N		3.3	3.7	1.9	2.1	2.5	1.3	2.2	2.8	5.1	NS	NS	NS	3.7	7.6

[1] Nitrogen as ammonium nitrate (34-0-0).

Table 4. Yields of winter wheat as influenced by tillage system and rate of nitrogen fertilizer in a wheat-sorghum-fallow cropping system on a 2% slope on a Crete silty clay loam soil, KSU Agricultural Research Center - Hays, KS, 1975 - 2003.

Tillage	N	Yield														
System	Rate[1]	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
	lb/a	bu/a														
Clean-till	0	40.4	22.0	31.1	15.8	34.4	41.4	18.1	28.1	30.6	26.7	38.2	30.7	29.6	11.8	1.6
Clean-till	20	49.3	25.6	33.6	27.7	33.1	45.1	24.3	35.5	41.2	25.2	46.2	48.2	45.1	18.4	4.7
Clean-till	40	45.3	33.2	35.2	28.4	34.1	45.1	21.9	35.3	43.8	24.6	46.3	36.1	47.4	18.6	3.8
Clean-till	60	53.6	40.2	34.7	27.3	33.4	45.5	22.1	36.1	40.9	22.3	44.8	35.7	50.0	19.4	3.5
Reduced-till	0	45.6	20.2	25.0	19.4	28.1	35.2	16.3	27.1	25.7	29.2	38.2	26.7	33.2	11.2	3.9
Reduced-till	20	46.3	27.1	30.7	28.7	32.0	48.3	22.6	32.7	36.6	25.1	40.9	38.8	36.2	14.9	4.1
Reduced-till	40	50.5	36.4	35.4	35.5	31.2	51.1	23.7	36.2	39.8	33.2	38.4	35.0	45.2	17.0	4.9
Reduced-till	60	48.5	42.0	37.0	39.0	29.3	49.9	25.5	37.3	37.6	31.9	48.1	31.0	48.6	19.3	7.0
No-till	0	36.3	18.2	20.6	19.4	19.6	14.6	10.1	18.5	4.6	29.6	19.2	19.6	19.4	11.1	6.9
No-till	20	46.4	25.9	27.1	26.2	28.9	22.6	14.5	26.1	15.5	28.3	29.1	34.3	27.7	12.9	9.6
No-till	40	52.0	35.8	31.1	34.6	30.9	26.7	23.4	31.5	21.8	41.0	27.6	32.5	44.9	12.7	11.6
No-till	60	47.5	40.8	34.5	29.2	30.9	30.0	23.2	33.3	28.4	37.3	38.7	28.0	52.4	15.0	15.6
Tillage System Averages																
Clean-till		47.7	30.2	33.6	24.8	33.8	44.3	21.6	33.7	39.1	24.7	43.9	37.7	43.0	17.0	3.4
Reduced-till		47.7	31.4	32.0	30.6	30.1	46.1	21.9	33.2	34.9	29.9	41.4	32.8	40.8	15.6	4.9
No-till		45.5	30.2	28.3	27.3	27.5	23.5	17.8	27.4	17.6	34.0	28.6	28.6	36.1	12.9	10.9
Nitrogen Rate Averages																
	0	41.4	20.2	25.5	18.2	27.3	30.4	14.8	24.6	20.3	28.5	31.8	25.7	27.4	11.3	4.2
	20	47.3	26.2	30.5	27.5	31.3	38.7	20.4	31.4	31.1	26.2	38.7	40.4	36.3	15.4	6.1
	40	49.3	35.1	33.9	32.8	32.1	41.0	23.0	34.3	35.1	32.9	37.5	34.5	45.8	16.1	6.8
	60	49.8	41.0	35.4	31.8	31.2	41.8	23.5	35.5	35.6	30.5	43.9	31.6	50.3	17.9	8.7
LSD ($P<.05$)																
Tillage		NS	0.8	0.9	1.0	1.0	2.0	0.8	0.2	0.8	0.6	1.3	0.8	1.9	1.1	0.5
Nitrogen Rate		3.0	0.9	1.0	1.2	1.1	2.3	0.9	0.2	0.9	0.7	1.5	0.9	2.2	1.3	0.7
T X N		4.9	1.5	1.7	2.0	1.8	3.9	1.6	0.4	1.5	1.1	2.4	1.6	3.7	2.2	1.2

[1] Nitrogen as ammonium nitrate (34-0-0).

Table 4. (con't.) Yields of winter wheat as influenced by tillage system and rate of nitrogen fertilizer in a wheat-sorghum-fallow cropping system on a 2% slope on a Crete silty clay loam soil, KSU Agricultural Research Center - Hays, KS, 1975 - 2003.

Tillage	N	Yield														29-Yr
System	Rate[1]	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	Avg.
	lb/a	bu/a														
Clean-till	0	31.4	18.3	23.4	19.3	15.7	9.9	19.0	28.5	27.0	32.0	30.1	33.8	21.3	21.1	25.3
Clean-till	20	37.4	21.6	27.6	30.0	23.4	16.1	28.0	33.7	39.1	39.5	46.3	41.4	39.4	38.3	33.3
Clean-till	40	45.7	22.0	27.4	34.7	32.8	16.7	34.8	38.7	41.8	43.8	50.4	40.2	44.5	44.3	35.1
Clean-till	60	47.4	21.4	33.8	33.6	37.5	21.5	38.1	38.9	40.3	50.6	57.6	38.9	52.2	49.6	36.7
Reduced-till	0	24.7	17.1	26.9	18.7	15.7	7.5	15.6	25.6	22.3	37.1	32.6	33.8	23.7	23.0	24.4
Reduced-till	20	32.0	18.4	37.8	26.9	28.0	11.3	25.1	34.0	32.9	45.2	40.7	41.5	36.1	38.9	31.5
Reduced-till	40	46.3	21.5	43.2	34.9	39.3	20.9	28.6	38.9	39.5	56.3	52.5	39.2	40.0	45.7	36.6
Reduced-till	60	52.1	22.4	46.5	40.9	41.5	17.2	38.0	38.6	40.2	62.2	54.3	40.3	47.6	55.1	38.9
No-till	0	26.9	14.2	28.8	9.1	16.6	4.5	1.7	25.7	15.5	25.0	24.4	25.1	23.5	20.2	18.1
No-till	20	30.2	15.1	37.8	21.1	24.2	8.2	6.0	29.6	22.8	36.1	30.7	26.1	32.7	29.9	24.9
No-till	40	42.8	18.1	43.2	29.6	30.5	10.5	14.1	31.6	29.6	41.0	37.2	29.2	39.2	33.3	30.4
No-till	60	47.0	19.8	46.5	37.1	30.3	7.3	16.9	31.3	36.6	46.8	44.6	29.6	37.0	45.1	32.9
Tillage System Averages																
Clean-till		40.5	20.8	28.1	29.4	27.3	16.0	30.0	34.9	37.1	41.5	44.6	38.6	39.3	38.3	32.6
Reduced-till		38.8	19.9	38.6	30.3	31.1	14.2	26.8	34.3	33.7	50.2	45.0	38.7	36.8	40.8	32.9
No-till		36.7	16.8	33.2	24.2	25.4	7.6	9.7	29.6	26.1	37.2	34.2	27.5	33.1	32.1	26.5
Nitrogen Rate Averages																
	0	27.7	16.5	24.7	15.7	16.0	7.3	12.1	26.6	21.6	31.4	29.0	30.9	22.8	21.4	22.6
	20	33.2	18.3	33.1	26.0	25.2	11.9	19.7	32.5	31.6	40.3	39.2	36.3	36.1	35.7	29.9
	40	44.9	20.5	35.4	33.1	34.2	16.0	25.8	36.4	37.0	47.0	46.7	36.2	41.2	41.1	34.0
	60	48.8	21.2	40.0	37.2	36.4	15.3	31.0	36.2	39.0	53.2	50.2	36.2	45.6	49.9	36.2
LSD (P<.05)																
Tillage		1.0	0.6	0.4	0.6	0.6	0.6	0.6	1.4	1.4	1.5	1.6	1.6	0.9	1.0	0.2
Nitrogen Rate		1.2	0.7	0.4	0.7	0.7	0.7	0.7	1.6	1.6	1.7	1.9	1.9	1.0	1.1	0.3
T X N		1.9	1.2	0.7	1.2	1.1	1.2	1.2	0.6	2.7	2.8	3.1	3.1	1.7	1.9	2.4

[1] Nitrogen as ammonium nitrate (34-0-0).

LONG-TERM EFFECTS OF CROPPING AND TILLAGE SYSTEMS ON WINTER WHEAT AND GRAIN SORGHUM YIELDS ON A CRETE SILTY CLAY LOAM SOIL

C.A. Thompson

Summary

In the years sorghum and wheat were grown on a Crete silty clay loam soil, yields from wheat-sorghum-fallow (W-S-F), sorghum-fallow (SF), and wheat-fallow (WF) exceeded yields from continuous sorghum (SSS) and continuous wheat (WWW). However, when examined on an annual basis, continuous cropping was highly favored, especially in the SSS cropping system. Yields within years and average yields showed a significant difference of reduced-till (RT) over no-till (NT) in the SSS cropping system

Introduction

In moderate to low precipitation areas, it is important to harvest the stored moisture in the most efficient manner possible. Cropping intensity is the main component in removing soil moisture. In addition, tillage systems may also influence soil moisture removal. Yield levels and economic returns are the main results of stored soil moisture. Due to space constraints, this paper addresses only the effects of cropping and tillage systems on yields of winter wheat and grain sorghum. Yearly and average yields are shown over the duration of this study. For effects of soil moisture refer to publication: Thompson, C.A. 2001. Winter wheat and grain sorghum production as influenced by depth of soil moisture, tillage and cropping system. Journal of Production Agriculture 56:56-63.

Procedures

This study was established in the summer of 1975 with 1976 as the first crop year. The nearly level high fertility Crete silty clay loam soil on which the study was established had been in crop production for more than 75 years at the KSU Agricultural Research Center-Hays. Tillage systems included clean-till (CT), RT and NT. Each crop, regardless of cropping system, received broadcast applied at 60 lb N/a as ammonium nitrate (34-0-0). Residue conserving tillage tools (V-blade, sweep, rod weeder, and mulch treader) incorporated the nitrogen (N) fertilizer in the RT system. NT relied on precipitation to move the N down into the soil. Five cropping systems used in the study included WWW, WF, W-S-F, SSS, and SF. Each phase of every cropping system was included each year. High yielding wheat varieties and sorghum hybrids were used throughout the study. Row spacing was 12 inches for both crops. Data were analyzed with statistical software package SAS. Treatments were replicated three times in a randomized complete block design.

Results

<u>Grain Sorghum</u>

It took 15 years before consistent significant yield differences were measured between tillage systems where grain sorghum was grown (Table 5). In SSS and SF cropping systems average yields were significantly higher under RT. In W-S-F cropping system, sorghum yields from the two tillage systems were not significantly different and there was no interaction over the 27 years. Average sorghum yields from W-S-F and SF under RT did not differ significantly. However, under NT, sorghum yields from W-S-F were significantly higher than from SF. Sorghum yields from SSS, regardless of tillage system, were significantly lower than W-S-F and SF. However, when averaged on an annual basis SSS sorghum yields were significantly higher than yields from W-S-F and SF cropping systems.

<u>Winter Wheat</u>

Where wheat (Table 6) was grown there was a cropping x tillage system interaction in 18 of the 28 years. In WWW cropping system, wheat yields favored NT in 7 of the 18 years, while under RT only 3 of the 18 years. In W-S-F cropping system, wheat yields favored NT in 3 of the 18 years, while under RT 7 of the 18 years. In WF cropping system, wheat yields favored NT in 11 of the 18 years, while under RT only 3 of the 18 years. For yearly consistency, WWW and WF favored the NT system but W-S-F favored the RT system. Even though there was a longer fallow period under the WF cropping system, wheat yields averaged only 2.5 bu/a higher than wheat in the W-S-F cropping system under the NT system. Under RT there was no significant difference between the two cropping systems. Yields from wheat grown under WWW cropping system were not only significantly lower than wheat from W-S-F and WF but, on an annual basis, were significantly higher than wheat grown in W-S-F and WF rotations.

Table 5. Effects of cropping and tillage systems on grain sorghum yields established on a nearly level Crete silty clay loam soil, KSU Agricultural Research Center-Hays, KS, 1975 to 2002.

Cropping System[1]	Tillage System	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
		Yield														
		bu/a														
SSS	Reduced-till	19.0	29.3	10.3	43.6	63.3	89.3	43.8	23.1	33.2	69.6	33.0	102.2	12.9	20.2	42.2
SSS	No-till	19.8	30.0	9.3	56.7	68.3	62.4	52.8	19.1	30.2	77.3	30.3	88.8	14.2	28.2	41.7
WSF	Reduced-till	50.6	58.0	35.3	67.6	73.0	109.6	110.0	30.5	34.3	77.6	72.0	110.0	54.7	38.1	74.9
WSF	No-till	64.9	67.0	33.3	80.1	73.0	99.5	123.3	31.1	36.9	78.3	79.4	109.8	61.7	46.5	74.4
SF	Reduced-till	39.4	61.7	28.7	53.3	65.3	86.6	88.8	17.4	38.0	77.2	95.9	115.6	78.1	33.7	71.2
SF	No-till	42.4	63.3	24.7	62.3	68.0	98.8	71.6	18.8	36.3	73.9	82.1	110.5	66.8	43.5	56.1
Cropping System Averages																
SSS		19.4	29.7	9.8	50.2	65.8	75.8	48.3	21.1	31.7	73.5	31.6	95.5	13.5	24.2	42.0
WSF		57.8	62.5	34.3	73.8	73.0	104.5	116.7	30.8	35.6	77.9	75.7	109.9	58.2	42.3	74.6
SF		40.9	62.5	26.7	57.8	66.7	92.7	80.2	18.1	37.2	75.6	89.0	113.1	72.5	38.6	63.7
Tillage System Averages																
	Reduced-till	36.4	49.7	24.8	54.8	67.2	95.1	80.8	23.7	35.2	74.8	66.9	109.3	48.6	30.7	62.8
	No-till	42.3	53.4	22.4	66.4	69.8	86.9	82.6	23.0	34.5	76.5	63.9	103.0	47.6	39.4	57.4
LSD ($P<.05$)																
Cropping System		11.1	10.1	5.9	9.6	3.6	12.6	18.3	1.1	NS	NS	26.8	9.5	5.8	2.3	1.8
Tillage System		NS	NS	NS	7.8	NS	NS	NS	NS	NS	NS	NS	NS	NS	1.8	1.4
C X T		NS	NS	NS	NS	NS	17.9	NS	1.5	NS	NS	NS	NS	8.2	NS	2.5

[1] SSS = continuous sorghum; WSF = wheat-sorghum-fallow; SF = sorghum-fallow.

Table 5. (con't.) Effects of cropping and tillage systems on grain sorghum yields established on a nearly level Crete silty clay loam soil, KSU Agricultural Research Center-Hays, KS, 1975 to 2002.

Cropping System[1]	Tillage System	Yield 1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	27-Yr Avg.	Annual Avg.
		- - - bu/a - - -												- - - bu/a - - -	
SSS	Reduced-till	30.8	117.2	20.9	47.9	37.7	74.0	71.0	55.2	69.6	74.6	60.6	51.2	49.8	49.8
SSS	No-till	34.6	93.1	17.1	29.9	24.9	67.1	55.4	42.1	63.2	53.9	26.1	54.4	44.1	44.1
WSF	Reduced-till	83.1	136.3	66.9	71.1	47.0	77.0	71.7	61.9	106.8	73.6	91.6	91.3	73.1	24.4
WSF	No-till	82.3	138.3	59.2	70.4	49.1	80.6	68.4	59.7	108.1	76.4	90.1	96.3	75.5	25.2
SF	Reduced-till	85.7	125.2	79.8	76.9	68.6	72.9	98.9	68.8	105.4	69.6	114.2	84.8	74.1	37.1
SF	No-till	72.0	102.0	68.7	39.7	12.2	57.9	94.6	57.3	94.2	62.7	40.2	86.7	63.2	31.6
Cropping System Averages															
SSS		32.7	105.2	19.0	38.9	31.3	70.5	63.2	48.7	66.4	64.3	90.9	52.8	47.0	47.0
WSF		82.7	137.3	63.0	70.7	48.1	78.8	70.1	60.8	107.5	75.0	77.2	93.8	74.3	24.8
SF		78.8	113.6	74.2	58.3	40.4	65.4	96.7	63.1	99.8	66.2	43.4	85.8	68.7	34.4
Tillage System Averages															
	Reduced-till	66.5	126.2	55.8	65.3	51.1	74.6	80.5	62.0	94.0	72.6	88.8	75.8	65.7	37.1
	No-till	62.9	111.1	48.3	46.6	28.7	68.5	72.8	53.0	88.5	64.3	52.1	79.1	60.9	33.6
LSD (P<.05)															
Cropping System		0.7	2.4	14.3	3.6	10.4	NS	6.4	7.8	4.6	7.7	9.3	5.3	1.9	1.3
Tillage System		0.6	2.0	NS	3.0	8.5	NS	5.3	6.4	3.7	6.3	7.6	NS	1.5	1.1
C X T		1.0	3.4	NS	5.2	14.7	NS	NS	NS	6.4	10.9	13.1	NS	13.8	9.6

[1] SSS = continuous sorghum; WSF = wheat-sorghum-fallow; SF = sorghum-fallow.

Table 6. Effects of cropping and tillage systems on winter wheat yields established on a nearly level Crete silty clay loam soil, KSU Agricultural Research Center-Hays, KS, 1976 to 2003.

Cropping System[1]	Tillage System	Yield 1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
		bu/a														
WWW	Reduced-till	33.1	23.1	20.5	19.7	18.0	20.7	21.7	10.5	12.8	35.2	23.2	52.7	12.6	2.2	44.8
WWW	No-till	36.8	20.9	23.9	12.6	18.0	27.7	23.3	11.9	15.4	38.3	24.1	46.3	13.6	9.3	48.5
WSF	Reduced-till	43.2	35.7	21.6	22.4	29.7	37.7	36.0	14.0	23.3	44.8	23.2	53.2	19.5	10.3	59.7
WSF	No-till	43.0	34.9	29.9	25.7	32.0	30.1	34.3	15.6	26.2	41.7	27.3	48.1	22.7	18.2	55.9
WF	Reduced-till	47.0	32.0	21.8	28.2	29.7	31.2	31.3	12.5	22.1	36.6	28.3	60.6	15.1	20.4	65.3
WF	No-till	39.5	37.9	28.8	31.8	33.0	41.5	32.3	20.5	24.1	43.6	30.8	56.3	22.5	21.8	66.2
Cropping System Averages																
WWW		34.9	22.0	22.2	16.2	18.0	24.2	22.5	11.2	14.1	36.7	23.7	49.5	13.1	5.7	46.6
WSF		43.1	35.3	25.7	24.1	30.8	33.9	35.2	14.8	24.8	43.3	25.2	50.7	21.1	14.3	57.8
WF		43.3	35.0	25.3	30.0	31.3	36.4	31.8	16.5	23.1	40.1	29.6	58.4	18.8	21.1	65.8
Tillage System Averages																
	Reduced-till	41.1	30.3	21.3	23.4	25.8	29.9	29.7	12.3	19.4	38.9	24.9	55.5	15.7	11.0	56.6
	No-till	39.8	31.2	27.5	23.4	27.7	33.1	30.0	16.0	21.9	41.2	27.4	50.3	19.6	16.4	56.9
LSD (P<.05)																
Cropping System		3.6	1.9	NS	3.0	5.6	4.2	2.9	3.9	3.9	4.0	2.5	5.5	1.2	0.6	0.6
Tillage System		NS	NS	3.2	NS	NS	NS	NS	3.2	NS	NS	2.0	4.5	1.0	0.5	NS
C X T		5.0	2.7	NS	4.2	NS	5.9	NS	NS	NS	5.7	NS	NS	1.8	0.8	0.9

[1] WWW = continuous wheat; WSF = wheat-sorghum-fallow; WF = wheat-fallow.

Table 6. (con't.) Effects of cropping and tillage systems on winter wheat yields established on a nearly level Crete silty clay loam soil, KSU Agricultural Research Center-Hays, KS, 1976 to 2003.

Cropping System[1]	Tillage System	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	28-Yr Avg.	Annual Avg.
		Yield														
		bu/a													bu/a	
WWW	Reduced-till	16.4	31.8	44.0	20.9	15.2	0.0	28.0	30.3	48.8	18.6	34.2	29.9	40.2	25.3	25.3
WWW	No-till	15.1	37.2	44.6	17.3	19.1	14.9	28.2	30.9	44.6	20.9	29.3	30.8	39.2	26.5	26.5
WSF	Reduced-till	25.7	47.8	54.0	36.9	30.3	12.1	39.2	37.6	39.4	39.4	32.1	45.2	50.0	34.4	11.5
WSF	No-till	24.9	43.9	52.4	37.5	18.7	23.8	40.0	37.0	40.5	34.1	34.4	42.0	41.7	34.2	11.4
WF	Reduced-till	21.3	45.9	51.2	32.3	17.4	13.3	39.6	33.7	43.6	40.3	29.5	49.0	55.4	34.3	17.2
WF	No-till	25.8	41.8	55.1	32.3	22.1	14.8	44.3	29.8	57.7	43.1	31.6	46.5	51.6	36.7	18.4
Cropping System Averages																
WWW		15.8	34.5	44.3	19.1	17.1	7.4	28.1	30.6	46.7	19.8	31.8	30.4	39.7	25.9	25.9
WSF		25.3	45.9	53.2	37.2	24.5	18.0	39.6	37.3	40.0	36.7	33.3	43.6	45.9	34.3	11.4
WF		23.6	43.9	56.6	32.3	19.8	14.1	41.9	31.8	50.6	41.7	30.5	47.7	53.5	35.5	17.8
Tillage System Averages																
	Reduced-till	21.2	41.8	52.1	30.0	21.0	8.5	35.6	33.8	43.9	32.8	31.9	41.4	48.6	31.4	18.0
	No-till	21.9	41.0	50.7	29.0	20.0	17.8	37.5	32.6	47.6	32.7	31.8	39.8	44.1	32.5	18.6
LSD (P<.05)																
Cropping System		1.2	0.8	1.0	0.5	2.2	2.5	8.3	2.7	3.0	1.5	1.8	2.0	1.1	1.0	0.9
Tillage System		NS	0.6	0.8	0.4	NS	2.1	NS	NS	2.5	NS	NS	NS	0.9	0.8	0.7
C X T		1.7	1.1	1.4	0.7	3.1	3.6	NS	NS	4.3	2.1	2.6	NS	1.6	1.4	6.5

[1] WWW = continuous wheat; WSF = wheat-sorghum-fallow; WF = wheat-fallow.

LONG-TERM EFFECTS OF TILLAGE SYSTEMS AND FERTILIZER TREATMENTS ON WINTER WHEAT AND GRAIN SORGHUM ON AN ERODED HARNEY SILT LOAM SOIL

C.A. Thompson

Summary

On this eroded Harney silt loam soil in a wheat-sorghum-fallow (W-S-F) rotation, wheat and sorghum yields from the no-till (NT) tillage system were significantly higher than clean-till (CT) and reduced-till (RT). Sorghum yields were highest from feedlot manure plus spring applied nitrogen (N) in the NT system. Under NT a small amount of N applied with the sorghum seed at planting produced 16.8 bu/a over the control. Wheat yields in each tillage system were highest from feedlot manure. Starter fertilizer alone applied at wheat planting resulted in an average increase of 4.6 bu/a over the control. Wheat yields from 10 of the 17 years favored NT over CT and RT tillage systems. Both crops responded more favorably to fall applied N than spring applied N.

Introduction

This scientist has noted little benefit of no-till on high fertility soils. However, there are few if any studies that have combined tillage systems with more than one nutrient, different times of application, and the effect of feedlot manure. Also, little has been reported on low fertility eroded soils with 2% or more slope. Growers need to know if response to tillage systems and a range of fertility treatments is the same or different under varying soil nutrient conditions. This study addresses these issues.

Procedures

This study was established in 1986 with the first crop harvest in 1987 reflecting treatment effect. The cropping system was W-S-F with each phase of the rotation represented each year. Tillage systems included CT, RT, and NT. CT employed residue incorporating tillage tools. On RT residue conserving tools were used. Only herbicides were used on NT. Seventeen fertilizer treatments were applied on each of the tillage systems for each crop. These treatments included nitrogen fertilizer applied in a band at planting, broadcast spring and fall applied N, starter fertilizer, feedlot manure, and combinations of the above. The latest high yielding wheat varieties and sorghum hybrids were used throughout the duration of the study. Precipitation during the 1987 to 2003 period averaged about 22.5 inches per year. Row spacing was 12 inches for both wheat and sorghum. Data were analyzed with statistical software package SAS. Treatments were replicated three times in a randomized complete block design.

Results

Grain Sorghum

The effects of tillage systems and fertilizer from 1987 to 2002 on grain sorghum yields are reported in Table 7. Although there are individual year interaction of tillage x fertilizer, the overall average was nonsignificant. Average yields from NT were significantly higher than CT and RT. The highest average fertilized yield under NT was from feedlot manure plus spring applied N. Manure by itself was only 2.8 bu/a less than the highest yield. A small amount of nitrogen banded with the seed resulted in a 16.8 bu/a increase over the control. Under each tillage system, fall applied N produced higher yields than spring applied N.

Winter Wheat

Results of tillage systems and fertilizer from 1987 to 2003 on winter wheat yields are reported in Table 8. There was individual year and average over years interaction of tillage x fertilizer. Average yields from NT were significantly higher than CT and RT. In each of the tillage systems over years, yields were highest where feedlot manure was added. Starter fertilizer alone resulted in yield increases of 3.8 bu/a under CT, 4.9 bu/a under RT, and 5.4 bu/a under NT. Under

each tillage system fall applied N produced higher yields than spring applied N. Yields from 10 of the 17 years favored NT over CT and RT tillage systems.

Table 7. Grain sorghum yields as affected by 17 fertilizer treatments in three tillage systems in a wheat-sorghum-fallow rotation. Depth of moist soil (taken at planting) as affected by tillage systems, Ed Stehno farm, Ellis Co., KS.

Tillage	Fert.	Year																16-Yr
System[1]	No.[2]	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	Avg.
		Yield, bu/a																
CT	1	64.8	55.3	46.9	57.4	77.4	95.1	66.7	66.1	24.8	47.9	38.2	53.9	89.5	61.4	67.3	64.4	61.1
CT	2	71.8	52.0	50.9	66.8	79.4	102.4	71.9	94.1	37.0	46.5	74.2	61.2	92.2	76.9	86.0	73.0	71.0
CT	3	60.9	65.7	58.1	70.8	72.7	127.3	82.1	104.8	37.5	56.0	66.8	79.2	94.1	75.7	91.0	81.8	76.5
CT	4	64.2	64.2	53.8	62.9	69.2	114.8	76.8	93.8	37.4	64.9	62.6	74.2	98.0	73.8	90.4	72.6	73.4
CT	5	82.4	57.6	59.5	69.4	43.6	132.9	81.8	101.3	59.6	69.9	72.7	92.8	112.8	77.7	106.4	69.7	80.6
CT	6	64.5	64.6	51.6	90.1	75.3	115.3	76.7	107.8	41.9	58.3	72.6	88.3	98.6	87.8	101.7	94.3	80.6
CT	7	67.8	50.3	43.0	75.2	67.6	116.2	82.3	103.5	49.1	68.5	77.1	78.7	119.0	79.7	100.4	98.0	79.8
CT	8	76.2	65.6	41.4	72.9	74.6	115.7	88.1	109.9	60.4	67.3	82.6	97.3	119.4	87.1	105.5	86.0	84.4
CT	9	82.6	51.5	45.0	80.4	82.0	134.2	85.6	101.4	58.5	56.4	78.5	83.5	104.5	77.2	111.6	89.2	82.6
CT	10	85.7	53.5	39.5	81.7	78.2	125.5	81.5	93.2	52.3	54.3	71.3	83.8	99.4	85.4	94.3	71.6	78.2
CT	11	83.7	62.9	53.3	78.4	56.5	138.6	107.2	92.6	60.9	69.1	85.3	115.8	116.0	73.4	114.0	74.0	86.4
CT	12	95.2	63.0	48.4	79.2	69.5	135.4	104.9	96.0	52.4	66.4	73.3	108.6	118.5	85.8	109.1	84.6	86.9
CT	13	90.3	59.6	38.5	77.5	77.8	130.1	107.2	112.9	59.1	59.2	84.5	91.4	104.0	80.5	112.6	83.2	85.5
CT	14	89.1	81.9	52.1	76.5	86.7	133.2	106.3	111.9	60.1	65.8	85.6	102.5	116.8	85.2	114.4	63.7	89.5
CT	15	92.4	68.4	48.7	63.3	72.0	114.3	91.3	113.9	59.8	53.1	90.1	96.1	120.1	76.4	105.6	85.5	84.4
CT	16	89.8	64.3	40.2	80.3	88.2	115.0	95.8	116.6	53.3	71.3	85.0	99.7	118.8	90.1	107.3	92.8	88.0
CT	17	82.8	53.4	51.4	82.5	80.8	120.3	99.2	121.4	68.6	50.8	85.5	95.0	112.0	89.6	106.6	92.9	87.0
RT	1	65.2	39.1	65.2	48.6	29.6	111.2	53.2	55.7	27.8	51.6	46.0	53.0	93.5	47.8	65.4	81.2	58.4
RT	2	73.5	43.7	64.1	53.1	38.9	126.5	66.6	74.1	41.3	64.6	60.5	63.8	93.6	54.7	92.2	99.7	69.4
RT	3	73.3	44.6	70.0	51.5	36.5	127.8	76.1	62.5	46.6	65.2	61.7	78.6	98.0	51.7	97.4	93.0	70.9
RT	4	73.1	47.4	62.3	50.0	34.4	125.6	69.2	65.3	47.3	69.9	61.4	65.2	95.9	49.3	88.2	93.9	68.7
RT	5	79.6	45.2	72.1	54.4	43.8	118.9	77.4	81.9	56.0	70.3	64.2	80.0	104.8	54.0	95.1	91.2	74.3
RT	6	73.2	44.0	70.8	54.6	53.0	121.4	82.5	74.5	63.4	63.0	71.4	76.2	100.8	56.6	104.1	99.8	75.6
RT	7	74.1	49.1	58.2	56.4	60.4	122.4	89.9	73.0	47.5	69.0	76.0	81.0	105.8	62.3	89.5	100.3	75.9
RT	8	79.3	39.5	58.8	56.3	35.0	133.6	97.8	72.4	64.8	65.9	85.6	77.3	114.7	57.4	110.7	90.0	77.4
RT	9	69.8	43.6	71.8	48.5	56.6	116.1	85.8	82.8	72.9	62.7	71.5	90.1	102.5	65.6	111.6	103.5	78.5
RT	10	72.6	46.0	68.0	48.5	61.4	129.9	74.0	89.9	63.4	63.7	67.3	80.9	100.5	56.9	104.9	95.6	76.5
RT	11	82.6	59.4	77.4	49.4	58.9	132.4	101.6	86.8	47.3	70.9	79.2	99.3	116.8	61.6	117.8	99.1	83.8
RT	12	85.4	60.0	62.6	57.5	63.0	130.1	113.0	100.4	56.6	62.3	88.1	97.2	119.6	61.9	122.2	94.1	85.9
RT	13	85.7	54.6	64.8	55.1	67.6	133.3	105.3	96.0	64.7	60.8	83.5	99.7	119.3	58.2	121.5	104.3	85.9
RT	14	82.8	61.1	70.0	57.1	49.4	134.5	109.2	97.7	53.5	78.8	92.0	102.2	122.9	65.0	120.1	99.2	87.2
RT	15	84.7	54.3	58.1	57.1	62.9	131.6	110.9	91.6	65.8	63.2	86.3	93.9	120.0	50.0	119.3	113.2	85.2
RT	16	91.2	49.9	71.3	57.0	53.7	125.8	113.2	98.0	55.8	69.3	88.8	95.6	124.1	64.8	120.9	105.6	86.6
RT	17	76.5	47.6	59.9	64.0	68.9	140.5	101.3	87.3	72.6	46.5	86.0	95.1	116.1	52.4	119.5	88.8	82.7
NT	1	70.4	60.9	72.3	68.9	65.6	116.8	52.2	77.7	14.9	50.1	44.1	75.0	89.0	66.2	68.6	83.1	67.2
NT	2	79.2	67.3	75.9	72.3	79.0	123.4	57.4	93.3	34.5	69.2	68.1	74.5	97.5	78.2	87.6	91.9	78.1
NT	3	84.9	74.7	88.4	70.6	78.8	134.6	71.6	93.4	39.7	69.4	80.7	87.9	102.7	79.4	90.5	96.9	84.0
NT	4	82.0	73.3	68.9	77.9	77.8	132.1	75.1	91.1	35.0	62.8	65.9	88.5	100.1	71.4	85.2	87.4	79.7
NT	5	82.9	64.3	94.2	72.3	79.0	133.2	75.8	99.4	44.0	69.8	69.4	102.2	100.9	83.3	104.3	92.4	85.5
NT	6	80.9	73.4	100.4	71.5	89.7	129.0	74.7	90.5	56.7	63.3	68.8	92.7	104.5	71.5	103.7	95.3	85.4
NT	7	79.9	70.5	92.8	75.0	107.9	140.1	81.4	104.2	48.0	73.1	76.5	100.5	114.1	82.9	91.9	95.2	89.6
NT	8	92.5	68.8	87.9	72.9	81.5	141.7	72.3	103.8	57.7	81.7	84.4	106.9	113.7	86.8	115.0	100.3	91.7
NT	9	82.8	56.9	78.5	76.2	77.0	139.9	87.0	106.0	57.6	55.2	75.6	106.7	111.8	88.7	116.3	104.8	88.8
NT	10	81.6	58.6	88.2	87.0	94.6	137.3	85.5	90.6	56.1	75.6	67.8	90.2	114.9	78.0	100.6	102.7	88.1
NT	11	74.7	64.2	94.0	85.7	105.7	159.0	94.1	122.6	53.4	72.3	85.7	118.4	118.8	89.9	123.1	93.2	97.2
NT	12	73.9	62.7	85.9	80.0	88.6	153.7	103.8	110.5	64.3	64.9	97.3	122.1	120.6	82.1	121.1	102.2	95.9
NT	13	72.8	58.9	95.0	92.0	78.7	148.0	101.4	117.8	60.8	65.3	85.7	112.4	124.0	88.5	110.7	99.0	94.4
NT	14	75.4	60.2	103.0	81.7	95.6	157.5	99.0	125.6	77.7	80.4	86.7	114.1	122.4	99.7	125.7	102.1	100.0
NT	15	78.9	64.2	100.9	85.1	99.3	148.2	107.9	105.9	63.7	78.7	90.1	110.5	126.3	90.8	117.1	98.6	97.9
NT	16	76.6	64.5	101.3	80.2	97.9	153.6	95.6	109.1	69.2	77.1	89.3	123.0	123.3	88.3	126.4	100.2	98.5
NT	17	68.6	53.6	88.2	78.9	95.8	149.6	104.1	120.7	64.6	65.8	86.6	101.4	119.9	95.1	119.1	97.2	94.3

Table 7. (con't.) Grain sorghum yields as affected by 17 fertilizer treatments in three tillage systems in a wheat-sorghum-fallow rotation. Depth of moist soil as affected by tillage systems, Ed Stehno farm, Ellis Co., KS.

Tillage System[1]	Fert. No.[2]	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	16-Yr Avg.
		Yield, bu/a																
Tillage System Averages																		
CT		79.1	60.8	48.4	74.4	73.6	121.5	88.6	102.4	51.3	60.3	75.7	88.4	107.9	80.2	101.4	81.0	80.9
RT		77.8	48.8	66.1	54.1	51.4	127.1	89.8	81.8	55.7	64.6	74.7	84.1	108.8	57.1	105.9	97.2	77.8
NT		78.7	64.5	89.2	78.1	87.7	141.0	84.6	103.6	52.9	69.1	77.8	101.5	112.0	83.6	106.3	96.6	89.2
Fertilizer Treatment Averages																		
	1	66.8	51.8	61.5	58.3	57.5	107.7	57.4	66.5	22.5	49.9	42.8	60.6	90.7	58.5	67.1	76.2	62.2
	2	74.8	54.4	63.6	64.1	65.8	117.4	65.3	87.2	37.6	60.1	67.6	66.5	94.4	69.9	88.6	88.2	72.8
	3	73.0	61.7	72.1	64.3	62.7	129.9	76.6	86.9	41.3	63.5	69.7	81.9	98.3	69.0	93.0	92.1	77.2
	4	73.1	61.7	61.7	63.6	60.5	124.2	73.7	83.4	39.9	65.9	63.3	76.0	98.0	64.8	88.0	84.6	73.9
	5	81.6	55.7	75.3	65.4	55.4	128.3	78.3	94.2	53.5	70.0	68.7	91.7	106.2	71.6	101.9	84.4	80.1
	6	72.9	60.7	74.3	72.0	72.7	121.9	78.0	90.9	54.0	61.5	70.9	85.4	101.3	72.0	103.2	96.5	80.5
	7	74.0	56.6	64.7	68.9	78.6	126.3	84.5	93.6	48.2	70.2	76.5	86.7	113.0	75.0	93.9	97.9	81.8
	8	82.7	58.0	62.7	67.4	63.7	130.3	86.1	95.4	60.9	71.6	84.2	93.9	115.9	77.1	110.4	92.1	84.5
	9	78.4	50.6	65.1	68.3	71.9	130.1	86.1	96.7	63.0	58.1	75.2	93.4	106.3	77.1	113.2	99.2	83.3
	10	80.0	52.7	65.2	72.4	78.0	130.9	80.3	91.2	57.3	64.6	68.8	85.0	104.9	73.4	100.0	90.0	80.9
	11	80.3	62.2	74.9	71.2	73.7	143.3	100.9	100.7	53.9	70.8	83.4	111.2	117.2	75.0	118.3	88.8	89.1
	12	84.8	61.9	65.6	72.2	73.7	139.7	107.2	102.3	57.8	64.5	86.3	109.3	119.6	76.6	117.5	93.6	89.5
	13	82.9	57.7	66.1	74.9	74.7	137.1	104.6	108.9	61.5	61.8	84.6	101.2	115.8	75.7	115.0	95.5	88.6
	14	82.4	67.7	74.7	71.8	77.2	141.7	104.9	111.7	63.8	75.0	88.1	106.2	120.7	83.3	120.1	88.3	92.4
	15	85.3	62.3	69.2	68.5	78.1	131.4	103.4	103.8	63.1	65.0	88.8	100.2	122.1	72.4	114.0	99.1	89.2
	16	85.9	59.6	71.0	72.5	79.9	131.5	101.5	107.9	59.4	72.6	87.7	106.1	122.1	81.1	118.2	99.5	91.0
	17	76.0	51.5	66.5	75.1	81.9	136.8	101.5	109.8	68.6	54.4	86.0	97.2	116.0	79.0	115.1	93.0	88.0
LSD (P<.05)																		
Tillage		NS	2.1	5.2	1.8	0.8	5.6	1.7	1.0	1.0	1.2	1.3	5.0	2.1	1.5	3.0	4.3	1.2
Fertilizer		7.7	5.0	NS	4.4	2.0	13.4	4.0	2.4	2.3	2.8	3.0	11.9	5.1	3.6	7.1	10.2	3.0
T X F		13.3	8.6	NS	7.6	3.5	NS	7.0	4.2	4.0	4.8	5.2	NS	8.8	6.2	NS	NS	NS
		Depth of moist soil, inch																
Tillage System																		
CT		56.0	46.0	40.0	54.0	54.0	70.0	64.0	72.0	40.0	48.0	54.0	62.0	72.0	60.0	70.0	56.0	57.4
RT		54.0	38.0	50.0	44.0	42.0	72.0	64.0	60.0	42.0	48.0	54.0	60.0	72.0	42.0	72.0	66.0	55.0
NT		56.0	48.0	62.0	56.0	62.0	72.0	62.0	72.0	42.0	50.0	56.0	70.0	72.0	60.0	72.0	66.0	61.1
LSD (P<.05)																		
Tillage System		1.3	1.1	1.0	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.8	NS	0.6	0.6	0.6	0.3

[1]
CT = clean-till
RT = reduced-till
NT = no-till

[2]

Fert. No.	Fertilizer Treatments	Fert. No.	Fertilizer Treatments
1	No fertilizer	10	St + N w/seed + Spring N
2	Starter (50 lb/a of 18-46-0)	11	Feedlot manure @ 10 ton/a
3	Nitrogen w/seed (20 lb N/a)	12	Manure + St
4	Nitrogen-spring applied (60 lb N/a)	13	Manure + N w/seed
5	Nitrogen-fall applied (60 lb N/a)	14	Manure + Spring N
6	St + N w/seed	15	Manure + St + N w/seed
7	St + Spring applied N	16	Manure + St + Spring N
8	St + Fall applied N	17	Manure + St + N w/seed + Spring N
9	St + N w/seed + Fall N		

Table 8. Winter wheat yields as affected by 17 fertilizer treatments in three tillage systems in a wheat-sorghum-fallow rotation. Depth of moist soil (taken at planting) as affected by tillage systems, Ed Stehno farm, Ellis Co., KS.

Tillage System[1]	Fert. No.[2]	Year 1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	17-Yr Avg.
		Yield, bu/a																	
CT	1	39.6	20.0	6.9	44.7	18.0	31.9	38.9	24.8	23.6	19.7	20.7	22.5	21.8	24.1	24.5	15.0	34.2	25.3
CT	2	45.5	24.7	5.9	51.6	32.2	27.3	35.4	27.9	23.2	21.9	35.7	22.4	36.7	26.6	28.5	15.0	34.1	29.1
CT	3	46.3	18.9	7.4	44.5	25.1	27.5	39.2	27.9	24.3	23.9	27.0	27.5	42.2	29.8	27.7	17.5	33.6	28.8
CT	4	38.5	16.5	6.4	41.1	20.3	33.2	41.8	32.1	24.5	20.3	24.6	24.2	41.7	26.3	29.3	16.5	34.4	27.7
CT	5	42.0	21.0	15.7	37.0	25.4	27.7	41.5	39.3	35.3	25.3	33.2	32.8	43.9	40.0	26.9	18.0	39.3	32.0
CT	6	50.7	28.9	7.0	49.3	34.7	23.6	43.1	35.4	35.7	19.9	33.2	33.8	44.9	35.2	29.7	17.9	37.4	33.0
CT	7	44.4	21.7	12.5	49.5	30.9	34.1	42.3	39.9	33.8	26.8	28.3	33.8	54.8	33.6	27.6	16.6	35.1	33.3
CT	8	48.5	25.5	11.4	58.6	34.5	27.5	43.7	46.1	42.0	25.8	37.6	37.1	55.4	39.8	32.3	20.1	33.9	36.5
CT	9	47.6	25.8	9.7	48.0	37.0	25.5	39.4	49.5	35.6	30.2	31.2	32.7	49.4	33.6	30.2	19.1	33.2	34.0
CT	10	46.3	28.0	8.6	51.6	35.2	28.4	38.5	39.7	27.7	20.5	34.7	30.0	54.8	33.5	31.1	18.7	31.2	32.9
CT	11	40.6	35.0	8.8	51.0	40.2	27.5	39.0	46.7	28.6	45.8	40.1	41.1	59.7	42.9	35.3	19.0	36.6	37.5
CT	12	41.1	30.9	13.7	52.1	37.3	26.4	30.9	57.4	30.3	43.4	35.9	37.5	60.8	45.8	34.1	16.4	35.1	37.0
CT	13	40.7	31.6	7.3	50.3	30.5	21.1	40.5	54.7	30.6	29.3	36.1	38.5	56.1	40.6	34.6	18.4	35.0	35.0
CT	14	43.6	30.5	9.9	54.7	36.3	25.1	35.2	51.0	30.9	49.5	39.2	34.6	53.0	40.8	31.4	17.6	37.3	36.5
CT	15	43.1	28.0	12.0	51.6	37.1	21.3	40.8	46.2	26.6	42.5	33.5	39.6	53.8	39.9	33.9	18.6	36.8	35.6
CT	16	47.3	28.4	10.8	54.4	30.9	22.4	34.5	45.6	28.4	37.0	47.6	39.4	49.2	44.8	37.8	17.0	38.7	36.1
CT	17	46.9	29.3	7.9	50.8	34.7	20.9	43.3	46.2	30.7	41.6	40.6	38.6	50.8	40.2	40.1	19.2	40.6	36.6
RT	1	37.9	19.3	2.4	30.5	18.3	31.2	41.2	21.7	23.0	15.2	19.3	17.3	24.5	21.4	20.3	15.4	37.3	23.3
RT	2	41.1	30.4	4.2	43.8	30.8	34.5	34.8	24.0	23.9	20.4	18.8	27.4	33.0	31.3	25.7	16.6	38.5	28.2
RT	3	40.0	18.9	5.7	34.8	17.6	28.4	41.3	29.0	31.1	22.7	25.7	22.9	39.6	34.0	24.1	16.3	38.2	27.7
RT	4	37.2	19.7	5.1	33.0	18.9	36.3	44.8	22.0	28.9	17.9	23.4	18.5	36.9	27.1	25.4	16.6	39.6	26.5
RT	5	40.6	18.1	7.8	35.2	20.2	29.7	48.8	31.7	30.2	21.2	29.2	31.5	44.6	41.1	30.8	18.6	41.9	30.7
RT	6	40.4	25.2	4.9	45.4	31.7	32.6	45.4	35.7	30.2	26.8	31.0	27.3	41.2	30.8	31.4	18.7	39.4	31.7
RT	7	39.4	30.9	11.7	54.0	30.4	32.8	46.2	27.8	29.0	18.6	23.9	26.7	50.1	33.0	31.3	16.4	38.4	31.8
RT	8	46.2	32.1	5.6	49.9	36.2	34.7	39.8	43.3	35.4	26.2	38.2	36.2	54.7	43.9	32.5	17.8	39.1	36.0
RT	9	44.5	31.0	9.4	51.4	33.0	27.8	42.1	44.1	37.7	24.6	35.5	34.7	53.4	36.4	33.2	19.9	38.0	35.1
RT	10	42.6	29.4	5.1	49.7	32.8	28.2	42.0	40.9	32.2	24.7	35.7	29.9	49.4	38.0	31.0	21.1	36.8	33.5
RT	11	47.4	37.3	9.3	55.5	38.3	35.0	36.5	44.2	29.6	43.7	43.7	45.2	57.9	45.2	39.3	18.6	37.0	39.0
RT	12	45.4	32.9	7.1	56.2	37.7	29.0	33.0	50.3	31.5	35.7	49.8	45.6	61.1	50.2	41.6	18.2	36.9	38.9
RT	13	43.6	33.8	4.9	54.4	34.8	31.9	38.7	55.8	30.1	33.7	50.8	40.3	60.9	44.0	33.6	16.2	38.0	38.0
RT	14	47.0	33.9	13.1	53.0	35.6	34.7	35.3	54.9	24.2	39.1	46.7	45.2	52.3	48.7	41.4	16.7	39.2	38.9
RT	15	43.1	34.7	8.0	53.4	39.0	29.9	33.7	54.2	31.1	40.8	48.5	46.1	57.5	48.9	36.3	17.1	38.6	38.9
RT	16	39.6	30.4	6.7	53.1	35.4	30.2	40.3	48.6	28.9	37.3	47.6	44.9	49.5	56.4	36.5	17.0	38.5	37.7
RT	17	50.1	29.9	6.1	51.9	33.6	28.2	40.5	55.7	27.9	41.1	48.1	31.8	53.7	47.8	33.8	19.2	40.1	37.6
NT	1	40.1	25.7	8.1	38.7	17.5	22.2	36.7	27.5	16.3	15.2	17.0	16.7	28.9	25.7	18.5	15.8	34.5	23.8
NT	2	52.0	35.2	6.5	44.1	32.8	30.0	35.4	32.4	21.4	19.6	19.4	18.3	33.6	34.2	27.9	19.3	34.0	29.2
NT	3	46.6	21.9	10.6	42.3	19.4	24.4	42.2	40.0	21.5	21.1	23.9	22.3	36.9	32.7	20.2	19.0	32.2	28.1
NT	4	44.4	23.5	8.0	55.9	21.2	26.6	42.9	32.5	18.2	17.5	20.0	16.5	36.3	28.2	17.9	19.5	38.1	27.5
NT	5	45.3	24.2	11.5	43.7	23.9	27.3	46.3	37.9	25.7	20.8	25.3	27.5	42.5	39.8	22.4	17.2	40.1	30.7
NT	6	46.4	34.0	4.5	53.6	37.2	25.3	43.6	44.5	21.8	19.5	25.3	26.2	41.4	41.1	24.6	20.5	39.6	32.3
NT	7	44.3	33.2	13.4	53.4	33.1	29.5	53.9	42.8	28.2	18.1	25.5	24.3	56.0	39.4	28.4	17.4	35.9	33.9
NT	8	51.4	34.9	5.8	59.9	37.6	26.2	40.0	48.9	30.4	24.6	35.6	36.0	56.0	48.6	28.5	17.5	34.4	36.2
NT	9	49.3	37.3	15.4	55.3	35.2	25.1	48.4	54.8	31.0	24.3	36.1	34.7	50.9	37.8	28.2	18.4	32.8	36.2
NT	10	44.8	38.2	6.3	55.3	35.4	24.4	46.5	44.2	25.3	20.3	29.2	29.1	49.6	42.2	27.1	19.2	31.9	33.5
NT	11	46.5	42.6	26.5	60.3	45.3	36.3	53.7	60.8	31.5	42.9	49.0	44.2	56.8	52.9	32.0	18.4	32.3	43.1
NT	12	48.8	39.0	20.3	60.1	45.3	32.6	39.3	60.8	33.6	35.4	53.3	44.5	57.6	45.8	31.3	17.5	33.5	41.1
NT	13	48.2	36.2	17.0	55.3	42.6	26.4	42.4	60.8	27.0	28.9	45.9	44.6	47.2	47.9	30.8	18.7	35.7	38.6
NT	14	46.5	40.5	24.8	54.6	47.3	30.4	42.4	62.7	28.1	38.9	51.7	44.1	55.0	50.6	35.3	17.2	37.4	41.6
NT	15	48.1	36.0	13.1	51.2	42.0	29.0	45.1	59.7	30.7	39.0	48.1	47.5	51.0	45.2	31.5	18.6	35.9	39.5
NT	16	42.8	38.3	12.1	53.6	48.9	29.9	49.5	57.8	33.0	35.7	47.1	48.3	56.2	49.2	33.3	17.6	36.8	40.6
NT	17	49.8	36.5	18.8	52.1	39.7	20.5	46.0	56.3	28.4	38.9	36.4	40.5	47.3	43.6	35.7	18.6	37.8	38.1

Table 8. (con't.) Wheat yields as affected by 17 fertilizer treatments in three tillage systems in a wheat-sorghum-fallow rotation. Depth of moist soil (taken at planting) as affected by tillage systems, Ed Stehno farm, Ellis Co., KS

Tillage System[1]	Fert. No.[2]	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	17-Yr Avg.
		Yield, bu/a																	
Tillage System Averages																			
CT		44.3	26.2	9.5	49.5	31.8	26.5	39.3	41.8	30.1	30.8	34.1	33.3	48.8	36.3	31.5	17.7	35.7	33.4
RT		42.7	28.7	6.9	47.4	30.8	31.5	40.3	40.2	29.7	28.8	36.2	33.6	48.3	39.9	32.2	17.7	38.6	33.7
NT		46.8	34.0	13.1	52.3	35.6	27.4	44.4	48.5	26.6	27.1	34.6	33.2	47.2	41.5	27.9	18.3	35.5	34.9
Fertilizer Treatment Averages																			
	1	39.2	21.6	5.8	38.0	17.9	28.4	38.9	24.7	21.0	16.7	19.0	18.8	25.1	23.7	21.1	15.4	35.3	24.2
	2	46.2	30.1	5.5	46.5	31.9	30.6	35.2	28.1	22.8	20.6	24.6	22.7	34.4	30.7	27.4	17.0	35.5	28.8
	3	44.3	19.9	7.9	40.5	20.7	26.8	40.9	32.3	25.6	22.6	25.5	24.2	39.6	32.2	24.0	17.6	34.7	28.2
	4	40.1	19.9	6.5	43.3	20.2	32.0	43.1	28.9	23.9	18.6	22.7	19.7	38.3	27.2	24.2	17.5	37.4	27.3
	5	42.6	21.1	11.7	38.7	23.2	28.2	45.5	36.3	30.4	22.4	29.2	30.6	43.7	40.3	26.7	17.9	40.4	31.1
	6	45.8	29.4	5.5	49.4	34.5	27.1	44.1	38.5	29.3	22.0	29.8	29.1	42.5	35.7	28.5	19.0	38.8	32.3
	7	42.7	28.6	12.5	52.3	31.5	32.1	47.4	36.8	30.3	21.2	25.9	28.3	53.6	35.3	29.1	16.8	36.4	33.0
	8	48.7	30.9	7.6	56.1	36.1	29.5	41.2	46.1	35.9	25.5	37.1	36.4	55.4	44.1	31.1	18.5	35.8	36.2
	9	47.1	31.4	11.5	51.6	35.1	26.1	43.3	49.4	34.8	26.4	34.3	34.0	51.2	35.9	30.5	19.2	34.7	35.1
	10	44.6	31.9	6.7	52.2	34.5	27.0	42.4	41.6	28.4	21.8	33.2	29.6	51.3	37.9	20.7	19.7	33.3	33.3
	11	44.8	38.3	14.9	55.6	41.3	32.9	43.1	50.6	29.9	44.1	44.3	43.5	58.1	47.0	35.5	18.7	35.3	39.9
	12	45.1	34.3	13.7	56.2	40.1	29.3	34.4	56.1	31.8	38.2	46.3	42.5	59.8	47.3	35.7	17.4	35.2	39.0
	13	44.1	33.9	9.7	53.3	36.0	26.5	40.5	57.1	29.2	30.6	44.3	41.1	54.7	44.1	33.0	17.8	36.2	37.2
	14	45.7	35.0	15.9	54.1	39.7	30.1	37.6	56.2	27.7	42.4	45.9	41.3	53.4	46.7	36.0	17.2	38.0	39.0
	15	44.7	32.9	11.0	52.1	39.3	26.7	39.9	53.4	29.4	40.8	43.4	44.4	54.1	44.7	33.9	18.1	37.1	38.0
	16	43.2	32.4	9.9	53.7	38.4	27.5	41.4	50.7	30.1	36.7	47.4	44.2	51.6	50.1	35.9	17.2	38.0	38.1
	17	48.9	31.9	11.0	51.6	36.0	23.2	43.3	52.7	29.0	40.5	41.7	37.0	50.6	43.9	36.5	19.0	39.5	37.4
LSD (P<.05)																			
Tillage		0.6	0.4	0.3	0.5	0.6	0.5	0.6	0.4	0.4	0.8	1.6	NS	1.2	1.0	1.0	NS	1.7	0.4
Fertilizer		1.3	0.9	0.6	1.2	1.4	1.1	1.5	0.9	0.8	1.8	3.9	6.5	2.9	2.3	2.3	1.7	3.9	0.9
T X F		2.2	1.0	1.0	2.1	3.1	1.9	2.6	1.6	1.5	3.2	6.7	NS	5.1	3.9	4.0	NS	NS	6.3
		Depth of moist soil, inch																	
Tillage System																			
CT		60.0	54.0	42.0	66.0	54.0	48.0	60.0	66.0	54.0	60.0	58.0	60.0	66.0	60.0	54.0	44.0	62.0	56.9
RT		60.0	54.0	36.0	66.0	54.0	54.0	60.0	66.0	54.0	60.0	64.0	60.0	72.0	66.0	58.0	42.0	64.0	58.2
NT		60.0	60.0	48.0	72.0	60.0	54.0	66.0	72.0	54.0	60.0	64.0	62.0	66.0	66.0	54.0	42.0	60.0	60.0
LSD (P<.05)																			
Tillage System		NS	0.6	0.6	0.6	0.6	0.6	0.6	0.6	NS	NS	1.4	1.0	0.6	0.6	2.3	0.6	1.1	0.1

1
CT = clean-till
RT = reduced-till
NT = no-till

2

Fert. No.	Fertilizer Treatments	Fert. No.	Fertilizer Treatments
1	No fertilizer	10	St + N w/seed + Spring N
2	Starter (50 lb/a of 18-46-0)	11	Feedlot manure @ 10 ton/a
3	Nitrogen w/seed (20 lb N/a)	12	Manure + St
4	Nitrogen-spring applied (60 lb N/a)	13	Manure + N w/seed
5	Nitrogen-fall applied (60 lb N/a)	14	Manure + Spring N
6	St + N w/seed	15	Manure + St + N w/seed
7	St + Spring applied N	16	Manure + St + Spring N
8	St + Fall applied N	17	Manure + St + N w/seed + Spring N
9	St + N w/seed + Fall N		

EFFECTS OF LAWN CLIPPINGS AND NEWSPRINT ON FORAGE SORGHUM PRODUCTION OVER A 12-YEAR PERIOD

C.A. Thompson

Summary

Applying biodegradeable wastes directly on the land instead of hauling them to the landfill can extend the life of the landfill and save the public a considerable amount of money. Grass clippings, whether applied yearly or during the residual years, continued to increase forage sorghum yields in both dryland and irrigated conditions. Newsprint decreased forage yields during the years of application. The residual negative effect of newsprint became less noticeable in succeeding years. During the years when a mixture of grass and newsprint was applied, a 3:2 ratio of grass to newsprint was necessary to be equal or greater than the control. This ratio during the residual years changed to 1:4. This is good news, because the volume of newsprint in our society is much higher than grass clippings. Grass clippings averaged about 2% nitrogen (N) while newsprint had little to no nitrogen.

Introduction

The cost of establishing and maintaining government regulated landfills is steadily increasing. Some of the materials going into the landfill are biodegradeable. This paper addresses forage sorghum performance of applying two of these raw biodegradeable materials directly on the soil. When raw biodegradeable materials are incorporated into the soil the micro-organisms decompose these products over time. Because soil nitrogen is a primary food source for these micro-organisms, the level of soil nitrogen and the amount and type of raw biodegradeable material applied greatly influences the time required to decompose these products.

Procedures

This study was established in the summer of 1990 on a Harney silt loam soil. Each week during the summer, lawn clippings were picked up by the city of Hays and brought to the KSU Agricultural Research Center-Hays and put into a trench silo. The lawn clippings were firmly packed into the silo after each unloading. Before individual plot application, lawn clippings were weighed over a truck scale. The clippings from the truck were dumped into a manure spreader and then applied to individual plots. Overage newsprint was obtained from the Hays Daily News and tied in bundles 12 inches in height, which equaled 40 lbs each. The bundles were ground through a tree chipper, blown into a truck and wetted down (to prevent blowing). As with the clippings, the newsprint was dumped into a manure spreader and applied to individual plots. In the first two years of the study, a manure spreader was not used, but both materials were spread out evenly by hand after being dumped into the center of the plot.

The clippings and newsprint were incorporated with a chisel and disc. Current high yielding forage sorghums were used throughout the duration of the study. Both continuous irrigated and dryland crop-fallow systems were used. Nitrogen fertilizer as ammonium nitrate was applied to about half of the plots. Harvest was with a self-propelled forage clipping machine with automatic weighing device, which left 4-inch stubble in the field. Individual harvested plot area was 3 ft x 30 ft. The remainder of each plot was harvested with a field swather and baler.

Results

<u>1991-1995</u>

From 1991 through 1995 (Table 9), lawn clippings and newsprint were applied annually. Each phase of every treatment was included each year. In the 15 and 45 ton/a newsprint treatments there was a gradual buildup of material to the point it was difficult to plant into soil. Much of the newsprint was still legible 4 to 5 years after application. Grass clippings raised forage yields, while newsprint decreased forage yields in each of the years. This finding was true in both dryland and irrigated plots. Because the N content of grass clippings was much higher than newsprint, decomposition was much faster. Nitrogen fertilizer in both dryland and irrigated conditions generally raised yields over comparable treatments without N in each year. When the two materials were mixed together, at least 3 parts of grass to 2 parts of paper were necessary to raise yields over the control. However, in 1995 a 1:4 ratio of grass to newsprint raised yields over the control.

1996-2002

From 1996 to 2002 (Table 10) no additional lawn clippings or newsprint were added to the soil. The residual effect of grass clippings was similar to the first five years of application. As decomposition of the newsprint took place each year, the yields gradually increased. Legibility and visibility of newsprint by year 2000 were nearly gone. The continued addition of nitrogen fertilizer continued to increase yields. The 1:4 ratio of grass to newsprint continued to produce yields that were nearly equal or greater than the control.

Table 9. Forage sorghum yields as affected by shredded newspaper and grass clippings applied in the fall, KSU Agricultural Research Center-Hays, KS.

Dryland/ Irrigated	Cropping Sequence	Grass[1]	Paper[1]	N Rate	Yield 1991	1992	1993	1994	1995	Avg.
		ton/a	ton/a	lb/a	- - - - - - - -	- - - - - -	ton/a	- - - - - -	- - - - - -	- - - -
Dryland	Crop-fallow	0	0	0	3.13	4.64	3.78	3.58	1.50	3.33
Dryland	Crop-fallow	5	0	0	3.37	4.86	3.52	3.70	1.54	3.40
Dryland	Crop-fallow	15	0	0	3.03	5.08	4.42	3.68	2.14	3.67
Dryland	Crop-fallow	45	0	0	3.30	4.45	4.67	4.48	2.49	3.88
Dryland	Crop-fallow	0	0	50	2.83	5.12	3.91	3.69	1.85	3.48
Dryland	Crop-fallow	5	0	50	3.03	5.63	4.52	3.82	1.98	3.80
Dryland	Crop-fallow	15	0	50	3.40	5.85	4.72	4.31	2.25	4.10
Dryland	Crop-fallow	45	0	50	3.53	6.22	4.79	4.75	2.55	4.37
Dryland	Crop-fallow	0	5	0	3.03	4.27	3.27	3.18	1.61	3.07
Dryland	Crop-fallow	0	15	0	2.37	2.03	2.54	2.27	1.05	2.05
Dryland	Crop-fallow	0	45	0	1.03	1.72	0.99	1.11	0.49	1.07
Dryland	Crop-fallow	0	5	50	3.03	4.52	3.61	3.72	1.93	3.36
Dryland	Crop-fallow	0	15	50	3.20	3.18	2.85	2.75	1.93	2.78
Dryland	Crop-fallow	0	45	50	1.33	2.01	1.43	1.66	0.74	1.43
Irrigated	Continuous	0	0	0	2.70	2.56	2.04	1.89	1.86	2.21
Irrigated	Continuous	15	0	0	3.03	2.40	3.76	3.78	2.11	3.02
Irrigated	Continuous	45	0	0	3.43	4.52	4.95	3.95	2.56	3.88
Irrigated	Continuous	0	0	50	3.20	3.24	2.67	2.79	1.97	2.78
Irrigated	Continuous	15	0	50	3.50	4.88	4.09	4.26	2.44	3.83
Irrigated	Continuous	45	0	50	3.70	5.98	5.51	4.43	2.69	4.46
Irrigated	Continuous	0	5	0	1.73	1.49	1.40	2.24	1.03	1.58
Irrigated	Continuous	0	15	0	1.50	1.08	0.97	1.15	0.69	1.08
Irrigated	Continuous	0	45	0	0.60	0.88	0.24	0.95	0.16	0.57
Irrigated	Continuous	0	5	50	3.67	2.28	1.65	2.84	1.47	2.38
Irrigated	Continuous	0	15	50	1.73	1.81	1.10	1.36	0.90	1.38
Irrigated	Continuous	0	45	50	1.57	1.24	0.37	1.10	0.20	0.89
Irrigated	Continuous	36	9	0	3.87	4.23	4.35	4.18	2.48	3.82
Irrigated	Continuous	27	18	0	3.73	3.84	3.29	4.00	2.19	3.41
Irrigated	Continuous	18	27	0	2.83	2.95	2.64	3.08	2.06	2.71
Irrigated	Continuous	9	36	0	1.13	1.64	1.52	1.84	2.14	1.66
Irrigated	Crop-fallow	45	0	0	3.67	5.73	4.78	4.61	2.81	4.32
Irrigated	Crop-fallow	45	0	50	3.77	5.95	4.91	4.98	3.00	4.52
LSD (P<.05)					0.21	0.14	0.18	0.14	0.12	0.07

[1] Grass and paper wastes applied on each crop.

Table 10. Forage sorghum yields as affected by the residual effect of shredded newspaper and grass clippings applied in the fall, KSU Agricultural Research Center-Hays, KS, 1991 to 1995.

Dryland/	Cropping			N	Yield							
Irrigated	Sequence	Grass	Paper	Rate	1996	1997	1998	1999	2000	2001	2002	Avg.
		ton/a	ton/a	lb/a	- - - - - - - - - - - - - - - ton/a - - - - - - - - - - - - - - -							
Dryland	Crop-fallow	0	0	0	2.86	1.97	2.11	1.13	3.50	4.78	4.40	2.96
Dryland	Crop-fallow	5	0	0	3.43	2.36	4.87	1.98	3.71	5.34	5.29	3.85
Dryland	Crop-fallow	15	0	0	4.19	2.73	5.04	2.37	4.15	5.73	5.73	4.28
Dryland	Crop-fallow	45	0	0	4.51	2.61	6.09	2.56	4.10	6.58	5.70	4.59
Dryland	Crop-fallow	0	0	50	3.25	2.17	3.93	1.54	3.74	5.41	4.85	3.56
Dryland	Crop-fallow	5	0	50	3.57	2.57	5.16	2.42	4.07	6.12	5.60	4.21
Dryland	Crop-fallow	15	0	50	4.45	2.84	5.67	2.52	4.25	6.22	5.89	4.55
Dryland	Crop-fallow	45	0	50	5.53	2.98	6.85	2.62	4.87	6.93	6.18	5.14
Dryland	Crop-fallow	0	5	0	2.80	1.90	3.95	1.11	3.66	4.64	4.83	3.27
Dryland	Crop-fallow	0	15	0	2.34	1.63	3.49	1.17	3.63	5.83	5.05	3.31
Dryland	Crop-fallow	0	45	0	1.15	1.11	1.78	0.85	3.63	6.38	4.93	2.83
Dryland	Crop-fallow	0	5	50	3.48	2.07	4.70	1.34	3.73	5.66	5.31	3.76
Dryland	Crop-fallow	0	15	50	2.92	1.88	4.31	1.39	3.71	6.48	6.05	3.82
Dryland	Crop-fallow	0	45	50	1.23	1.20	2.63	1.02	3.68	7.08	6.61	3.35
Irrigated	Continuous	0	0	0	2.55	1.47	2.81	1.06	3.78	7.58	5.59	3.55
Irrigated	Continuous	15	0	0	2.82	2.30	4.29	1.93	3.83	6.94	5.91	4.00
Irrigated	Continuous	45	0	0	3.37	3.03	5.03	2.83	4.17	7.69	5.64	4.54
Irrigated	Continuous	0	0	50	3.70	1.70	3.40	1.57	3.89	5.91	5.78	3.71
Irrigated	Continuous	15	0	50	3.42	2.58	4.98	2.55	4.14	7.08	6.57	4.47
Irrigated	Continuous	45	0	50	4.14	3.36	5.94	3.13	4.36	7.16	6.68	4.97
Irrigated	Continuous	0	5	0	2.51	1.53	3.74	1.08	3.64	6.31	5.25	3.44
Irrigated	Continuous	0	15	0	2.24	0.95	2.69	0.92	3.52	6.73	5.16	3.17
Irrigated	Continuous	0	45	0	0.74	0.38	2.06	0.69	1.37	7.37	5.15	2.54
Irrigated	Continuous	0	5	50	3.10	1.86	4.23	1.24	3.90	6.98	5.62	3.85
Irrigated	Continuous	0	15	50	2.48	1.66	3.29	1.44	3.66	7.64	5.32	3.64
Irrigated	Continuous	0	45	50	1.12	0.66	2.72	1.22	1.80	7.36	5.65	2.93
Irrigated	Continuous	36	9	0	4.45	2.86	5.85	2.73	4.85	7.21	6.07	4.86
Irrigated	Continuous	27	18	0	3.88	2.76	5.21	2.53	3.91	7.00	5.83	4.45
Irrigated	Continuous	18	27	0	3.17	2.66	4.80	2.02	3.64	6.73	5.88	4.13
Irrigated	Continuous	9	36	0	3.01	2.42	4.17	1.43	2.84	6.59	5.25	3.67
Irrigated	Crop-fallow	45	0	0	4.17	2.16	6.11	2.82	4.15	7.38	6.13	4.70
Irrigated	Crop-fallow	45	0	50	4.53	3.37	7.24	2.93	4.30	7.85	6.75	5.28
LSD (P<.05)					0.51	0.22	0.65	0.35	0.32	0.70	0.77	0.20

LONG-TERM EFFECTS OF NITROGEN AND PHOSPHORUS FERTILIZER ON CONTINUOUS GRAIN SORGHUM ON A CRETE SILTY CLAY LOAM SOIL

C.A. Thompson

Summary

Monitoring the depth of moist soil before planting sorghum in continuous cropping is critically important in the 22.5-inch precipitation area of Kansas to ensure a profitable return from fertilizer usage. The first 20 lb/a of nitrogen (N) gave the highest return per fertilizer dollar invested. However, when depth of moist soil at planting was 48 inches or deeper, 60 lb N/a maximized yields and net fertilizer return. Using low N rates is advised only when depth of moist soil is limited. Phosphorus (P) addition on this medium fertility soil was not cost-effective.

Introduction

Crop rotation studies have shown continuous grain sorghum to be a viable cropping system in the 22.5-inch precipitation zone of Kansas. Moisture storage is critical to assure profitable production levels. In addition, amount and type of fertilizer to apply is also critical. Too much fertilizer could provide good vegetative growth, but, because of limited soil moisture, yield levels could be low. However, too little fertilizer may not use the stored moisture effectively and would not optimize profitable yields. This study attempts to address these issues.

Procedures

This study was initiated in 1970 with the first yields as affected by commercial fertilizer taken in 1971. The study was located on medium fertility nearly level Crete silty clay loam soil. Nitrogen (ammonium nitrate, 34-0-0) and phosphate (0-46-0) fertilizers were applied in the fall each year just before chiseling. Reduced-tillage was performed throughout the study. Plots were 12 x 30 feet and replicated 4 times. Grain sorghum was planted in 12-inch rows at 60,000 seeds/a (Super Thick grain sorghum). A 5/16-inch rod with a ½-inch ball bearing welded to the end was pushed into the soil to determine the depth of soil water. Sorghum was calculated at $1.98/bu. Fertilizer costs (including application) were $10.40 for 20 lb N/a, $17.40 for 40 lb N/a, $24.40 for 60 lb N/a, and $28.25 for 40+46+0. This study had a randomized block design and was analyzed with SAS using ANOVA.

Results

A majority of the years favored applying 60 lb N/a to achieve maximum yields (Table 11). Average yields and net return over fertilizer during the 32 years (1971 to 2002) also favored 60 lb N/a. Only 2 of 32 years showed an increase in profit with phosphorus addition. The first 20 lb N/a gave the highest return per dollar invested.

Depth of moist soil at planting ranged from 12 to 72 inches (Table 11). In general, the greater the depth of moist soil, the higher the yields and net return. Chiseling in the fall after harvest is recommended to ensure deep soil moisture penetration from winter snows and spring rains.

The overall effect of depth of moist soil is shown in Table 12. Having 48-inch or deeper moist soil at planting provided a consistent yield and net profit increase with 60 lb N/a fertilizer. When depth of moist soil was from 30 to 42 inches, 40 lb N/a is recommended. When depth of moist soil is less than 30 inches, no fertilizer is recommended.

Table 11. Yearly effect of commercial fertilizer on yield and net return (over fertilizer) on continuous grain sorghum, Harney silt loam soil, KSU Agricultural Research Center-Hays, KS, 1971 to 2002.

Fertilizer $N+P_2O_5+K_2O$	1971 Yield	1971 Net Return	1972 Yield	1972 Net Return	1973 Yield	1973 Net Return	1974 Yield	1974 Net Return	1975 Yield	1975 Net Return	1976 Yield	1976 Net Return
lb/a	bu/a	$/a	bu/a	$/a	bu/a	$/a	bu/a	$/a	bu/a	$/a	bu/a	$/a
0+0+0	33.0	65.42	49.6	98.25	30.7	60.92	30.8	60.97	30.6	60.72	7.0	13.92
20+0+0	41.3	71.41	64.2	116.67	39.1	67.16	59.8	108.16	43.0	74.78	14.3	17.93
40+0+0	39.1	60.00	71.9	125.08	46.2	74.17	62.0	105.41	43.7	69.21	13.4	9.19
60+0+0	40.0	54.78	77.4	128.92	48.0	70.64	79.4	132.83	37.9	50.62	9.3	-6.03
40+46+0	42.4	55.74	68.4	107.25	53.2	77.19	67.0	104.53	52.7	48.12	14.3	0.08
LSD (P=.05)	NS	NS	11.8	23.43	12.4	NS	23.4	46.40	NS	NS	NS	NS
Moist Soil (in)	42		66		48		60		42		12	

Fertilizer $N+P_2O_5+K_2O$	1977 Yield	1977 Net Return	1978 Yield	1978 Net Return	1979 Yield	1979 Net Return	1980 Yield	1980 Net Return	1981 Yield	1981 Net Return	1982 Yield	1982 Net Return
lb/a	bu/a	$/a	bu/a	$/a	bu/a	$/a	bu/a	$/a	bu/a	$/a	bu/a	$/a
0+0+0	27.8	55.12	12.1	23.87	45.4	89.85	24.8	49.17	42.3	83.75	34.2	67.75
20+0+0	39.2	67.25	16.0	21.30	52.4	93.39	35.6	60.08	60.1	108.70	49.5	87.71
40+0+0	38.7	59.21	14.7	11.66	53.9	89.42	43.0	67.74	64.9	111.12	49.0	79.66
60+0+0	40.4	55.63	18.1	11.49	63.4	101.23	45.0	64.76	70.3	114.81	55.9	86.24
40+46+0	38.5	48.01	15.8	3.11	61.3	93.29	41.3	53.56	68.2	106.81	52.5	75.80
LSD (P=.05)	5.9	11.79	2.3	4.65	5.3	NS	9.3	NS	12.5	NS	5.0	9.81
Moist Soil (in)	36		18		60		42		66		48	

Fertilizer $N+P_2O_5+K_2O$	1983 Yield	1983 Net Return	1984 Yield	1984 Net Return	1985 Yield	1985 Net Return	1986 Yield	1986 Net Return	1987 Yield	1987 Net Return	1988 Yield	1988 Net Return
lb/a	bu/a	$/a	bu/a	$/a	bu/a	$/a	bu/a	$/a	bu/a	$/a	bu/a	$/a
0+0+0	5.0	9.96	17.9	35.46	26.9	53.29	46.9	93.01	42.3	83.84	20.5	40.67
20+0+0	5.2	-0.01	23.1	35.42	32.4	53.77	56.4	101.28	55.6	99.79	22.1	33.28
40+0+0	6.3	5.03	30.2	42.47	39.7	61.29	65.2	111.76	61.9	105.22	24.9	31.83
60+0+0	7.3	9.94	28.9	32.79	41.5	57.85	62.9	100.15	78.8	131.65	13.5	2.39
40+46+0	6.9	14.53	34.2	39.40	39.8	50.50	57.5	85.56	63.3	97.15	16.8	4.99
LSD (P=.05)	1.3	2.52	2.9	5.71	5.6	NS	NS	NS	11.0	21.72	4.5	9.00
Moist Soil (in)	12		30		36		60		66		18	

Table 11. (cont.) Yearly effect of commercial fertilizer on yield and net return (over fertilizer) on continuous grain sorghum. Conducted on a Harney silt loam soil on the KSU Agricultural Research Center-Hays from 1971 to 2002.

	1989		1990		1991		1992		1993		1994	
Fertilizer $N+P_2O_5+K_2O$	Yield	Net Return	Yield	Net Return	Yield	Net Return	Yield	Net Return	Yield	Net Return	Yield	Net Return
lb/a	bu/a	$/a	bu/a	$/a	bu/a	$/a	bu/a	$/a	bu/a	$/a	bu/a	$/a
0+0+0	19.4	38.48	24.0	47.53	27.3	54.14	56.8	112.48	6.3	12.49	27.7	54.88
20+0+0	22.8	34.72	27.9	44.81	23.5	36.11	76.3	140.65	22.7	34.52	45.0	78.74
40+0+0	15.8	13.89	21.4	25.04	17.5	17.31	79.1	139.30	36.5	54.89	56.9	95.37
60+0+0	12.0	-0.73	25.0	25.16	17.9	11.01	94.1	162.00	44.9	64.55	72.6	119.31
40+46+0	15.9	3.16	24.5	20.23	11.9	-4.82	85.7	141.52	37.7	46.39	56.7	84.12
LSD (P=.05)	2.8	5.53	2.4	4.67	1.5	7.31	1.8	3.60	2.6	5.15	3.2	6.35
Moist Soil (in)	18		24		24		72		30		54	

	1995		1996		1997		1998		1999		2000	
Fertilizer $N+P_2O_5+K_2O$	Yield	Net Return	Yield	Net Return	Yield	Net Return	Yield	Net Return	Yield	Net Return	Yield	Net Return
lb/a	bu/a	$/a	bu/a	$/a	bu/a	$/a	bu/a	$/a	bu/a	$/a	bu/a	$/a
0+0+0	19.9	39.52	49.7	98.46	29.1	57.64	18.1	35.85	13.2	26.15	27.9	55.27
20+0+0	27.3	43.72	69.8	127.87	47.2	83.10	30.9	50.76	32.0	52.88	53.0	94.54
40+0+0	39.2	60.25	86.2	153.30	54.6	90.80	39.2	60.30	55.0	91.65	53.0	87.59
60+0+0	53.0	80.64	101.8	177.22	65.6	105.54	55.2	84.89	73.7	121.64	68.4	111.10
40+46+0	37.3	45.70	96.5	162.82	59.4	89.39	45.7	62.29	58.7	81.30	57.5	85.61
LSD (P=.05)	1.5	2.96	2.1	4.22	8.8	17.37	6.6	13.17	13.4	26.52	17.0	33.78
Moist Soil (in)	36		72		66		42		48		54	

	2001		2003		19712002 avg	
Fertilizer $N+P_2O_5+K_2O$	Yield	Net Return	Yield	Net Return	Yield	Net Return
lb/a	bu/a	$/a	bu/a	$/a	bu/a	$/a
0+0+0	47.8	94.64	37.6	74.49	29.2	57.75
20+0+0	67.7	123.65	47.5	83.69	40.7	70.24
40+0+0	75.6	132.31	51.7	84.91	45.3	72.39
60+0+0	93.0	159.73	47.9	70.43	51.3	77.29
40+46+0	89.7	149.50	51.2	73.23	47.5	65.78
LSD (P=.05)	9.7	19.14	4.5	8.94	1.9	3.75
Moist Soil (in)	72		54		45	

Table 12. Average yield and net return from fertilizer as influenced by fertilizer and depth of moist soil on continuous grain sorghum on a Harney silt loam soil, KSU Agricultural Research Center-Hays, KS, 1971 to 2002.

Fertilizer $N+P_2O_5+K_2O$ lb/a	Depth of Moist Soil, Inch											
	12	18	24	30	36	42	48	54	60	66	72	Avg	R^2
	Yield, bu/a												
0+0+0	6.0	17.3	25.7	12.1	24.9	26.6	26.1	30.6	41.0	44.7	51.4	29.2	0.68
20+0+0	9.8	20.3	25.7	22.9	33.0	37.7	40.2	48.2	56.2	60.0	71.2	40.7	0.83
40+0+0	9.8	18.5	19.5	33.4	39.2	41.3	50.1	54.1	60.4	66.2	80.3	45.3	0.89
60+0+0	8.3	14.5	21.4	36.9	45.0	44.5	59.2	63.6	68.6	75.5	96.3	51.3	0.87
40+46+0	10.6	16.2	18.1	35.9	38.5	45.5	53.7	56.2	61.9	66.6	90.6	47.5	0.86
LSD (P=.05)	NS	3.6	5.4	7.2	4.4	5.9	9.3	5.5	10.1	6.3	4.8	1.9	
R^2	0.36	0.31	0.43	0.80	0.71	0.55	0.64	0.75	0.53	0.76	0.92	0.95	

Fertilizer $N+P_2O_5+K_2O$ lb/a	Depth of Moist Soil, Inch											
	12	18	24	30	36	42	48	54	60	66	72	Avg	R^2
	Net Return Over Fertilizer, $/a												
0+0+0	11.94	34.34	50.84	23.97	49.31	52.79	51.61	60.57	81.28	88.61	101.86	57.75	0.68
20+0+0	8.96	29.76	40.46	34.97	54.92	64.26	69.25	85.02	100.94	108.39	130.73	70.24	0.83
40+0+0	2.08	19.12	21.18	48.69	60.25	64.32	81.82	89.67	102.20	113.87	141.64	72.39	0.89
60+0+0	-7.99	4.38	18.09	48.67	64.71	63.76	92.84	101.59	111.40	125.13	166.32	77.29	0.87
40+46+0	-7.23	3.75	7.71	42.90	48.07	61.95	78.10	83.09	94.46	103.73	151.28	65.78	0.86
LSD (P=.05)	-11.99	7.11	10.73	14.18	8.81	NS	18.40	10.91	19.97	12.58	9.50	3.75	
R^2	0.58	0.77	0.82	0.50	0.38	0.29	0.41	0.56	0.35	0.59	0.85	0.95	

LONG-TERM EFFECTS OF FEEDLOT MANURE AND NITROGEN FERTILIZER ON CROPS IN A WHEAT-SORGHUM-FALLOW ROTATION

C.A. Thompson

Summary

Grain sorghum responded more consistently to feedlot manure additions on a Harney silt loam soil than did winter wheat. Because of this, applying feedlot manure on grain sorghum and relying on carryover for winter wheat is recommended. Manure rates applied to sorghum can range from 10 to 40 ton/a depending on how many acres are available. However, 10 ton manure/a was more cost effective than higher rates when applied on this medium fertility soil.

Introduction

Privately owned and commercial feedlots have a large volume of animal manure to dispose of each year. Traditionally, fields where crops are grown are the primary area where the feedlot manure is applied. However, many of the fields where manure is applied may not necessarily be low in soil fertility. Thus, the amount of feedlot manure to apply is in question. This paper addresses these issues.

Procedures

This four-replication study on a Harney silt loam soil was initiated in 1969 with the first sorghum crop in 1970 and first wheat crop in 1971. Every phase of the wheat-sorghum-fallow rotation was included each year. Tonnages of 10, 20, 40, and 80 were applied on both crops for the first nine years. The residual effects were monitored for the next 24 years. One nitrogen (N) fertilizer (ammonium nitrate, 34-0-0) treatment at 40 lb N/a was applied on each crop throughout the 33-year period. Plot size was 20 x 20 feet. Current high yielding sorghum hybrids and wheat varieties were used. This study had a randomized block design and was analyzed with SAS using ANOVA.

Results

<u>Grain Sorghum</u>

For the first nine years (Table 13) there was little yield difference between 10, 20, and 40 tons/a from feedlot manure additions. This is good news when a large volume of manure exists in the feedlot. However, if a farmer wants to apply manure on as many acres as possible, then the 10 ton/a rate is a strong option. Sorghum yields from the 80 ton manure/a rate were significantly less than the lower tonnages.

The residual effect of feedlot manure (Table 14) was studied for the next 24 years. The residual yield effect was very similar to the first nine years of application. This is good news because it shows the positive effect, after manure applications were stopped, can last for several years.

<u>Winter Wheat</u>

Feedlot manure was applied the first nine years (Table 15). For the first six years either no yield response or a significant negative response resulted from the manure applications. The low rate of 10 ton manure/a resulted in yields that were as good as or better than higher tonnages.

Residual manure rates of 40 and 80 tons/a resulted in reduced wheat yields in several of the 24 years (Table 16). More years responded to the low rate of 10 ton manure/a than did higher rates. Wheat responded more consistently to nitrogen fertilizer additions than to feedlot manure. Because of the inconsistent response of wheat to feedlot manure, applying manure to grain sorghum and relying on carryover on winter wheat is recommended.

Table 13. Effects of feedlot manure and nitrogen fertilizer on grain sorghum yields. Each phase of the wheat-sorghum-fallow rotation was included each year, KSU Agricultural Research Center-Hays, KS, 1970 to 1978.

Feedlot Manure and Nitrogen Fertilizer[1]	Yield									
	1970	1971	1972	1973	1974	1975	1976	1977	1978	9-Yr Avg.
	bu/a									
Control	42.9	64.5	76.0	39.0	68.5	54.6	67.2	110.0	29.3	61.3
10 ton/a	50.7	73.2	85.5	42.2	76.9	62.1	81.8	118.4	38.3	69.9
20 ton/a	50.5	70.3	85.6	42.6	69.1	63.4	75.9	112.1	44.7	68.2
40 ton/a	46.6	54.5	82.4	38.7	74.0	62.7	77.8	113.4	51.5	66.8
80 ton/a	48.9	37.3	71.3	35.1	52.2	51.0	74.8	106.5	46.0	58.1
40 lb N/a	46.1	71.0	82.8	44.0	68.8	56.5	66.2	109.0	40.5	65.0
LSD (P=.05)	2.0	18.9	NS	1.4	NS	NS	NS	NS	6.3	5.2

[1] Nitrogen as ammonium nitrate (34-0-0).

Table 14. Residual effects of feedlot manure and nitrogen fertilizer on grain sorghum yields. Each phase of the wheat-sorghum fallow rotation was included each year, KSU Agricultural Research Center-Hays, KS, 1979 to 2002.

Feedlot Manure and Nitrogen Fertilizer[1]	Yield												
	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	
	bu/a												
Control	93.8	54.5	56.8	73.5	20.3	26.2	63.2	102.7	129.0	81.3	66.7	33.3	
10 ton/a	96.0	77.5	68.2	89.6	21.1	29.5	75.1	80.8	141.8	79.5	62.2	36.5	
20 ton/a	100.6	70.9	65.0	78.6	28.4	31.4	86.1	81.7	137.3	88.3	71.6	36.7	
40 ton/a	100.8	68.8	70.1	76.5	16.7	16.7	88.9	93.3	124.1	80.5	63.8	25.7	
80 ton/a	97.8	60.1	66.8	68.1	16.2	13.1	87.2	83.5	99.9	77.5	41.6	24.7	
40 lb N/a	95.8	73.2	68.2	70.2	11.2	27.5	82.2	96.0	147.3	89.3	73.8	48.5	
LSD (P=.05)	NS	13.2	NS	6.0	2.5	5.5	8.9	13.7	24.6	NS	3.6	1.2	
	Yield												
	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	24-Yr Avg.
	bu/a												
Control	44.5	76.5	91.7	94.9	59.0	95.8	92.1	84.8	92.8	39.7	81.6	40.2	70.6
10 ton/a	31.4	99.8	94.8	106.0	78.3	106.7	98.4	108.5	110.2	46.1	114.9	67.9	80.1
20 ton/a	30.2	84.3	100.8	96.0	69.7	101.3	99.6	116.1	117.1	53.5	113.4	66.3	79.7
40 ton/a	27.9	89.6	112.5	94.1	68.7	108.7	105.8	123.8	115.8	83.3	125.7	64.2	81.1
80 ton/a	21.6	85.5	105.9	93.1	74.9	99.8	96.3	124.0	115.7	88.2	126.5	60.5	76.2
40 lb N/a	37.2	81.0	97.9	101.7	70.3	104.7	101.1	112.9	115.6	94.0	120.8	44.9	81.9
LSD (P=.05)	2.0	1.4	3.6	2.3	2.8	3.1	3.6	9.7	12.9	11.2	20.4	3.3	2.8

[1]Nitrogen as ammonium nitrate (34-0-0).

Table 15. Effects of feedlot manure and nitrogen fertilizer on winter wheat yields. Each phase of the wheat-sorghum-fallow rotation was included each year, 1971 to 1979. KSU Agricultural Research Center-Hays.

Feedlot Manure and Nitrogen Fertilizer[1]	Yield									
	1971	1972	1973	1974	1975	1976	1977	1978	1979	Avg.
Ton/a	- - - - - - - - - - - - - - - - bu/a - - - - - - - - - - - - - - - -									
Control	18.7	35.0	61.6	51.0	43.4	38.4	34.2	22.0	26.1	36.7
10 ton/a	18.0	28.7	44.1	46.0	50.4	33.7	37.9	20.7	32.6	34.7
20 ton/a	21.0	27.3	46.3	38.5	46.4	32.3	36.0	21.1	34.9	33.7
40 ton/a	18.5	29.9	49.6	32.3	43.2	33.2	35.1	22.4	33.7	33.1
80 ton/a	18.2	31.0	49.1	30.8	45.7	31.4	34.0	19.1	33.0	32.5
40 lb N/a	17.8	28.0	55.8	44.0	49.3	38.3	37.2	22.4	29.3	35.8
LSD (P=.05)	NS	2.6	4.0	6.5	NS	NS	0.2	NS	3.4	2.0

[1]Nitrogen as ammonium nitrate (34-0-0).

Table 16. Residual effects of feedlot manure and nitrogen fertilizer on winter wheat yields. Each phase of the wheat-sorghum fallow rotation was included each year, KSU Agricultural Research Center-Hays, KS, 1980 to 2002.

Feedlot Manure and Nitrogen Fertilizer[1]	Yield											
	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991
Ton/a	- - - - - - - - - - - - - - - - bu/a - - - - - - - - - - - - - - - -											
Control	29.8	35.1	45.3	34.3	29.2	35.3	27.6	42.8	24.5	15.1	33.3	31.5
10 ton/a	30.9	33.2	45.6	31.5	26.7	26.4	39.3	22.6	31.6	18.2	36.5	31.4
20 ton/a	29.2	32.1	45.4	33.9	25.5	27.2	28.4	22.1	29.7	19.6	36.7	27.7
40 ton/a	25.7	31.2	46.4	32.0	22.7	25.4	26.7	22.6	30.7	17.4	25.7	33.0
80 ton/a	28.8	29.2	42.4	17.2	15.2	22.7	23.3	26.7	26.7	15.4	24.7	24.8
40 lb N/a	27.2	35.3	55.2	34.5	22.6	27.7	34.7	45.8	28.1	24.3	48.5	37.2
LSD (P=.05)	NS	0.2	7.7	3.0	4.5	5.7	7.5	9.0	1.5	1.1	1.2	5

	Yield											
	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	- - - - - - - - - - - - - - - - bu/a - - - - - - - - - - - - - - - -											
Control	38.6	44.5	40.6	31.8	30.2	40.8	34.0	41.7	38.7	15.3	43.4	37.4
10 ton/a	29.9	45.8	45.2	35.3	37.3	45.0	39.6	54.7	54.0	24.9	55.7	48.8
20 ton/a	31.8	45.1	39.5	36.1	41.1	52.9	44.2	53.8	54.7	25.1	58.5	52.1
40 ton/a	30.9	35.4	37.6	28.8	50.1	51.4	44.0	50.0	52.8	22.9	60.5	51.1
80 ton/a	13.7	31.0	32.8	22.4	40.3	45.5	44.7	49.2	48.7	25.2	54.5	48.2
40 lb N/a	40.9	42.5	44.3	33.5	38.4	48.2	42.6	60.5	46.9	32.1	61.6	53.5
LSD (P=.05)	2.1	1.4	1.1	3.3	1.8	4.4	5.7	6.0	5.8	1.5	4.7	1.6

[1]Nitrogen as ammonium nitrate (34-0-0).

LONG-TERM EFFECTS OF NITROGEN FERTILIZER ON CONTINUOUS WINTER WHEAT ON A HARNEY SILT-LOAM SOIL UNDER REDUCED-TILLAGE

C.A. Thompson

Summary

This continuous cropped winter wheat study under reduced-till on a Harney silt-loam soil showed a significant response to the first 20 lb/a of broadcast nitrogen (N) in most years (1972-2003). Although higher N rates had a higher yield average, they lacked the year by year consistency. Every year there was a significant positive increase in grain protein from added nitrogen fertilizer. When comparing a higher N rate with the next lowest N rate, the first 20 lb N/a had the largest protein percent increase. This Harney silt loam soil mineralized nearly 30 lb N/a.

Introduction

Because of the wide variation in precipitation from year to year, it is often difficult to determine the amount of nitrogen fertilizer to apply. From wheat harvest to the next planting is only three months. The 30-year average precipitation July through September was 8.31 inches. This sounds high but about 80 percent of the precipitation is evaporated, leaving only 1.66 inches. Also, depending on rainfall intensity, it is possible some runoff will occur. But if the entire 1.66 inches were to remain in the soil, it still would be very little to get the wheat off to a good start and certainly not enough to produce a profitable crop. Drought on continuous wheat is common and should be weighed heavily when fertilizing.

Procedures

This study on a Harney silt-loam soil was initiated in 1971 with the first crop taken in 1972. Nitrogen fertilizer as ammonium nitrate (34-0-0) was broadcast applied and incorporated by tillage in August of each year. Nitrogen rates were in 20 lb/a increments up to 100 lb/a. Reduced-tillage, hoe-opener and current high yielding wheat varieties were used throughout the study. Treatments were replicated four times in a randomized complete block design. Data were analyzed with the statistical software package SAS, and ANOVA was used to determine treatment differences.

Results

Wheat was dusted in about 20% of the time. Planting depth was about 2 inches when the topsoil was dry. The latest planting date was October 15, regardless of soil moisture conditions. There was no grain production in 1996.

Yield

In most years, wheat responded to the first 20 lb N/a (Table 17). In most years, response declined with each additional increment of N. Even though the average yields were highest with 60 lb N/a, only in eight years was this rate significantly higher than lower rates. Also, because of higher fertilizer prices, 60 lb N/a may not be cost-effective in most areas in Kansas. Positive response with the first 20 lb N/a is good news because in other studies, 20 lb N/a banded with the seed produced yields nearly as high as 40 lb N/a broadcast. This speaks well of the cost effectiveness of a low N rate.

Protein

Every year there was a significant positive increase in grain protein from added nitrogen fertilizer (Table 17). In general, protein increased with each increment of nitrogen fertilizer applied . However, in most years, the response to the first 20 lb N/a was greater than additional 20 lb N/a increments. From 1972 to 2003, the soil mineralized nearly 30 lb N/a/year [yield x 60 x (protein/100/5.7)]. This speaks well for this dryland Harney silt-loam soil. Therefore, it is easy to understand why the first 20 lb N/a was more consistent in yield and protein response.

Table 17. Effects of August broadcast nitrogen fertilizer (ammonium nitrate) on winter wheat on a Harney silt-loam soil under reduced-till, KSU Agricultural Research Center-Hays, KS.

Nitrogen	1972		1973		1974		1975		1976		1977	
Rate	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein
lb N/a	bu/a	%	bu/a	%	bu/a	%	bu/a	%	bu/a	%	bu/a	%
0	19.0	11.1	19.8	9.6	15.3	11.3	21.4	11.7	18.8	10.8	19.9	12.0
20	26.8	11.8	29.8	10.4	19.6	12.5	25.8	12.3	32.1	10.8	24.4	12.1
40	32.8	11.9	30.1	11.1	21.5	12.8	24.4	13.8	30.7	11.6	27.1	13.0
60	34.2	12.5	39.8	11.6	21.3	12.8	23.8	14.4	30.5	12.6	29.2	14.1
80	37.0	13.8	34.8	11.9	22.8	13.3	24.6	14.7	29.5	13.4	30.3	14.3
100	36.4	14.3	42.6	13.2	23.8	13.7	25.0	15.3	28.4	13.8	29.0	14.5
LSD (P<.05)	6.4	0.4	4.0	0.4	2.8	0.2	NS	0.6	3.7	0.5	3.7	0.5

	1978		1979		1980		1981		1982		1983	
	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein
	bu/a	%	bu/a	%	bu/a	%	bu/a	%	bu/a	%	bu/a	%
0	26.4	12.4	14.8	14.0	30.7	11.9	18.5	13.1	26.6	11.4	29.8	11.8
20	29.3	13.8	22.1	14.9	38.3	13.3	24.8	14.0	34.6	11.6	33.4	14.2
40	30.1	14.3	23.0	15.2	40.8	13.9	26.5	14.4	35.9	11.7	35.1	15.5
60	29.4	14.5	25.6	14.8	40.0	14.5	25.3	14.7	36.1	11.8	33.2	14.9
80	29.1	14.6	27.0	15.1	39.8	14.3	26.5	14.6	36.1	12.6	34.2	15.4
100	27.9	15.3	26.8	15.2	39.9	14.3	25.6	14.6	36.1	12.2	32.7	15.2
LSD (P<.05)	1.2	1.2	2.1	0.5	5.7	0.9	2.7	0.6	3.1	0.4	3.1	0.7

	1984		1985		1986		1987		1988		1989	
	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein
	bu/a	%	bu/a	%	bu/a	%	bu/a	%	bu/a	%	bu/a	%
0	12.4	13.3	15.5	14.6	20.3	11.6	35.8	10.7	19.1	13.5	17.4	12.8
20	14.5	14.3	17.3	15.8	21.1	12.4	43.6	12.2	25.7	14.0	20.2	13.6
40	13.2	14.4	16.8	16.2	21.7	12.7	43.4	12.6	23.2	15.4	21.8	15.0
60	13.4	15.6	17.1	16.6	21.8	13.4	43.0	13.0	23.6	15.9	21.0	15.5
80	11.6	15.7	16.6	16.6	21.7	13.6	42.3	13.1	20.9	16.3	20.6	16.0
100	10.7	16.0	16.2	16.6	23.0	13.9	40.3	13.0	20.9	16.5	19.1	16.3
LSD (P<.05)	2.0	1.1	NS	0.5	NS	0.6	4.1	0.3	1.6	0.9	1.6	0.5

	1990		1991		1992		1993		1994		1995	
	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein
	bu/a	%	bu/a	%	bu/a	%	bu/a	%	bu/a	%	bu/a	%
0	26.9	11.1	45.7	12.0	28.6	12.1	29.1	10.9	17.2	12.1	6.1	13.2
20	35.2	12.5	45.5	12.7	29.2	13.5	37.0	11.4	32.5	11.8	14.3	13.1
40	28.0	15.1	44.0	13.2	26.8	14.1	36.6	12.3	35.2	13.0	17.7	13.3
60	30.5	16.0	52.5	14.0	27.9	14.0	36.4	12.3	37.0	13.5	22.0	13.7
80	29.8	16.3	54.2	14.0	26.5	14.0	34.9	13.6	36.3	15.3	24.9	14.2
100	29.4	16.3	48.0	13.9	25.8	14.3	32.9	13.2	35.9	15.5	20.3	14.3
LSD (P<.05)	1.2	0.3	NS	0.5	NS	0.4	1.2	0.9	0.8	0.9	3.5	0.5

Table 17. (con't.) Effects of August broadcast nitrogen fertilizer (ammonium nitrate) on winter wheat on a Harney silt-loam soil under reduced-till, KSU Agricultural Research Center-Hays, KS.

Nitrogen	1997		1998		1999		2000		2001		2002	
Rate	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein
lb/a	bu/a	%	bu/a	%	bu/a	%	bu/a	%	bu/a	%	bu/a	%
0	41.5	12.8	19.7	11.2	27.4	11.8	24.5	10.4	25.4	11.3	28.1	11.2
20	48.0	13.6	27.1	12.4	44.8	12.5	35.7	11.5	30.3	12.3	34.5	12.2
40	50.0	14.4	29.3	13.3	49.7	13.3	35.7	12.4	33.8	12.8	36.0	13.3
60	50.2	14.8	28.3	13.8	52.1	13.0	36.3	13.1	34.8	13.4	38.4	13.6
80	48.6	14.9	28.4	14.4	50.8	14.4	32.2	13.6	33.2	14.3	40.9	14.2
100	50.5	15.1	28.5	14.9	49.6	14.9	31.0	14.3	32.9	15.3	37.9	14.7
LSD (P<.05)	3.5	0.6	2.9	0.4	2.4	1.1	3.8	0.5	3.3	0.3	4.4	0.5

	2003		1972-2003 Avg.	
	Yield	Protein	Yield	Protein
	bu/a	%	bu/a	%
0	31.2	12.0	23.6	11.9
20	37.2	12.4	30.1	12.8
40	35.6	13.0	30.9	13.5
60	39.8	13.4	32.1	13.9
80	41.3	13.9	31.8	14.4
100	41.0	14.5	31.2	14.7
LSD (P<.05)	2.4	0.3	1.0	0.1

LONG-TERM EFFECTS OF NITROGEN FERTILIZER ON NO-TILL WHEAT GROWN ON A HARNEY SILT-LOAM SOIL

C.A. Thompson

Summary

Annual yield increases (1981-2003) on this no-till Harney silt loam soil were more consistent with the first 20 lb/a of nitrogen (N) than with higher rates. Annual and perennial weeds were a constant problem in spite of timely herbicide applications. The 40 lb N/a rate gave the largest protein percent increase when examined between each 20 lb N/a increment. It seldom pays to apply additional N to increase protein only. Because of the high rate of N mineralized from the soil, it is not surprising that only a low rate of additional N is needed.

Introduction

Maintaining crop residue on the soil surface, by utilizing no-till, will reduce wind and water erosion, reduce water runoff, and increase infiltration and soil moisture storage. However, on no-till soils containing 20 percent or more clay in the seed zone, long periods of marginal precipitation can cause the soil in the top 3 to 4 inches to become very hard and difficult to penetrate with the drill opener. Under dry conditions at planting, a hoe opener acts like a chisel opener creating large hard clods. Soil-seed contact is often poor, and stands are thin and erratic. Disc-type openers often fail to penetrate to the desired depth. If a timely rain occurs just before planting, it softens the soil surface, allowing a much more desirable seedbed.

Procedures

This no-till nitrogen rate study was initiated in 1980 with the first harvested crop in 1981. No-till was accomplished by herbicides. Herbicides included Roundup and Landmaster applied at labeled rates. Nitrogen as ammonium nitrate was broadcast applied in August in 20 lb/a increments up to 100 lb/a. Planting was accomplished with a hoe-drill with three ranks of openers. High yielding wheat varieties were used throughout the study. Treatments were replicated six times in a randomized complete block design. Data were analyzed with the statistical software package SAS, and ANOVA was used to determine treatment differences.

Results

Yields

Over the 22 years of this study, annual yield increases were more consistent with the first 20 lb N/a (Table 18). Yearly consistency of yield increase decreased with additional N. Yields tended to level off when higher than 60 lb N/a was applied. Weeds such as downy brome, volunteer wheat, prairie cupgrass, windmillgrass, witchgrass, and jointed goatgrass were a constant challenge to control throughout the study depressing yields in some years. Also, the abundance of weeds at harvest made grain separation difficult. Low N rates tend to be more cost-efficient than high N rates. Although the 20 lb N/a rate was broadcast in August, other studies show that this rate could be applied with the seed at planting, further increasing fertilizer efficiency.

Protein

Grain protein generally increased with each increment of applied N (Table 18). Between each 20 lb N/a increment, the 40 lb N/a rate gave the largest protein percent increase. Unless the grower knows several months ahead of harvest, it seldom pays to apply additional N to increase protein only. Soil mineralization, on the average (1981-2003), produced nearly 26 lb N/a/year [yield x 60 x (protein/100/5.7)]. Because of this high rate of N produced by this dryland soil, it is not surprising that only a low rate of additional N is needed each year.

Table 18. Effects of August broadcast nitrogen fertilizer (ammonium nitrate) on winter wheat on a Harney silt-loam soil under no-till, KSU Agricultural Research Center-Hays, KS.

Nitrogen	1981		1982		1983		1984		1985		1986	
Rate	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein
lb/a	bu/a	%	bu/a	%	bu/a	%	bu/a	%	bu/a	%	bu/a	%
0	21.6	14.5	21.3	11.9	21.7	11.8	16.9	12.2	20.7	11.8	28.8	12.2
20	25.5	15.3	24.9	12.2	29.1	12.8	23.3	12.2	23.3	13.3	29.3	12.8
40	22.6	15.4	33.6	12.1	30.6	13.8	29.2	13.5	22.7	13.8	23.2	13.3
60	22.9	16.1	31.9	12.2	28.6	14.1	30.6	14.7	22.7	13.8	23.8	13.8
80	22.4	16.2	26.6	12.9	28.8	15.1	29.5	14.9	23.7	14.9	24.0	14.3
100	24.3	16.6	29.3	13.1	28.4	15.1	31.1	15.6	20.7	15.6	24.3	14.9
LSD (P<.05)	NS	0.5	4.2	0.6	2.5	0.6	2.0	0.8	1.7	1.2	2.2	0.3

	1987		1988		1989		1990		1991		1992	
	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein
	bu/a	%	bu/a	%	bu/a	%	bu/a	%	bu/a	%	bu/a	%
0	32.3	11.1	11.3	13.9	4.4	16.4	29.2	11.7	14.6	12.3	16.0	12.1
20	35.8	11.7	18.1	14.2	6.3	16.8	39.5	11.9	16.8	13.1	19.4	13.7
40	38.1	12.2	17.3	15.9	5.8	17.4	36.5	13.5	21.3	13.3	19.9	15.1
60	38.5	12.9	19.0	16.7	9.8	17.2	30.2	14.8	20.2	14.1	20.7	15.3
80	39.6	13.1	14.5	17.4	10.3	17.4	24.8	15.2	18.9	14.3	21.6	15.7
100	39.5	13.3	12.8	17.4	11.0	17.3	24.5	15.6	18.8	14.1	23.9	15.5
LSD (P<.05)	4.9	0.5	2.0	0.5	0.8	0.4	0.7	0.2	0.9	0.5	1.8	0.5

	1993		1994		1995		1997		1998		1999	
	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein
	bu/a	%	bu/a	%	bu/a	%	bu/a	%	bu/a	%	bu/a	%
0	25.3	10.6	8.4	13.2	5.1	15.4	21.3	13.1	17.2	12.7	26.6	12.1
20	37.2	10.7	16.2	13.2	9.6	15.7	25.5	13.5	28.4	12.7	38.2	12.1
40	38.4	11.6	19.6	14.1	21.4	14.9	31.2	13.6	31.4	14.0	42.1	12.9
60	38.1	12.4	22.0	15.5	31.3	15.1	28.4	14.0	30.9	13.7	42.5	13.9
80	36.8	12.8	22.1	15.6	32.8	15.1	26.2	14.2	30.6	14.6	42.8	14.3
100	34.8	12.9	24.7	15.7	33.6	15.0	31.0	14.2	32.2	15.0	38.7	14.6
LSD (P<.05)	1.1	0.4	0.7	0.6	1.1	0.5	4.7	0.4	1.7	0.3	2.7	0.4

	2000		2001		2002		2003		1981-2003 Avg.	
	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein
	bu/a	%	bu/a	%	bu/a	%	bu/a	%	bu/a	%
0	16.3	12.7	23.1	11.6	19.3	12.3	25.4	11.3	19.4	12.6
20	20.5	12.7	30.7	11.3	26.6	12.4	31.1	12.5	25.2	13.0
40	23.3	14.0	33.2	12.8	35.0	13.6	36.6	13.0	27.8	13.8
60	23.9	14.0	34.9	12.7	37.1	13.9	42.0	13.8	28.6	14.3
80	22.2	14.5	33.0	13.5	37.5	14.2	38.8	14.1	27.6	14.7
100	20.4	15.1	32.6	13.7	37.9	14.8	35.4	14.5	27.7	14.9
LSD (P<.05)	3.0	0.3	2.4	0.3	2.7	0.2	1.8	0.3	0.6	0.1

EFFECTS OF THREE NITROGEN CARRIERS AND FOUR NITROGEN RATES BANDED WITH THE WHEAT SEED AT PLANTING

C.A. Thompson

Summary

When urea fertilizer was applied with the wheat seed, only the nitrogen (N) 10 lb/a rate increased yields. Also, N, as urea, decreased yields when 30 and 40 lb N/a were used. Ammonium nitrate and UAN responded similarly, with a slight edge to UAN at the 20 lb N/a rate. Wheat yields were not decreased with ammonium nitrate or UAN, regardless of nitrogen rate. Stands were consistently decreased when rates were 20 lb N/a or higher. The poorest emergence was from urea fertilizer at 30 and 40 lb N/a. Because of wheat's ability to tiller, decreased emergence did not always translate to depressed yields. Only with urea fertilizer were visual ratings, at the 30 and 40 lb N/a rates, significantly decreased.

Introduction

Studies have shown that nitrogen fertilizer placed with the seed at planting increases uptake efficiency over other methods of application. However, comparing several nitrogen carriers at multiple nitrogen rates is missing. Furthermore, past research reveals that urea fertilizer can reduce stands and yields. With these thoughts in mind, a study was designed to address these issues.

Procedures

This study was conducted under reduced-till on four sites at the KSU Agricultural Research Center-Hays on Harney silt loam soils during the 2002 and 2003 period. Three nitrogen carriers, ammonium nitrate (34-0-0), urea (45-0-0), and urea ammonium nitrate (UAN) solution (28-0-0) were compared at four nitrogen rates (0, 10, 20, 30, and 40 lb N/a) banded with the wheat seed. Ammonium nitrate and urea were metered out through a cone-spinner device mounted on a hoe-type grain drill. UAN was metered through a ground driven John Blue pump. All N carriers were banded with the seed. Trego winter wheat at 60 lb/a was used on all sites. Plot size was 8 x 60 feet. These sites were replicated four times in a randomized complete block design with SAS using ANOVA.

Results

The effects of nitrogen carriers and nitrogen rates are reported in Table 19. Emergence ratings were taken 10 days after planting. Visual ratings were taken 2 days before harvest.

<u>Yields</u>

Only one of the four sites exhibited a significant difference between ammonium nitrate and urea. Yields from urea were significantly lower than ammonium nitrate and UAN except at the 10 lb N/a rate. Site 2 did not respond to nitrogen fertilizer. Of the three remaining sites that responded to N, yields from 10 lb N/a were significantly better than higher rates with ammonium nitrate and UAN. Only one site showed significant response to 20 lb N/a over other rates with ammonium nitrate and UAN.

<u>Emergence</u>

Emergence was decreased consistently at 20 lb N/a and higher for all three N carriers. Emergence was not improved by any of the N carriers at any of the N rates. The highest decrease in emergence occurred with urea fertilizer at the 30 and 40 lb N/a rates. If the decimal point is moved one digit to the right, this would represent the percent emergence.

<u>Visual</u>

Wheat has the ability to tiller to the point of making up for moderately poor stands. However, when stands were reduced by 50% or more, tillering did not make up for this stand loss. Thus, yields were decreased with urea at 30 and 40 lb N/a. As expected, visual ratings correlated well with yield response.

Table 19. Effects of three nitrogen carriers at four nitrogen rates (applied w/seed) on winter wheat under reduced-till on a Harney silt loam soil, KSU Agricultural Research Center-Hays, KS, 2002 and 2003.

Nitrogen	Nitrogen	Site 1-2002			Site 2-2002			Site 3-2002			Site 1-2003			4 Site Average		
Carrier	Rate w/seed	Yield	Emerge[1]	Visual[1]	Yield	Emerge	Visual	Yield	Emerge	Visual	Yield	Emerge	Visual	Yield	Emerge	Visual
	lb/a	bu/a			bu/a			bu/a			bu/a			bu/a		
Am Nitrate	0	45.9	9.8	7.0	35.1	8.0	5.0	54.4	9.0	7.5	46.9	9.0	6.8	45.5	8.9	6.5
	10	52.6	10.0	8.0	36.0	7.8	5.5	60.1	8.8	8.3	46.8	8.8	7.0	48.8	8.8	7.2
	20	53.5	7.0	8.0	35.6	7.0	5.3	55.3	9.0	7.5	49.1	7.3	7.0	48.4	7.3	6.9
	30	54.8	8.3	8.8	36.5	6.8	6.0	53.5	7.8	7.3	48.8	7.5	6.8	48.4	7.6	7.2
	40	54.9	7.3	8.8	37.5	5.8	6.0	52.4	6.5	7.0	48.1	6.3	7.3	48.2	6.4	7.3
Urea	0	46.2	10.0	6.8	35.1	7.8	5.8	54.1	8.8	7.8	46.9	9.0	6.8	45.6	8.9	6.8
	10	53.5	8.5	7.8	36.8	7.2	6.0	55.8	7.5	7.5	48.2	7.8	7.0	48.6	7.8	7.1
	20	55.0	8.8	8.5	34.9	5.8	5.8	53.7	6.3	7.0	42.0	7.0	5.8	46.4	6.9	6.8
	30	50.5	4.0	7.5	31.8	3.3	5.3	46.8	4.8	6.0	37.9	4.0	5.3	41.7	4.0	6.0
	40	45.5	3.0	6.8	31.2	2.3	4.8	47.1	3.5	6.3	33.5	3.0	4.5	39.3	2.9	5.6
UAN	0	46.1	9.8	6.8	36.7	8.0	6.3	54.9	9.0	7.8	47.7	9.0	7.3	46.3	8.9	7.0
	10	54.9	9.8	8.5	36.0	7.8	6.5	54.2	8.0	7.8	49.9	8.5	6.5	48.7	8.5	7.3
	20	53.9	9.5	8.0	35.5	7.3	5.8	60.5	8.3	8.8	48.1	8.3	7.0	49.5	8.4	7.4
	30	55.9	9.0	8.8	35.0	7.0	6.3	57.3	7.5	8.3	49.5	7.8	7.0	49.4	7.8	7.3
	40	56.0	8.8	8.8	37.5	6.8	6.3	54.2	7.3	7.5	48.7	7.5	6.8	49.1	7.6	7.3
Summary of Nitrogen Carrier Averages																
Am Nitrate		52.3	8.5	8.1	36.1	7.1	5.6	55.1	8.0	7.5	47.9	7.8	7.0	47.9	7.8	7.0
Urea		50.1	6.9	7.5	33.9	5.3	5.5	51.5	6.2	6.9	41.7	6.2	5.9	44.3	6.1	6.4
UAN		53.3	9.4	8.2	36.1	7.4	6.0	56.2	8.0	8.0	48.8	8.2	6.9	48.6	8.2	7.3
Summary of Nitrogen Rate Averages																
	0	46.0	9.8	6.8	35.6	7.9	5.7	54.5	8.9	7.7	47.1	9.0	6.9	45.8	8.9	6.8
	10	53.6	9.4	8.1	36.2	7.6	6.0	56.7	8.1	7.8	48.3	8.3	6.8	48.7	8.4	7.2
	20	54.1	8.4	8.2	35.3	6.8	5.6	56.5	7.5	7.8	46.4	7.5	6.6	48.1	7.5	7.0
	30	53.7	7.1	8.3	34.4	5.7	5.5	52.5	6.7	7.2	45.4	6.4	6.3	46.5	6.5	6.8
	40	52.1	6.3	8.1	35.4	4.9	5.7	51.2	5.8	6.9	43.4	5.6	6.2	45.5	5.6	6.7
LSD (P<.05)																
Nitrogen Carrier		1.5	0.5	0.5	1.6	0.4	0.6	1.5	0.3	0.5	0.7	0.3	0.5	0.6	0.2	0.2
Nitrogen Rate		2.0	0.6	0.5	NS	0.5	0.6	4.0	0.3	0.5	0.8	0.4	0.5	1.1	0.2	0.2
NC x NR		3.7	0.7	0.7	2.6	0.7	1.0	4.3	0.7	0.8	1.7	0.5	0.8	3.1	0.6	0.8

[1]Emergence (soon after planting) and visual (just prior to harvest) ratings are on a scale of 1 to 10, with 10 being the best.

LONG-TERM EFFECTS OF SEEDING RATE AND NITROGEN RATE ON WINTER WHEAT ON HARNEY SILT LOAM SOILS

C.A. Thompson

Summary

Seeding rates at 1 to 1.5 bu/a were more consistent in increasing yields than lower or higher seeding rates. Adding nitrogen (N) fertilizer increased yields in 15 of the 18 years of the study. Test weight was only increased at the 1 bu/a. In general, 40 lb N/a decreased test weight over the control for each of the seeding rates. Plant height was decreased at 2 bu/a and above. Visual ratings (crop performance) correlated well with grain yields.

Introduction

Newly released wheat varieties are often high priced. Also, newly acquired acreage can put a strain on existing bushels available. In addition, there are occasions when a higher seeding rate may be necessary because of reduction in acreage, low tillering on a certain soil type, and competition with existing weed population. Because of these complex issues, growers need to know what effects low to high seeding rates have on wheat yields.

Procedures

This study was established on a different site each year on a Harney silt loam soil. Crop rotation was wheat-sorghum-fallow. The study was established in the fall of 1984 with the first crop in 1985. The seed was prepackaged and metered out through a cone/spinner device mounted on the drill. There was only one positive nitrogen rate at 40 lb N/a using ammonium nitrate surface applied in the fall after emergence. High yielding wheat varieties were used throughout the duration of the study. Seeding ranged from September 25 to October 1. Plot size was 8 x 30 feet. Each year the sites were replicated four times in a randomized complete block design with SAS using ANOVA.

Results

Yearly yields are reported in Table 20. Averages are reported in Table 21. No crop was harvested in 1991.

<u>Yields</u>

Fourteen of 18 years responded to the 1.0 bu/a seeding rate with 40 lb N/a over 0.5 bu/a with 40 lb N/a. In four years 1.5 bu/a was significantly lower than 1.0 bu/a. Only in five years did seeding rates greater than 1.5 bu/a decrease yields. Average yields were highest with the 1.5 bu/a seeding rate. Applying 40 lb N/a increased yields over no nitrogen in 15 of the 18 years. Over the 18 year average, 40 lb N/a increased yields 3.0 bu/a over the control.

<u>Test Weight</u>

At 1 bu/a test weight was significantly increased. In general, 40 lb N/a decreased test weight over the control for each of the seeding rates.

<u>Plant Height</u>

At 2 bu/a and above plant height was decreased. Nitrogen at 40 lb N/a increased plant height by 0.5 inch.

<u>Visual Rating</u>

Visual ratings (crop performance) taken at harvest correlated well with yields. Seeding at 1.5 bu/a had the highest visual rating. Nitrogen increased visual ratings for each of the seeding rates.

Table 20. Long-term effects of seeding rate and nitrogen rate on winter wheat on a Harney silt loam soil, KSU Agricultural Research Center-Hays, KS, 1985 to 2003.

Seeding Rate	N Rate	Yield 1985	1986	1987	1988	1989	1990	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
bu/a	lb/a	bu/a																	
0.5	0	30.9	42.3	39.3	40.3	22.2	48.8	29.7	45.5	46.0	15.8	27.3	15.7	42.3	25.4	20.7	38.6	41.0	30.0
0.5	40	33.4	43.4	43.2	37.4	22.8	52.8	25.9	51.6	45.6	16.4	30.5	21.2	47.2	43.1	23.8	27.8	45.4	33.6
1.0	0	35.4	50.9	44.2	41.0	21.1	55.2	37.2	44.2	49.4	17.4	35.3	23.7	47.8	39.3	26.2	36.9	42.2	32.5
1.0	40	36.1	53.4	46.8	42.4	23.8	56.3	31.9	48.7	51.9	18.5	35.5	24.6	52.2	52.3	30.5	39.8	50.5	42.3
1.5	0	36.6	54.8	46.7	36.5	20.6	64.1	35.5	45.0	58.2	20.6	35.3	23.2	49.2	36.0	27.0	39.8	45.5	37.0
1.5	40	41.3	56.0	45.6	40.8	18.7	57.7	31.1	44.8	55.6	26.6	35.6	25.4	51.3	54.2	30.5	38.2	49.4	44.6
2.0	0	35.4	57.1	45.2	40.1	20.4	61.7	33.4	41.6	54.8	17.9	36.7	22.8	47.5	37.1	26.8	35.1	45.3	37.1
2.0	40	43.5	56.6	45.0	39.9	20.4	57.5	32.0	46.3	53.4	23.4	38.1	26.7	51.4	54.2	33.0	33.0	50.4	46.6
2.5	0	35.0	55.5	45.6	36.1	21.0	54.7	30.3	39.2	54.9	24.0	38.3	24.1	44.7	38.0	25.9	34.0	41.9	35.5
2.5	40	43.2	55.1	38.7	38.8	17.7	65.2	35.4	43.1	56.2	25.1	38.7	23.7	52.4	52.4	38.9	34.5	49.5	44.9
3.0	0	36.4	47.4	43.1	35.4	17.7	60.7	36.9	39.0	55.8	20.8	38.9	23.5	43.0	41.7	31.0	39.7	43.6	36.2
3.0	40	43.6	55.3	40.7	39.7	20.6	55.7	34.5	42.0	60.0	28.3	39.3	24.6	53.8	52.7	33.1	40.1	40.2	45.9
Summary of Seeding Rate Averages																			
0.5		32.2	42.8	41.3	38.8	22.5	50.8	27.8	48.5	45.8	16.1	28.9	18.5	44.8	34.3	22.2	33.2	43.2	31.8
1.0		32.7	52.2	45.5	41.7	22.4	55.7	34.6	46.5	50.6	17.9	35.4	24.1	50.0	45.8	28.4	38.3	46.3	37.4
1.5		38.9	55.4	46.2	38.6	19.6	60.9	33.3	44.9	56.9	23.6	35.5	24.3	50.2	45.1	28.8	39.0	47.4	40.8
2.0		39.4	56.8	45.1	40.0	20.4	59.6	32.7	44.0	54.1	20.6	37.4	24.7	49.4	45.6	29.9	34.0	47.9	41.9
2.5		39.1	55.3	42.1	37.4	19.4	59.9	32.9	41.1	55.5	24.6	38.5	23.9	48.5	45.2	32.4	34.2	45.7	40.2
3.0		40.0	51.4	41.9	37.6	19.2	58.2	35.7	40.5	57.9	24.5	39.1	24.1	48.4	47.2	32.0	39.9	41.9	41.0
Summary of Nitrogen Rate Averages																			
	0	34.9	51.3	44.0	38.2	20.5	57.5	33.8	42.4	53.2	19.4	35.3	22.2	45.7	36.2	26.3	37.3	43.2	34.7
	40	40.2	53.3	43.3	39.8	20.7	57.5	31.8	46.1	53.8	23.0	36.3	24.4	51.4	51.5	31.6	35.6	47.6	43.0
LSD (P<.05)																			
Seeding Rate		1.0	4.9	3.4	0.8	0.9	0.9	0.7	1.0	1.1	0.9	1.1	2.7	NS	7.2	2.6	1.0	3.2	1.8
N Rate		1.2	1.4	NS	0.2	NS	NS	0.3	0.9	NS	0.4	0.3	NS	1.7	9.4	4.2	0.6	2.5	0.7
SR x NR		1.5	NS	2.3	1.3	2.6	1.2	1.4	1.0	1.8	1.1	1.1	NS	NS	NS	4.9	1.4	4.7	NS

Table 21. Summary of long-term effects of seeding rate and nitrogen rate on winter wheat, Harney silt loam soil, KSU Agricultural Research Center-Hays, KS, 1985-2003.

Seeding	N	1985-2003 Average			
Rate	Rate	Yield	Test Weight	Plant Height	Visual[1]
bu/a	lb/a	bu/a	lb/bu	inch	rating
0.5	0	33.4	60.3	28.9	4.9
0.5	40	35.8	59.6	29.5	5.4
1.0	0	37.8	60.5	29.1	5.9
1.0	40	41.0	60.2	29.8	6.6
1.5	0	39.5	60.3	29.2	6.4
1.5	40	41.5	60.0	29.7	6.7
2.0	0	38.7	60.2	28.9	6.3
2.0	40	41.7	59.8	28.9	6.8
2.5	0	37.7	60.1	28.3	6.2
2.5	40	41.9	60.0	28.7	6.7
3.0	0	38.4	60.0	27.9	6.1
3.0	40	41.7	59.8	28.3	6.8
Summary of Seeding Rate Averages					
0.5		34.6	60.0	29.2	5.2
1.0		39.4	60.3	29.5	6.3
1.5		40.5	60.1	29.4	6.6
2.0		40.2	60.0	28.9	6.5
2.5		39.8	60.0	28.5	6.5
3.0		40.0	59.9	28.1	6.5
Summary of Nitrogen Rate Averages					
	0	37.6	60.2	28.7	6.0
	40	40.6	59.9	29.2	6.5
LSD (P<.05)					
Seeding Rate		1.0	0.3	0.6	0.2
N Rate		1.0	0.1	0.3	0.2
SR x NR		NS	0.2	NS	0.2

[1] Crop performance rating with 10 = best.

SOIL FERTILITY RESEARCH
SOUTHEAST AGRICULTURAL RESEARCH CENTER

EFFECTS OF PREVIOUS CROP, FERTILIZER PLACEMENT METHOD, AND NITROGEN RATE ON WINTER WHEAT GRAIN YIELD WHEN PLANTED NO-TILL

K.W. Kelley and D.W. Sweeney

Summary

Wheat yields were influenced significantly by previous crop, fertilizer nitrogen (N) and phosphorus (P) placement method, and N rate. Grain yields averaged 65 bu/a following corn, 60 bu/a following soybean, and 54 bu/a following grain sorghum. Applying fertilizer N (28% UAN) and P (10 - 34 - 0) below crop residues with a coulter-knife applicator also significantly increased grain yield compared with surface strip band and broadcast fertilizer treatments, regardless of previous crop. In addition, grain yields increased along with N rate, except for wheat following soybean.

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 N efficiency. Placement of both N and P 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 seeks to evaluate how the previous crop (corn, grain sorghum, or soybean) affects the utilization of applied N and P fertilizer by winter wheat when planted no-till. Various N rates also were evaluated.

Procedures

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-inch centers at a depth of 4 to 6 inches; 2) liquid N and P surface-applied in 15-inch 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. All N-P fertilizer treatments were fall-applied before planting. All plots received 120 lbs K_20/a as a preplant broadcast application. Seeding rate was 100 lbs/a.

Soil samples taken in the fall after harvest and before wheat fertilization showed that residual nitrate-N levels in the top 12 inches of soil averaged 38 lb N/a following corn, 34 lb N/a following soybean, and 21 lb N/a following grain sorghum. Soil organic matter averaged 2.7% (0 to 6 inches), while soil P level was 46 lb P/a in the top 6 inches.

Results

Wheat yields were influenced significantly by previous crop, N-P application method, and N rate (Table 1). Grain yields averaged 65 bu/a following short-season corn, 54 bu/a following grain sorghum, and 60 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 where N was applied below crop residues with the coulter-knife applicator following soybean. With the knifed N-P application, wheat yields were reduced at the highest N rate (120 lb N/a) following soybean because of plant lodging.

Previous crop residues did not appear to affect wheat germination or early seedling growth through the process of allelopathy. Yield results suggest that N losses from leaching or denitrification were minimal at this site, where soil slope prevented ponding of surface water. Wheat yield differences between previous crops and N-P placement methods appear to be primarily related to greater availability of both fertilizer and residual soil N following corn. However, at the highest N rate, yield differences between previous crops were less pronounced compared to lower N rates.

In this study, where initial soil test P levels averaged nearly 45 lb P/a, grain yields were affected more by fertilizer N management than by P placement. However, research has shown that the dual placement of liquid N and P in a concentrated band application enhances P availability due to the presence of higher ammonium concentrations. Thus, P availability may be greater in knifed and strip band applications compared to surface broadcast treatments.

Results indicate that wheat yields under no-till conditions are greatly influenced by fertilizer N management practices, including both rate of application and placement method. Applying fertilizer below the soil surface results in greater fertilizer efficiency and less potential for nutrient loss from rainfall. In addition, planting wheat no-till into previous crop residues reduces soil erosion.

Table 1. Effects of previous crop, nitrogen and phosphorus method, and nitrogen rate on hard winter wheat grain yield when planted no-till, Southeast Ag Research Center, Parsons, KS, 2003.

N and P	Fertilizer Rate		Wheat Yield After		
Applic. Method	N	P_2O_5	Corn	Grain Sorghum	Soybean
	----- lb/a -----		------------------------------ bu/a ------------------------------		
Knife	20	68	57.7	47.5	55.0
Knife	40	68	66.8	48.1	56.4
Knife	80	68	71.9	65.6	72.0
Knife	120	68	72.7	74.8	69.2
Strip Band	20	68	58.4	37.0	48.8
Strip Band	40	68	62.8	45.6	52.3
Strip Band	80	68	70.1	56.5	64.2
Strip Band	120	68	70.4	68.9	73.1
Broadcast	20	68	57.1	38.7	47.0
Broadcast	40	68	58.6	42.1	51.8
Broadcast	80	68	67.4	51.5	57.9
Broadcast	120	68	71.3	65.7	66.6
Knife Control	0	0	49.9	29.8	39.7
Control	0	0	50.5	30.1	39.8
LSD (0.05)	Within same PC			5.2	
	For different PC			5.3	
Means: (controls omitted)			65.4	53.5	59.5
N-P Application Method					
Knife			67.3	59.0	63.1
Strip Band			65.4	52.0	59.6
Broadcast			63.6	49.5	55.8
LSD (0.05)			2.6	2.6	2.6
N Rate (lb/a)					
20			57.7	41.0	50.3
40			62.7	45.3	53.5
80			69.8	57.9	64.7
120			71.5	69.8	69.7
LSD (0.05)			3.0	3.0	3.0

N source = urea ammonium nitrate 28% N solution; P source = 10-34-0.
Planting date = Oct. 16, 2002; variety = Jagger.
All plots received 120 lbs/a of K_2O as a preplant broadcast application.

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

D.W. Sweeney

Summary

In 2002, soybean yields were unaffected by tillage or residual nitrogen (N) treatments. Analysis across all years from 1984 to 2002 showed similar results.

Introduction

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

Procedures

A split-plot design with four replications was initiated in 1983, with tillage system as the whole plot and N treatment as the subplot. The three tillage systems were conventional, reduced, and no tillage. The conventional system consisted of chiseling, disking, and field cultivation. The reduced-tillage system consisted of disking and field cultivation. Glyphosate (Roundup®) was applied each year at 1.5 qt/a to the no-till areas. The four N treatments for the odd-year grain sorghum crops from 1983 to 1999 were: 1) no N (check), 2) anhydrous ammonia knifed to a depth of 6 inches, 3) broadcast urea-ammonium nitrate (UAN - 28% N) solution, and d) broadcast solid urea. The N rate was 125 lb/a. Harvests were collected from each subplot for both grain sorghum (odd years) and soybean (even years) crops. Effects of residual N were addressed for soybean, even though N fertilization was applied only to grain sorghum.

Results

In 2002, soybean yields averaged 18.6 bu/a (data not shown). Yields were unaffected by tillage or residual N treatments. Analyzed across all soybean years (even-numbered years) from 1984 to 2002, yield averaged 22.2 bu/a and was unaffected by tillage or N residual (data not shown).

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

D.W. Sweeney

Summary

In 2002, increasing antecedent soil K test levels produced greater soybean yield, whereas different soil P test levels did not increase yield.

Introduction

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

Procedures

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

Results

In 1999, wet conditions during the early part of the growing season followed by dry conditions resulted in low overall soybean yields of less than 14 bu/a (data not shown). Increasing soil P test level from 5 ppm to more than 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 (less than 12 bu/a) than in 1999. As a result, yield or yield components were either not affected or were influenced by an unexplainable interaction between P and K fertility levels (data not shown).

Similar to 2001 (data not shown), environmental conditions in 2002 were somewhat more favorable than 1999 and 2000, resulting in soybean yields greater than 20 bu/a (Table 2). Greater soil P levels tended to slightly increase yield, but the difference was not significant. However, increased number of pods/plant with increased soil test P may suggest a potential for increased yield under better growing conditions. Greater soil K levels increased glyphosate-tolerant soybean yield by as much as 21% compared to plots that have never received K fertilizer. This yield increase may have been related to nonsignificant changes in seed weight, pods/plant, and seeds/pod as soil K level increased.

Table 2. Effects of antecedent soil phosphorus and potassium test levels on glyphosate-tolerant soybean yield and yield components, Southeast Agricultural Research Center, 2002.

Initial Soil Test Level	Yield	Population	Seed Weight	Pods/Plant	Seeds/Pod
	bu/a	plants/a	mg		
P (ppm)					
5	22.6	123 000	121	21	1.6
11	25.1	110 000	117	28	1.6
28	25.3	112 000	117	28	1.7
LSD (0.05)	NS	NS	NS	3	NS
K (ppm)					
52	21.9	114 000	115	25	1.5
85	24.5	113 000	123	24	1.6
157	26.6	118 000	117	28	1.7
LSD (0.05)	3.6	NS	NS	NS	NS
PxK Interaction	NS	NS	NS	NS	NS

SOIL FERTILITY RESEARCH
NORTH CENTRAL KANSAS EXPERIMENT FIELD

THE USE OF POTASSIUM IN STARTERS FOR CORN IN REDUCED TILLAGE PRODUCTION SYSTEMS

W.B. Gordon

Summary

Potassium (K) deficiency can be a problem on soils that have been managed with reduced tillage practices. The large amount of residue left on the soil surface can depress soil temperature and interfere with plant growth, nutrient uptake, and ultimately grain yield. Soil temperature influences both K uptake by root and K diffusion through the soil.

The appearance of K deficiency in fields managed with conservation tillage systems has been reported with greater frequency in recent years and has become a concern for producers. In these experiments, addition of K to starters containing N and P was shown to improve early season growth, nutrient uptake, earliness, and yield of corn grown in a long-term ridge-tillage production system on soils that were not low in available K.

Introduction

The use of conservation-tillage has increased in recent years because of its effectiveness in conserving soil and water. Potassium (K) deficiency can be a problem on soils that have been managed with reduced tillage practices. The large amount of residue left on the soil surface can depress soil temperature early in the growing season. Low soil temperature can interfere with plant root growth, nutrient availability in soil, and crop nutrient uptake. Soil temperature influences both K uptake by roots and K diffusion through the soil. Low soil water content or zones of soil compaction also can reduce K availability. Potassium uptake in corn is greatest early in the growing season and accumulates in plant parts at a relatively faster rate than dry matter, N, or P. Cool spring temperatures can limit early- season root growth and K uptake by corn.

In plant physiology, K is the most important cation not only in regard to concentration in tissues but also with respect to physiological functions. A deficiency in K affects such important physiological processes as respiration, photosynthesis, chlorophyll development, and regulation of stomatal activity. Plants suffering from a K deficiency show a decrease in turgor, making resistance to drought poor. The main function of K in biochemistry is its function in activating many different enzyme systems involved in plant growth and development. Potassium also influences crop maturity and plays a role in reducing disease and stalk lodging in corn. The appearance of K deficiency in fields managed with conservation tillage systems has been reported with greater frequency in recent years and has become a concern for producers. Starter fertilizer applications have proven effective in enhancing nutrient uptake and yield of corn even on soils that are not low in available nutrients. The objective of these studies was to determine if K applied as a starter at planting could improve K uptake and yield of corn on soils that had been managed in a ridge-tillage production system.

Two separate studies were conducted at the North Central Kansas Experiment Field. Both experiments were conducted on a Crete silt loam soil in areas that had been ridge-tilled since 1984. Both sites also were furrow irrigated. Potassium deficiencies had been observed in these two areas prior to the initiation of the studies. Ear leaf K concentrations had proven to be below published sufficiency ranges.

Procedures

<u>Experiment 1</u>.

This field experiment was conducted for three crop years, 2000-2002. Soil test results showed that initial pH was 6.2, organic matter was 2.4%, Bray-1 P and exchangeable K in the top 6 inches of soil was 40 and 420 ppm, respectively. Treatments consisted of the liquid starter fertilizer N-P_2O_5-K_2O combinations 30-15-5, 15-30-5 , 30-30-0 and 30-30-5. A no starter check also was included. Starters were made using 28% UAN, ammonium polyphosphate (10-43-0), and potassium thiosulfate (0-0-25-17). Nitrogen was balanced so that all plots received 220 lbs/a N, regardless of starter treatment. On plots receiving no K as KTS, ammonium sulfate was included to eliminate sulfur as a variable. Starter fertilizer was applied 2 inches to the side and 2 inches below the seed at planting.

Experiment 2.

This experiment was conducted during the 2002-2003 growing seasons on a site that was lower in soil test K than the previous experiment. Analysis showed that initial soil pH was 6.9; organic matter was 2.5%; Bray-1 P was 35 ppm, and exchangeable K was 150 ppm. Treatments consisted of liquid starter fertilizer rates of 0, 5, 15 or 25 lbs/a K_2O applied in combination with 30 lb N, 15 lb P_2O_5 and 5 lb/a S. A 30-15-15-0 treatment was included to separate the effects of K and S. The K source used in this treatment was KCl. The source of K used in all other treatments was potassium thiosulfate. Starter fertilizer was again applied 2 inches to the side and 2 inches below the seed at planting. Nitrogen was balance on all plots to give a total of 220 lbs/a.

Both experiments were furrow irrigated.

Results

Experiment 1.

The 30-30-5 starter treatment increased corn 6-leaf stage dry matter and tissue K content, decreased the number of days from emergence to mid-silk and increased grain yield as compared to the 30-30-0 treatment (Table 1). A small amount of K applied as a starter on this high soil test K soil resulted in better growth, nutrient uptake and 12 bu/a greater yield than starter that did not include K. In all cases, the 30-30-5 starter also was superior to the 15-30-5 treatment, indicating that N is an important element of starter fertilizer composition. All starter treatments improved growth and yield over the no-starter check.

Experiment 2.

Grain yield was maximized with application of 15 lbs of K_2O in the starter (Table 2). Addition of 15 lbs/a K_2O to starter increased grain yield by 13 bu/a over the starter containing only N and P. No response to sulfur was seen at this site. All combinations improved yields over the no-starter check.

Even though soil test K was in the high range, addition of K in the starter fertilizer increased early season growth and yield of corn. At this site, 15 lbs/a K_2O was required to reach maximum yield. In the previous experiment on a soil much higher in available K, only 5 lbs/a K was need to maximize yields.

Conclusion

Nutrient management in conservation tillage systems can be challenging. The increased amounts of crop residue present in these systems can cause early season nutrient deficiency problems that the plant may not be able to overcome later in the growing season. Early season P and K nutrition is essential for maximizing corn yield. In these experiments, addition of K to starters containing N and P has been shown to improve early season growth, nutrient uptake, earliness, and yield of corn grown in a long-term ridge-tillage production system.

Table 1. Starter fertilizer combinations effects on V6 dry weight, K uptake, days from emergence to mid-silk, and yield of corn, Experiment 1, 2000-2002.

Treatments $N\text{-}P_2O_5\text{-}K_2O$	V6 Dry Weight	V6 K Uptake	Days To Mid-Silk	Grain Yield
lb/a	- - - - - - - - - lb/a	- - - - - - - - -		bu/a
0-0-0 Check	210	6.2	79	162
30-15-0	382	10.9	71	185
15-30-5	355	15.2	71	173
30-30-0	395	11.2	71	184
30-30-5	460	15.2	68	195
LSD(0.05)	28	1.5	2	10

Table 2. Starter fertilizer combinations effects on V6 dry weight, K uptake, days from emergence to mid-silk, and yield of corn, Experiment 2, 2002-2003.

Treatments $N\text{-}P_2O_5\text{-}K_2O$	V6 Dry Weight	V6 K Uptake	Days To Mid-Silk	Grain Yield
lb/a	- - - - - - - - - lb/a	- - - - - - - - -		bu/a
0-0-0-0 Check	208	6.9	82	161
30-15- 5-5	312	12.8	76	189
30-15-15-5	395	16.2	72	198
30-15-25-5	398	16.9	72	197
30-15-0	290	8.8	76	185
30-15-15-0	398	16.1	72	198
LSD(0.05)	31	1.9	2	11

MAXIMIZING IRRIGATED CORN YIELDS IN THE GREAT PLAINS

W.B. Gordon

Summary

This experiment was conducted on a producer's field in the Republican River Valley on a Carr sandy loam soil in 2000-2002 and on the North Central Kansas Experiment Field on a Crete silt loam soil in 2003. Treatments consisted of 2 plant populations (28,000 and 42,000 plants/a) and 9 fertility treatments consisting of 3 nitrogen (N) rates (160, 230, and 300 lb/a) in combination with rates of phosphorus (P), potassium (K) and sulphur (S). The results of the experiment show a clear interaction between plant density and fertility management. At the high plant population, yields at the optimum N rate increased from 159 bu/a to 223 bu/a with the addition of more P in combination with K and S. At the low P rate, yields decreased by 3 bu/a when population was increased from 28,000 to 42,000 plants/a. On the sandy Carr soil, yield increases were achieved with the addition of both K and S; on the silt loam, yield increases were seen with the addition of K but not S. This experiment illustrates the importance of using a systems approach when attempting to increase yield, because factors interact with one another.

Introduction

With advances in genetic improvement of corn, yield levels continue to rise. New hybrids suffer less yield reduction under conditions of water and temperature stress. Hybrids now no longer lose yield to insect infestations. Newer hybrids have the ability to increase yields in response to higher plant populations. For many reasons, both environmental and agronomic, reduced tillage production systems are becoming more popular with producers. The large amount of surface residue present in reduced tillage systems can reduce seed zone temperatures, which may interfere with plant growth and development and nutrient uptake. Crops may respond to the addition of fertilizer even though soil test values are not low. Increasing plant population may increase yields and create a higher demand for crop nutrients. This research was designed to assess whether higher levels of crop nutrients are need in systems managed for maximum yields.

Procedures

This experiment was conducted on a producer's field located near the North Central Kansas Experiment Field, near Scandia, KS, on a Carr sandy loam soil in 2000-2003. Analysis by Kansas State University showed that initial soil pH was 6.8; organic matter was 2.0%; Bray 1-P was 20 ppm; exchangeable K was 240 ppm; SO_4-S was 6 ppm. In 2003 the experiment was conducted on a Crete silt loam soil. Soil test values for this site were: pH, 6.5; organic matter, 2.6 %; Bray-1 P, 30 ppm; exchangeable K, 170 ppm; and S was 15 ppm. Treatments included two plant populations (28,000 and 42,000 plants/acre) and 9 fertility treatments. Fertility treatments consisted of 3 nitrogen rates (160, 230, and 300 lb/acre) applied in combination with: 1) current soil test recommendations for P, K and S (this would consist of only 30 lb/a P_2O_5 at this site); 2) 100 lb/a P_2O_5+80 lb/a K_2O+40 lb/a SO4 applied preplant, N applied in 2 split applications; and 3) 100 lb/a P_2O_5+ 80 lb/a K_2O+40 lb/a SO4 applied preplant in combination with N applied in four split applications (preplant, V4, V8, and tassel). A complete description of treatments is given in Table 3. Preplant applications were made 14 to18 days before planting. Fertilizer sources used were ammonium nitrate, diammonium phosphate, ammonium sulfate, and potassium chloride. The experiment was fully irrigated.

Results

At the high plant population on the Carr sandy loam soil, yields at the 230 lb/a N rate increased from 159 bu/a to 223 bu/a with the addition of more P in combination with K and S (Table 4). At the low P rate, yields decreased by 3 bu/a when population was increased from 28,000 to 42,000 plants/a. At the optimum N rate with addition of P, K, and S, yields were increased by 18 bu/a by increasing population from 28,000 to 48,000 plants/a. On the Carr soil, significant yield increases were achieved with the addition of both K and S (Table 5).

Results in 2003 on the Crete soil were similar to that on the Carr soil in previous years. At the 230 lb/a N rate with the addition of higher rates of P in combination with K and S, yields were 45 bu/a greater when population was increased from 28,000 to 42,000 plants/a (Table 6). On the Crete silt loam soil, no response to S was seen (Table 7). No yield advantage was gained by splitting N fertilizer into 4 applications on either soil.

The results of this experiment show a clear interaction between plant density and fertility management, illustrating importance of using a systems approach when attempting to increase yield.

Table 3. Treatments

A. Population

28,000 plants/a and 42,000 plants/acre

B. Fertility

1. 160 lb/a N, 30 lb P_2O_5.
   P in the first 3 treatments was applied preplant. N was applied as a split application (1/2 preplant and 1/2 at the V4 stage).
2. 230 lb/a N, 30 lb P_2O_5.
3. 300 lb/a N, 30 lb P_2O_5.
4. 160 lb/a N, 100 lb/a P_2O_5, 80 lb/a K_2O, 40 lb/a S. For treatment 4, 5 and 6, P, K, and S were applied preplant. N was applied as a split application (1/2 preplant and 1/2 at V4 stage.
5. 230 lb/a N, 100 lb/a P_2O_5, 80 lb/a K_2O, 40 lb/a S.
6. 300 lb/a N, 100 lb/a P_2O_5, 80 lb/a K_2O, 40 lb/a S.
7. 160 lb/a N, 100 lb/a P_2O_5, 80 lb/a K_2O, 40 lb/a S. For treatment 7, 8, and 9, P, K and S were applied preplant. N was applied in 4 split applications (preplant, V 4, V8, and tassel).
8. 230 lb/a N, 100 lb/a P_2O_5, 80 lb/a K_20, 40 lb/a S.
9. 300 lb/a N ,100 lb/a P_2O_5, 80 lb/a K_20, 40 lb/a S.

Table 4. Effects of plant population and fertilizer rates and timing on irrigated corn grown on a Carr sandy loam soil, Scandia, KS, 2000-2002.

		……………..*Timing of N Application*…………		
		Pre+V4	Pre+V4	Pre+V4+V8+Tassel
		……………………*Elements*…………………...		
		P_2O_5	P_2O_5-K_2O-S	P_2O_5+K_2O+S
		…………………*Rates, lb/a*………………….		
		30	100-80-40	100-80-40
Population	N-Rate		Yield	
plants/a	lb/a	- - - - - - - - - - - -	bu/a	- - - - - - - - - - - -
28,000				
	160	143	180	185
	230	162	205	206
	300	164	205	206
	N-Rate Avg	156	197	199
42,000	160	137	185	191
	230	159	223	222
	300	163	223	222
	N-Rate Avg	153	210	212
Pop Avg	bu/a			
28,000	184			
42,000	192			
LSD(0.05)	7			
N-Rate Avg				
160	170			
230	196			
300	197			
LSD(0.05)	5			

Table 5. Nutrient effects on corn grown on a Carr sandy loam soil, Scandia, KS, 2001-2002.

Nutrient and Rate	Yield
lb/a	bu/a
0-0-0-0-0 Check	80
300 N	151
300 N+100 P_2O_5	179
300 N+100 P_2O_5+80 K_2O	221
300 N+100 P_2O_5+80 K_2O+40 S	239
LSD(0.05)	10

Table 6. Effects of plant population and fertilizer rates and timing on irrigated corn grown on a Crete silt loam soil, Scandia, KS, 2003.

		……………..*Timing of N Application*…………		
		Pre+V4	Pre+V4	Pre+V4+V8+Tassel
		……………………*Elements*……………………		
		P_2O_5	P_2O_5-K_2O-S	P_2O_5+K_2O+S
		…………………*Rates, lb/a*………………….		
		30	100-80-40	100-80-40
Population	N-Rate	Yield		
plants/a	lb/a	- - - - - - - - - - - - bu/a - - - - - - - - - - -		
28,000				
	160	152	196	215
	230	176	202	220
	300	183	205	223
	N-Rate Avg	170	201	219
42,000	160	144	220	233
	230	174	247	251
	300	193	250	251
	N-Rate Avg	171	239	245
Pop Avg	bu/a			
28,000	197			
42,000	218			
LSD(0.05)	9			
N-Rate Avg				
160	194			
230	212			
300	218			
LSD(0.05)	9			

Table 7. Nutrient effects on corn grown on a Crete silt loam soil, Scandia, KS, 2003.

Nutrient and Rate	Grain Yield
lb/a	bu/a
0-0-0-0-0 Check	114
300 N	154
300 N + 100 P_2O_5	229
300 N + 100 P_2O_5 + 40 K_2O	243
300 N + 100 P_2O_5 + 40 K_2O + 40 S	244
LSD(0.05)	11

CONTROLLED RELEASED UREA FOR IRRIGATED CORN PRODUCTION

W.B. Gordon

Summary

No-tillage production systems are being used by an increasing number of producers in the central Great Plains. Advantages include reduction of soil erosion, increased efficiency of soil moisture use and improved soil quality. However, the large amount of residue left on the soil surface can make nitrogen (N) management difficult. Surface applications of urea-containing fertilizers are subject to volatilization losses. Leaching can also be a problem on course textured soils when N is applied in one preplant application. Slow-release polymer-coated urea products are beginning to become available for agricultural use. The polymer coating allows the urea to be released at a slower rate than uncoated urea.

This experiment compares urea, controlled-release polymer-coated urea (CRU), and ammonium nitrate at 3 N rates (80, 160, and 240 lbs/a). Split applications (1/2 preplant + 1/2 at V4 stage) at the 160 lb/a N rate also were included. The study was conducted on a farmer's field on a Carr sandy loam soil. The field was furrow-irrigated. The CRU product yield was greater than urea at all N rates. Ammonium nitrate and CRU yields were essentially the same. Maximum yield with CRU came at 160 lb N/a, whereas yields of plots receiving urea continued to increase with increasing N rate up to 240 lb/a. Splitting N application improved yields when urea was applied but not when CRU was the N source. The polymer-coated urea product has the potential to increase efficiency of surface N application in no-tillage systems.

Introduction

Conservation tillage production systems are being used by an increasing number of producers in the Great Plains. Advantages include reduced soil erosion losses, more efficient soil water use, and improved soil quality. A disadvantage is the large amount of residue left on the soil surface in no-tillage systems, which can make N management difficult. Surface application of N fertilizers is popular with producers. When urea-containing N fertilizers are placed on the soil surface, they are subject to volatilization losses. Nitrogen immobilization also can be a problem when N fertilizers are surface-applied. Nitrogen leaching can be both an agronomic and environmental problem on course-textured soils. Polymer-coated urea has the potential to simplify surface-applied N management in no-tillage systems.

Procedures

This experiment was conducted on a farmer's field in the Republican River valley on a Carr sandy loam soil. Soil pH was 6.9; organic matter was 1.8%; Bray-1 P was 25 ppm, and exchangeable K was 150 ppm. The corn hybrid Pioneer 33P67 was planted without tillage into corn stubble on May 1, 2003 at the rate of 28,000 seeds/a. Nitrogen was applied on the soil surface immediately after planting. Split applications consisted of 1/2 of the N applied immediately after planting and 1/2 applied at the V4 stage. Treatments consisted of controlled-released polymer-coated urea (CRU), urea, and ammonium nitrate applied at three rates (80, 160, and 240 lbs/a. A no-N check plot also was included. Additional treatments were split applications of CRU, urea, ammonium nitrate, and UAN at the 160 lb/a N rate. The experimental area was adequately irrigated throughout the growing season. Plots were hand harvested October 30, 2003.

Results

The CRU product gave greater corn yield at all levels of N than urea (Table 8). Yields achieved with CRU application were equal to those of ammonium nitrate. The lower yields with urea indicate that volatilization of N may have been significant. Splitting applications of N with CRU and ammonium nitrate did not improve corn yields. When urea was the N source, yields increased from 139 bu/a to 156 bu/a by splitting N application. Maximum yield came at 160 lb N/a when CRU was used as the N source, but continued to increase up to the 240 lb N/a rate when urea was used as the N source (Figure 1).

Results of this study suggest that slow release polymer-coated urea can improve N use efficiency compared to urea and UAN when surface applied in no-tillage conditions.

Table 8. Effects of nitrogen source and rate on corn grain yield and earleaf N, Scandia, KS, 2003.

N Source	N-Rate	Yield	Earleaf N
	lb/a	bu/a	%
	0-N check	89	1.66
CRU	80	151	2.16
	160	175	2.83
	240	178	2.31
Urea	80	123	1.97
	160	139	2.11
	240	160	2.20
Ammonium nitrate	80	154	2.19
	160	175	2.25
	240	177	2.28
CRU	80+ 80 split	177	2.28
Urea	80+80 split	156	2.17
Ammonium nitrate	80+80 split	178	2.28
28% UAN	80+ 80 split	164	2.18
LSD (0.05)		14	0.14

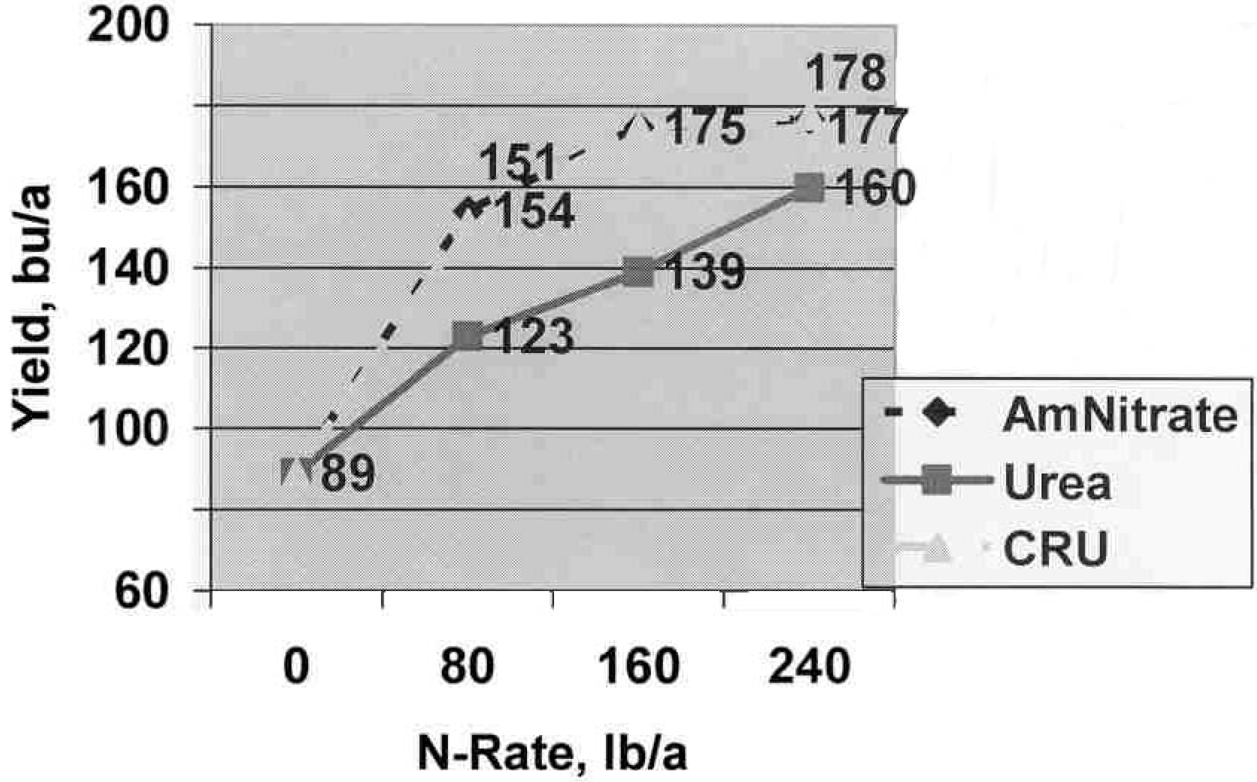


Figure 1. Nitrogen source and rate effects on corn grain yield, Scandia 2003.

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 6 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 65 bu/a were obtained with 120 lb/a of N. Plant height and plant N concentration also increased with N rate. Grain protein increased more with yield when wheat received 120 lb/a of N following 120 lb/a on sorghum than when it followed sorghum with the lower N rate. Wheat yields were not significantly affected by seeding rate, presumably because of abundant early fall precipitation.

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 diminished or largely 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 a period of 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 third cycle of the sorghum/wheat rotation with its treatment variables, Pioneer 8500 grain sorghum was planted at 42,000 seeds/a in 30-in. rows on May 21 and harvested on September 5, 2002. Nitrogen rates were applied as ammonium nitrate on October 16-17. Wheat planting was delayed somewhat by substantial early October rains. Variety 2137 was planted on October 18, 2002, into undisturbed sorghum stubble with a no-till drill equipped with double-disk openers on 8-in. spacing. P_2O_5 at 35 lb/a was banded in the seed furrow. Whole-plant wheat samples were collected at heading stage for determination of N and P concentrations. Wheat was harvested on June 25, 2003. Grain subsamples were analyzed for N content.

Results

Antecedent grain sorghum yields, averaged across previous wheat N rates and seeding rates, were 93 and 96 bu/a with 60 and 120 lb/a of N, respectively. Rainfall totaled 2.58 in. during the first 12 days after planting. However, November and December were much dryer than usual. Although average October temperatures were 9°F below normal and November also was somewhat cooler than usual, stand establishment and fall wheat development were good. Winter precipitation was below normal in January, but above normal during the other winter months. Rainfall was about 1.5 inches above normal in April and only slightly below normal in May and the first half of June. April temperatures were equal to long-term averages, while May and June averaged about 4°F below normal. This combination of moisture and temperatures resulted in a favorable grain filling period that culminated in good wheat yields and excellent test weights. Residual effect of sorghum N rate 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 0.17% N and yield by 6 bu/a.

N rate significantly affected most wheat response variables measured. Yields increased with each 40 lb/a increment of fertilizer. Overall average yields of 65 bu/a were obtained with 120 lb/a of N. Plant height and plant N concentration also increased with N rate. Grain protein decreased with N rate, especially at intermediate levels of N fertilizer. Plant P concentration also was highest at the zero N rate, reflecting the dilution effect of greater plant growth that resulted from fertilizer application.

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. Grain protein was highest with zero fertilizer N following 60 lb/a of N on sorghum and with 120 lb/a of N after 120 lb/a of N on sorghum. At intermediate N rates, protein levels tended to be lower than at the zero rate. Protein increased more with yield when wheat received 120 lb/a of N following 120 lb/a on sorghum than when it followed sorghum with the lower N rate.

Seeding rate main effect on wheat was generally not significant, most likely because of abundant moisture during the establishment phase of the crop. Plant P concentration declined slightly at the highest seeding rate.

Table 1. Effects of nitrogen and seeding rate on no-till winter wheat after grain sorghum, Hesston, KS, 2003.

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	14.1	62.3	21	1.19	0.28	10.2
		90	13.2	62.5	20	1.16	0.27	10.4
		120	15.9	62.3	19	1.13	0.26	10.1
	40	60	32.1	62.0	26	1.14	0.23	8.9
		90	33.5	61.9	27	1.14	0.22	8.9
		120	32.4	61.6	26	1.14	0.22	8.9
	80	60	51.4	62.0	30	1.32	0.21	8.8
		90	52.4	61.6	30	1.31	0.22	8.6
		120	52.6	61.9	30	1.36	0.22	8.9
	120	60	64.9	62.0	31	1.71	0.23	9.2
		90	64.8	62.1	32	1.62	0.21	9.2
		120	64.5	62.3	31	1.60	0.21	9.5
120	0	60	22.2	62.2	25	1.26	0.26	9.9
		90	24.7	62.3	24	1.20	0.26	9.6
		120	23.7	62.2	23	1.29	0.24	9.6
	40	60	41.3	62.2	28	1.32	0.23	9.2
		90	43.6	62.1	28	1.36	0.22	9.3
		120	42.2	62.1	27	1.28	0.21	9.0
	80	60	57.4	62.0	30	1.60	0.22	9.5
		90	55.8	62.1	30	1.55	0.22	9.3
		120	57.6	62.2	30	1.55	0.21	9.3
	120	60	65.2	62.2	31	1.91	0.22	10.1
		90	63.8	62.4	30	1.80	0.21	10.2
		120	66.0	62.5	31	1.79	0.21	10.0
LSD .05	Means at same Sor. N		4.9	0.38	2.3	0.16	0.02	0.45
	Means at diff. Sor. N		5.6	0.82	2.6	0.19	0.03	0.59
Means: Sorghum N Rate								
60			41.0	62.0	27	1.32	0.23	9.3
120			47.0	62.2	28	1.49	0.23	9.6
LSD .05			3.3	NS	NS	0.12	NS	NS
LSD .15			----	NS	1.0	----	NS	NS
	N Rate							
	0		19.0	62.3	22	1.20	0.26	10.0
	40		37.5	61.9	27	1.23	0.22	9.0
	80		54.5	62.0	30	1.45	0.22	9.1
	120		64.9	62.2	31	1.74	0.21	9.7
	LSD .05		2.0	0.16	0.9	0.06	0.01	0.18
		Seed Rate						
		60	43.6	62.1	28	1.43	0.23	9.5
		90	44.0	62.1	28	1.39	0.23	9.5
		120	44.4	62.1	27	1.39	0.22	9.4
		LSD .05	NS	NS	NS	NS	0.01	NS

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

EFFECTS OF LATE-MATURING SOYBEAN AND SUNN HEMP SUMMER COVER CROPS AND NITROGEN RATE ON NO-TILL GRAIN SORGHUM AFTER WHEAT

M.M. Claassen

Summary

Late-maturing Roundup Ready® soybean and sunn hemp drilled in wheat stubble at 59 and 10 lb/a, respectively, produced an average of 3.91 and 3.52 ton/a of above-ground dry matter. Corresponding nitrogen (N) yields of 146 and119 lb/a were potentially available to the succeeding grain sorghum crop. When averaged across N fertilizer rates, soybean and sunn hemp significantly increased sorghum leaf nutrient levels by 0.24% N and 0.29% N, respectively. Sorghum leaf N concentration indicated no interaction between cover crop and N rate. Cover crops shortened the period from planting to half bloom by 2 days. Sunn hemp increased grain sorghum yields by 10.6 bu/a, whereas soybean did not significantly benefit sorghum under existing conditions. Sorghum test weights decreased by an average of 1.2 lb/bu with either cover crop. Nitrogen rates of 60 lb/a or more tended to increase leaf N in comparison with lower rates. No other N rate effects were measured.

Introduction

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

New interest in cover crops has been generated by research in other areas showing the positive effect these crops can have on the overall productivity of no-till systems. In a 2002 pilot project at Hesston, a Group VI maturity soybean grown as a summer cover crop after wheat produced 2.25 ton/a of above-ground dry matter and an N yield of 87 lb/a potentially available to the succeeding crop. Soybean cover crop did not affect grain sorghum yield in the following growing season, but, when averaged over N rate, resulted in 0.15% N increase in flag leaves. In the current experiment, late-maturing soybean and sunn hemp, a tropical legume, were evaluated as summer cover crops for their impact on no-till sorghum grown in the spring following wheat harvest.

Procedures

The experiment was established on a Geary silt loam site which had been utilized for hairy vetch cover crop research in a wheat-sorghum rotation from 1995 to 2001. In keeping with the previous experimental design, soybean and sunn hemp were assigned to plots where vetch had been grown, and the remaining plots retained the no-cover crop treatment. The existing factorial arrangement of N rates on each cropping system also was retained.

Following wheat harvest in 2002, weeds were controlled with Roundup Ultra Max® herbicide. Hartz H8001 Roundup Ready® soybean and sunn hemp seed were treated with respective rhizobium inoculants and no-till planted in 8-inch rows with a CrustBuster stubble drill on July 5 at 59 lb/a and 10 lb/a, respectively. Sunn hemp began flowering in late September and was terminated at that time by a combination of rolling with a roller harrow and application of 26 oz/a of Roundup Ultra Max®. Soybeans were rolled after initial frost in mid October. Forage yield of each cover crop was determined by harvesting a 3.28 feet^2 area in each plot just before termination. Samples were subsequently analyzed for N content.

Weeds were controlled during the fallow period and row crop season with Roundup

Ultra Max®, atrazine, and Dual II Magnum®. Pioneer 8505 grain sorghum treated with Concept® safener and Gaucho® insecticide was planted at approximately 42,000 seeds/a on June 12, 2003.

All plots received 37 lb/a of P_2O_5 banded as 0-46-0 at planting. Nitrogen fertilizer treatments were applied as 28-0-0 injected at 10 inches from the row on July 9, 2003. Grain sorghum was combine harvested on October 24.

Results

Modest but timely rains three days before and five days after soybean and sunn hemp planting resulted in good cover crop stand establishment. Although July and August rainfall in 2002 was below normal, both crops developed well. Late-maturing soybean reached an average height of 35 inches, showed limited pod development, and produced 3.91 ton/a of above-ground dry matter with an N content of 1.86% or 146 lb/a (Table 2). Sunn hemp averaged 82 inches in height and produced 3.52 ton/a with 1.71% N or 119 lb/a of N. It was noted, however, that sunn hemp roots had little or no nodulation, evidence that the inoculant was ineffective. Soybean and sunn hemp effectively suppressed volunteer wheat and, in the fall, reduced the density of henbit in comparison with areas having no cover crop.

Grain sorghum emerged on June 17, with final stands averaging 39,340 plants/a. Extreme drouth stress characterized the period from late June until late August, during which little rain fell and temperatures on 21 days reached or exceeded 100°F. Cover crops had no effect on sorghum population, but shortened the period from planting to half bloom by an average of two days. Both cover crops significantly increased leaf N concentration. Across N rates, these increases averaged 0.24% N and 0.29% N, respectively, for soybean and sunn hemp. The positive effect of cover crops on sorghum leaf N concentration was significant at each level of fertilizer N except the 60 lb/a rate. Cover crops did not affect the number of heads/plant. However, sunn hemp increased grain sorghum yields by 10.6 bu/a, whereas soybean did not significantly benefit sorghum under existing conditions. Sorghum test weights decreased by an average of 1.2 lb/bu with either cover crop.

Nitrogen rates of 60 and 90 lb/a versus 0 and 30 lb/a resulted in an average of 0.12% N increase in sorghum leaves, significant at $p=0.06$. No other meaningful effects of N rate on grain sorghum were observed or measured.

Table 2. Effects of soybean and sunn hemp summer cover crops and nitrogen rate on no-till grain sorghum after wheat, Hesston, KS, 2003.

Cover Crop	N Rate[1]	Cover Crop Yield[2] Forage	Cover Crop Yield[2] N	Grain Sorghum Grain Yield	Bushel Wt	Stand	Half[3] Bloom	Heads/ Plant	Leaf N[4]
	lb/a	ton/a	lb/a	bu/a	lb	1000's/a	days	no.	%
None	0	----	----	49.2	57.5	38.5	61	0.67	1.98
	30	----	----	48.2	57.9	39.4	62	0.66	1.94
	60	----	----	48.8	56.1	39.3	61	0.69	2.20
	90	----	----	45.8	56.8	39.0	61	0.67	2.08
LSD .05				NS	NS	NS	NS	NS	0.16
Soybean	0	3.54	130	47.9	56.0	40.3	59	0.66	2.27
	30	3.99	133	48.3	56.2	39.4	59	0.67	2.26
	60	3.88	152	56.2	55.7	38.9	59	0.69	2.32
	90	4.23	170	50.7	55.9	39.1	59	0.66	2.31
LSD .05		----	----	NS	NS	NS	NS	NS	NS
Sunn hemp	0	3.93	128	58.8	56.7	40.0	59	0.65	2.24
	30	3.44	122	53.0	55.3	39.2	59	0.69	2.31
	60	3.28	111	59.9	55.9	39.4	60	0.67	2.34
	90	3.42	114	62.6	55.8	39.7	59	0.68	2.48
LSD .05		----	----	NS	0.88	NS	NS	NS	NS
LSD .05 across systems		NS	38	10.0	0.97	NS	1.1	NS	0.21
Means: Cover Crop/ Termination									
None		----	----	48.0	57.1	39.0	61	0.67	2.05
Soybean		3.91	146	50.8	55.9	39.4	59	0.67	2.29
Sunn hemp		3.52	119	58.6	55.9	39.6	59	0.67	2.34
LSD .05		NS	19	5.0	0.49	NS	0.5	NS	0.11
N Rate									
0		3.74	129	51.9	56.7	39.6	60	0.66	2.17
30		3.72	128	49.9	56.5	39.3	60	0.68	2.17
60		3.58	132	55.0	55.9	39.2	60	0.68	2.29
90		3.82	142	53.0	56.2	39.3	60	0.67	2.29
LSD .05		NS	NS	NS	0.56	NS	NS	NS	NS

[1] N applied as 28-0-0 on July 9, 2003.
[2] Oven dry weight and N content on October 16, 2002.
[3] Days from planting (June 12, 2003) to half bloom.
[4] Flag leaf at late boot to early heading.

SOIL FERTILITY RESEARCH
EAST CENTRAL EXPERIMENT FIELD

STRIP-TILL AND NO-TILL TILLAGE/FERTILIZER SYSTEMS COMPARED FOR CORN

K.A. Janssen, W.B. Gordon, and R.E. Lamond

Summary

Strip-till and no-till tillage/fertilizer systems were compared for corn using different fertilizer configurations on a somewhat poorly drained soil in east-central Kansas. Averaged across all fertilizer treatments, fall strip-till increased stand, 6-leaf dry matter, nutrient uptake, and yield compared to no-till. There was no indication that fall-applied fertilizer performed less well than spring-applied fertilizer. More testing is needed, but fall strip-till with fall banded fertilizer shows promise as an option for no-till corn production. Additional trials are planned for next year.

Introduction

Corn producers in east-central and southeast Kansas need to reduce sediment and nutrient losses via runoff. Edge of field studies show that conventional tillage systems are losing significant amounts of sediment and total phosphorus (P) in runoff. No-till systems can reduce sediment and total P losses by two to three times compared to conventional systems. However, for corn, no-tillage can cause serious challenges some years. Nonirrigated corn in eastern Kansas needs to be planted early (middle March - early April) and grow rapidly to produce grain before hot and dry conditions occur in the middle to later part of July. The increased residue levels, along with reduced air exchange and water evaporation associated with no-tillage, can keep soils cooler and wet longer in the spring. That, in turn, can delay planting and reduce early-season nutrient uptake and growth. Application of starter fertilizer can offset some of the slower early-season growth effects with no-till, but delayed planting remains a deterrent to no-till corn planting.

In the cold northern states, timely early planting of corn is also important. Corn needs to be planted early to mature before fall freezing weather. Strip-tillage is a conservation tillage system that is gaining favor with northern corn producers. Strip-tillage is a hybrid between no-till, conventional till, and ridge-till. Tillage is confined to narrow strips where the seed rows are to be planted. Row middles are left untilled. The tilled strip creates a raised bed 3 to 4 inches high, which improves soil drainage and warming. By spring, the raised bed usually settles down to 1 to 2 inches high, and after planting the field is level. Banding fertilizer is generally performed in the same strip-tillage operation. Banding fertilizer can improve fertilizer use efficiency compared to broadcast by placing fertilizer in a position to be readily useable by young, developing corn roots. Strip-tillage with fertilizer banded below the row would seem to be applicable also for eastern Kansas corn production.

The objectives of this study were 1) to compare the effectiveness of strip-tillage and no-tillage systems with different fertilizer configurations for upland, rain-fed corn in east-central Kansas, and 2) to assess the effects of fall versus spring applications of N-P-K-S fertilizer on growth, grain yield, and nutrient uptake of corn.

Procedures

The study site was at the K-State East Central Experiment Field at Ottawa on a somewhat poorly drained Woodson silt loam soil that had been no-tilled for the previous five years. The previous crop was corn, and the corn stalks were shredded before the tillage systems and fertilizer treatments were established. The tillage/fertilizer systems and the dates fertilizers were applied are shown in Table 1. Burn-down herbicide for pre-plant weed control was applied on March 31, 2003, and consisted of 1qt/a atrazine 4L + 0.66pt/a 2,4-D LV4 + 1 qt/a COC. Pioneer 35P12 corn was planted on April 10, 2003. Pre-emergence herbicide consisting of 0.33 qt/a atrazine 4L + 1.33 pt/a Dual II Magnum® was applied April 23, 2003. Plant counts were taken on May 20, 2003, and whole above-ground plants (six plants per plot) were taken for biomass and nutrient uptake measurements at the 6-leaf growth stage. Harvest was August 28, 2003.

Results

Moisture during the fall and winter months following the fall strip-till applications was below normal, but late winter and early spring moisture was slightly above normal. Rainfall during May and June was near normal. July and most of August were hot and very dry. Overall air temperatures during the corn planting period were normal to below normal.

Corn Emergence, Plant Stands and Early Season Growth

In general, emergence was more uniform in strip-till corn rows than in no-till. Plant stands were 15% better in strip-till treatments compared with no-till (Table 1). Early-season corn growth (dry matter accumulation), when averaged across similar fertilizer treatments, was 30% greater with fall strip-till and fall-applied fertilizer than with no-till and planting time fertilizer.

Nutrient Uptake

Nitrogen, phosphorus, potassium and sulfur uptake in lbs/a for corn, when averaged across all fertilizer rates, was 39, 39, 9, and 56% greater, respectively, with fall strip-till and fall-applied fertilizer than with no-till and 2x2 planting time fertilizer.

Yield

Fall strip-till by itself increased corn grain yield 11.6 bu/a compared to no-till (0-0-0-0 fertilizer treatments). With fall strip-till and 40-30-5-5 lb/a fertilizer applied at planting, fall strip-till increased corn yield 9.7 bu/a compared to the same fertilizer amount applied for no-till. At the 80-30-5-5 lb/a fertilizer rate there were no statistically significant differences in yield between the tillage systems. The 120-30-5-5 fertilizer rate did not increase yield over the 80-30-5-5 rate in either tillage system. The 120-30-5-5 fertilizer rate when applied 2x2 at planting with fall strip-till reduced yield compared to the 40-30-5-5 2x2 planting rate. This is a warning that too high a fertilizer concentration in the loosened strip-till soil zone near the time of planting may cause some negative effects. The highest overall corn yield was produced with fall strip-till and 80-30-5-5 applied in the fall. There was no indication that fall-applied fertilizer performed less well than spring-applied fertilizer. If anything, the trend was in favor of fall-applied fertilizer. All strip-till and fall-applied fertilizer operations were performed after soil temperatures had dropped below 50° degrees.

Conclusions

The results for the first year's study with fall-early winter strip-till looks promising. Additional studies are planned for next year.

Table 1. Strip-till and no-till tillage/fertilizer comparison study for corn, Ottawa, KS, 2003.

Treatments	Yield	Plant Stand	6-Leaf Stage Plant Dry Matter	6-Leaf Stage Nutrient Uptake N	P	K	S
	bu/a	1000/a	lb/a	- - - - - - - lb/a - - - - - - -			
Fall Strip-Till + Fall Applied (11/2/02) **Fertilizer (N-P-K-S lb/a)**							
1. Check 0-0-0-0	78.0	21.1	124	4.0	0.54	2.4	0.25
2. 40-30-5-5	85.5	21.1	305	10.8	1.21	5.4	0.67
3. 80-30-5-5	96.1	21.2	335	12.8	1.37	6.0	0.72
4. 120-30-5-5	91.0	21.8	345	13.9	1.37	6.4	0.77
5. 80-15-2.5-2.5 fall + 40-15-2.5-2.5 at planting	88.6	21.1	363	14.7	1.50	10.4	0.75
Fall Strip-Till + Planting Time (2x2) Applied (4/10/03) **Fertilizer (N-P-K-S lb/a)**							
6. 40-30-5-5	89.7	21.0	423	14.1	1.70	7.7	0.81
7. 80-30-5-5	87.6	21.3	361	14.4	1.45	6.5	0.72
8. 120-30-5-5	78.4	22.2	326	13.7	1.31	6.3	0.66
No-Tillage + Planting Time (2x2) Applied (4/10/03) **Fertilizer (N-P-K-S lb/a)**							
9. Check 0-0-0-0	66.4	18.4	97	2.9	0.43	2.4	0.18
10. 40-30-5-5	80.0	18.8	254	9.3	1.06	6.0	0.51
11. 80-30-5-5	90.4	18.8	231	9.4	0.94	5.4	0.43
12 120-30-5-5	85.5	18.1	193	8.3	0.80	4.7	0.42
No-Tillage + Preplant Deep-Band (15" Centers) Applied (3/26/03) **Fertilizer (N-P-K-S lb/a)**							
13. 120-30-5-5	87.0	18.9	201	8.2	0.78	4.3	0.41
LSD (0.05)	9.4	2.4	91	3.2	0.32	2.3	0.17

FERTILIZER MANAGEMENT FOR STRIP-TILL AND NO-TILL CORN PRODUCTION

L.J. Ferdinand, R.E. Lamond, W.B. Gordon, and C.B. Godsey

Summary

Strip-tillage for corn production can be advantageous over no-till, particularly in areas with heavy soils and high rainfall during spring months. Under these conditions in no-till systems, planting delays and/or slow, uneven emergence are common. Strip-tillage creates a narrow tilled area for the seedbed while maintaining the inter-row residue cover, allowing for erosion protection associated with no-till, yet providing an area in the row where the soil will dry out and warm up earlier in the season. Results to date from this research indicate that strip-till provides for warmer soil temperatures early in the season, resulting in better early season growth, and higher grain yields than no-till. Fertilizer applied during the fall strip-till performed similarly to fertilizer applied at planting where fall strip-tillage was done.

Introduction

Conservation tillage practices leave residue from previous crops on the soil surface, reduce soil erosion, and decrease trips across the field with heavy tillage equipment. Although no-till provides soil and water conservation benefits to producers, the cooler, wetter soil conditions result in potential problems for planting and establishing crops. The inherent residue layer associated with no-till contributes to cooler temperatures in the seed zone at spring planting. Lower soil temperatures negatively affect seedling emergence and early season growth, especially with early planting dates. If no-till systems are limited by crop residues on the soil surface, then seed-row residue removal should lead to corn growth similar to that of tilled systems. Strip-tillage provides an ideal combination of no-till with conventional tillage. Residue removal from within the row should allow for development rates that are similar to those of conventional tillage. Maintaining a concentration of residue in the inter-row will allow the no-till advantages of lower soil water evaporation and reduced runoff. Strip-till also offers the option of applying fertilizer nutrients during the fall strip-till operation. A second option is to apply nutrients in the spring at planting after creating the strip-till in the fall. The overall objective for this research is to compare strip-till and no-till as options for early planted corn in Kansas by evaluating 1) seed row temperature differences, effects on emergence, early season growth, and grain yield between strip-till and no-till; and 2) management options for rates and timing of fertilizer application.

Procedures

Field experiments were conducted in 2003 at two K-State Research and Extension dryland field sites in central and eastern Kansas (Belleville: Crete silty clay loam; Manhattan: Reading silt loam). Tillage treatments were no-tillage and strip-tillage. A four-row strip-till rig was used in the fall at each site to disturb the soil to a depth of approximately 6 inches in the row with a 4- to 5-inch area of residue-free soil over the row. Inter-row regions were left undisturbed. Previous crops included wheat (Belleville) and soybean (Manhattan). Fertilizer treatments included either 40, 80, or 120 lbs N/a applied with 30 lbs P_2O_5/a, 5 lbs K_2O/a, and 5 lbs S/a. No-fertilizer check plots were included for both strip-till and no-till at each site. Time of fertilizer application for the strip-till treatments occurred either in the fall during the strip-till operation or with the planter in the spring. One strip-till fertilizer treatment consisted of a split application with 2/3 applied during fall strip-till and the balance at planting time. No-tillage plots received fertilizer applications during the planting operation. Fertilizer was placed to approximately 5- to 6-inch depth with the strip-till operation or in a 2x2 placement with the planter on no-till plots and strip-till plots receiving spring nutrient application. Fertilizer combinations were made using UAN, 10-34-0 and potassium thiosulfate. Corn was planted in early April. At the Manhattan site and the Belleville site Cu-constantan thermocouples were installed at the seeding depth in selected no-till plots and strip-till plots to measure soil temperature. Daily temperature data were taken at in-row positions in each of the selected plots from mid-April through May. At the V6 growth stage, plants were randomly selected from non-harvest rows in each plot to determine dry matter yield and analyzed for nutrient concentration. Ear leaf samples were collected for nutrient analysis at tasselling. Whole plot samples were taken at physiological maturity at the Manhattan site to determine total biomass and nutrient analysis. Grain yields were determined by either hand harvesting or machine harvest, depending on location.

Results

Although there were no differences in final plant stands due to tillage, corn in the strip-till treatments emerged quicker and more uniformly than no-till (data not shown), likely due to higher soil temperatures. Average daily soil temperatures at both Manhattan and Belleville through April and May were higher in strip-till compared to no-till (Figures 1 and 2). The effect of higher soil temperatures in strip-till was reflected in the increased V6 dry matter production compared to no-till at all locations (Tables 1, 2, 3). In addition to the better early growth, strip-tillage significantly increased corn yields in comparison to no-till at all locations in 2003 (Tables 1, 2, 3).

Grain yields were excellent in 2003 at the Manhattan site for dryland corn due to early planting and timely rains through mid-July. Strip-till provided significantly increased early season growth over no-till and a 28 bu/a grain yield advantage over no-till at the Manhattan site (Table 3). Grain yields at Belleville were reduced due to dry conditions, but even with lower yields, strip-till yields were 12 bu/a higher than no-till yields at Belleville (Table 3).

No significant difference existed between fertilizer applications made in the fall with the strip-till operation as compared to applying fertilizer in the spring after fall strip-till (Table 2). Results suggest that under similar conditions fertilizer can be applied during fall strip-till without concern of yield reduction. Nitrogen rate effects varied by location and previous crop, but increasing N rates generally increased grain yields.

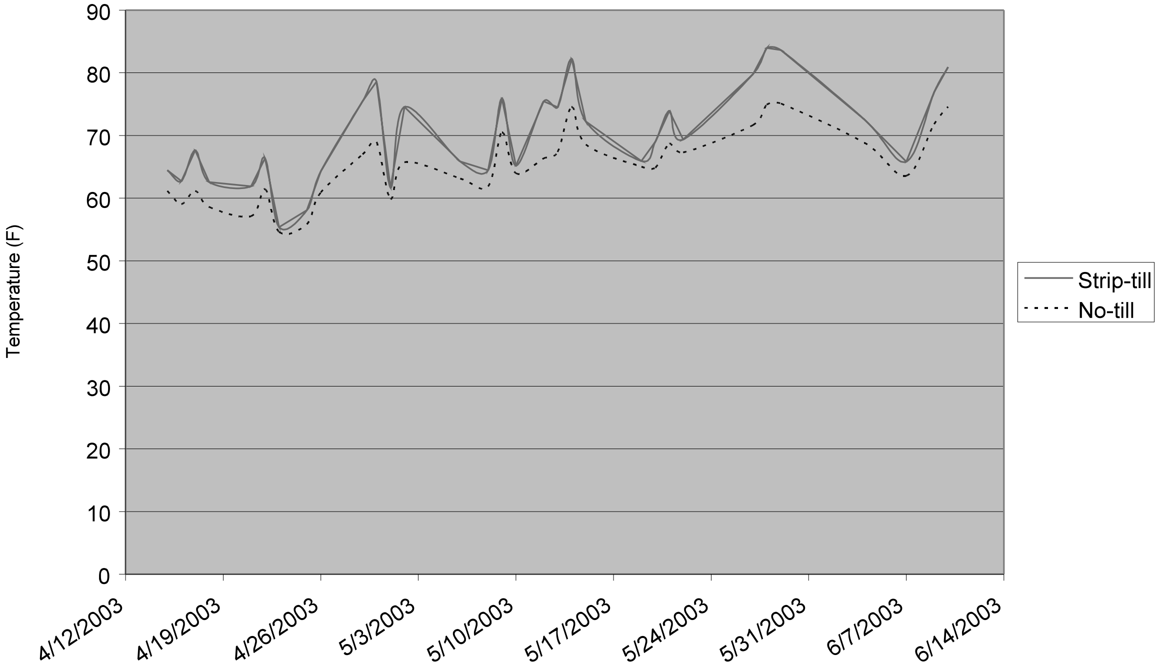


Figure 1. Daily soil temperatures at seeding depth, Manhattan, KS.

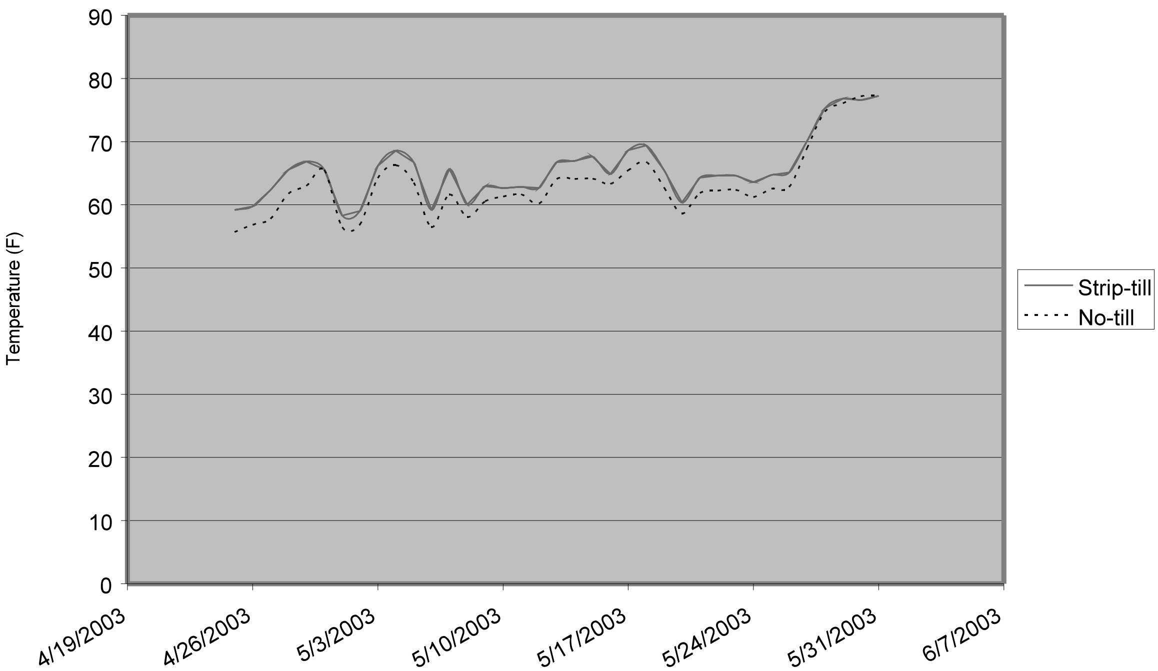


Figure 2. Daily soil temperatures at seeding depth, Belleville, KS.

Table 1. Effects of tillage, time of fertilizer application and nitrogen rate on corn.

Tillage	Time of Fertilizer Application	Fertilizer Rate N	P	K	S	Manhattan V6 Dry Weight	Manhattan Grain Yield	Belleville V6 Dry Weight	Belleville Grain Yield
		- - - - - - lb/a - - - - - -				lb/a	bu/a	lb/a	bu/a
Strip-till	--	0	0	0	0	339	170	155	42
Strip-till	Fall	40	30	5	5	417	182	276	56
Strip-till	Fall	80	30	5	5	450	193	284	58
Strip-till	Fall	120	30	5	5	452	205	361	67
Strip-till	2/3 Fall 1/3 Planting	120	30	5	5	493	193	406	75
Strip-till	Planting	40	30	5	5	468	185	263	52
Strip-till	Planting	80	30	5	5	485	187	283	60
Strip-till	Planting	120	30	5	5	424	187	353	71
No-till	Planting	40	30	5	5	366	152	178	45
No-till	Planting	80	30	5	5	360	167	189	48
No-till	Planting	120	30	5	5	310	174	198	51
No-till	--	0	0	0	0	263	121	105	36
LSD (0.05)						76	25	34	12

Table 2. Effects of time of fertilizer application and nitrogen rate on strip-till corn.

Variable		Manhattan V6 Dry Weight	Manhattan Grain Yield	Belleville V6 Dry Weight	Belleville Grain Yield
		lb/a	bu/a	lb/a	bu/a
Time of fertilizer					
Application:	During strip-till (fall)	440	193	307	60
	Planting time	459	186	300	61
	LSD (0.05)	NS	NS	NS	NS
N Rate:	40	443	184	269	54
lb/a	80	468	190	283	59
	120	438	196	357	69
	LSD (0.05)	NS	NS	24	6

Table 3. Effects of tillage and nitrogen rate on corn[1].

Variable		Manhattan V6 Dry Weight	Manhattan Grain Yield	Belleville V6 Dry Weight	Belleville Grain Yield
		lb/a	bu/a	lb/a	bu/a
Tillage:	Strip-till	429	182	264	57
	No-till	325	154	168	45
	LSD (0.05)	37	15	17	7
N Rate:	0	301	146	130	40
lb/a	40	417	169	221	49
	80	423	177	236	54
	120	367	181	276	61
	LSD (0.05)	52	21	25	10

[1] Averaged across treatments receiving fertilizer at planting time.

EFFECTS OF NITROGEN MANAGEMENT AND TILLAGE ON GRAIN SORGHUM

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

Summary

Since 1982, responses of grain sorghum to tillage system and nitrogen (N) rate, source, and placement have been investigated. Until 1995, N sources and placements used were ammonium nitrate, broadcast, and urea-ammonium nitrate solution, either broadcast or knifed, at rates of 0, 30, 60, 120 lb N/a. In 1995, the placement variable was dropped, and N sources (ammonium nitrate, urea, and AgrotaiN®) were evaluated. In 2000, AgrotaiN® was dropped as a N source and replaced by CRU, a polymer-coated, slow-release urea that may be less susceptible to volatilization. All N was surface broadcast. The tillage systems used were no-till or conventional. In 2003, dry conditions in late July and August limited yields. Conventional tillage resulted in higher yields than no-till. Nitrogen sources performed similarly in conventional tillage and no-till in 2002.

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. Large amounts 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.

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

Procedures

Three N sources at three rates each (30, 60, 120 lb N/a) were used. These were ammonium nitrate, urea, and CRU. All materials were surface broadcast. The two tillage methods were conventional tillage, consisting of fall chisel and field cultivation before planting, and no tillage. The N was incorporated in the conventional-tillage system. A check plot without N was included within each tillage method. The treatments were replicated three times and arranged in a split-plot design with tillage as the main plot treatment and N source by N rate as the subplot treatments. Planting (Pioneer 8505) and harvesting of grain sorghum were done on May 29 and September 16, respectively.

Results

Results are summarized in Table 4. Grain yields were increased significantly by N fertilization, although 60 lb N/a was enough to produce optimum yields due to the low yield levels. With the reduced yields, grain protein levels were significantly increased by N fertilization up to 120 lb/a. All N sources performed similarly in conventional till and no-till. Conventional tillage significantly out performed no-till in 2003, even though dry conditions existed from mid-July through August. The conventional tillage sorghum was more advanced when stressful conditions began. The no-till sorghum was delayed in maturity and thus more affected by stress.

This research will continue in 2004.

Table 4. Effects of nitrogen management and tillage on continuous grain sorghum, North Agronomy Farm, Manhattan, KS, 2002.

N Rate	N Source	Tillage	Grain Yield	Protein
lb/a			bu/a	%
0	--	No-till	17	6.5
30	Am. nit.	No-till	43	7.1
60	Am. nit.	No-till	54	9.7
120	Am. nit.	No-till	50	14.3
30	Urea	No-till	39	7.3
60	Urea	No-till	48	8.4
120	Urea	No-till	49	13.1
30	CRU	No-till	36	6.9
60	CRU	No-till	46	10.9
120	CRU	No-till	52	13.9
0	--	Conventional	25	6.7
30	Am. nit.	Conventional	54	8.5
60	Am. nit.	Conventional	51	10.3
120	Am. nit.	Conventional	50	14.7
30	Urea	Conventional	53	8.5
60	Urea	Conventional	58	9.8
120	Urea	Conventional	50	13.5
30	CRU	Conventional	48	8.4
60	CRU	Conventional	55	11.0
120	CRU	Conventional	52	14.8
LSD (0.10)			9	1.8
Mean Values:				
N	30		46	7.8
Rate	60		52	9.8
	120		50	14.01
LSD (0.10)			4	0.8
N	Am. nit.		50	10.5
Source	Urea		50	10.3
	CRU		49	10.9
LSD (0.10)			NS	NS
Tillage	No-till		46	10.2
	Conventional		52	11.0
LSD (0.10)			3	0.7

EFFECTS OF LIME APPLICATION ON NO-TILLAGE CROPPING SYSTEMS

C.B. Godsey, R.E. Lamond, and L.J. Ferdinand

Summary

The acidifying effect of surface-applied nitrogen (N) fertilizers in no-tillage cropping systems creates problems for producers. In 2000, a no-tillage lime study was started to deter-mine proper management of acid soils in no-till cropping systems. Reaction of the lime with the soil was still being observed three years from the date of application. The addition of surface-applied lime on acidic soils in no-till fields raised soil pH in the soil surface. However, since the initial lime applications, the deepest observed change in soil pH was observed at a depth of 3 inches below the soil surface.

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 may lead 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 as having below-optimal soil pH (pH < 6.0). In 2000, seven treatments included four rates of Ag Lime (0, 1000, 1000 annually for four years, 2000, and 4000 lb ECC Ag Lime/a); 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 as applied annually for four years. Applications were first made in the spring of 2000, before planting. Treatments were replicated four times in a randomized complete block design. Soil samples from each plot were collected in spring 2001, 2002, and 2003 at 1-inch increments to a depth of 6 inches and analyzed for 1:1 soil pH. Grain yields were calculated for each year.

Results

Soil pH from samples collected in 2001, 2002, and 2003 from Sites A and B are listed in Tables 5-10. Significant treatment effects were observed in all three years but only in the surface inch (Tables 5, 6, and 7). In 2001, soil pH increased by an average of 0.37 at site A with the addition of lime. Increases for 2002 and 2003 where 0.84 and 0.68, respectively, when averages of the lime treatments where compared to the control (Table 6 and 7).

Comparing individual treatments, soil pH increased significantly in the top inch with the addition of 2000 and 4000 lb ECC Ag Lime/a when compared to the control (Pr>F=0.01 and Pr>F=0.01) at site A in 2001, while in 2002 all lime treatments significantly increased pH in the 0- to1-inch depth when compared to the control (Table 6). In 2002, the only observed lime movement below the surface inch was the 4000 lb ECC Ag Lime/a treatment which increased soil pH (Pr>F=0.09) by 0.35 in the 1- to 2-inch depth when compared to the control (Table 6). Soil samples from 2003 indicated no additional vertical movement of lime. The only treatments that significantly increased soil pH below the surface inch when compared to the control were the 4000 lb ECC Ag Lime/a and the 1000 lb ECC Pell Lime/a applied annually four times (Pr>F= 0.01 and Pr>F=0.06 respectively).

In both 2002 and 2003, at site B a significant treatment difference was detected (Table 8) in the surface inch. The application of lime increased soil pH by an average of 0.64 in 2002 and 1.2 in 2003. This indicated that neutralization of soil acidity was still occurring three years after initial lime application. In addition to the treatment effects observed in the surface inch, soil pH was significantly increased in the 1- to 2-inch depth by an average of 0.41 with the addition of lime (Table 10). The neutralizing capability and movement of the lime may have been limited by the lack of precipitation during 2000 and 2001. In 2002 at site B, all treatments significantly increased soil pH in the surface inch when compared to the control except the 1000 lb ECC Ag Lime/a applied annually four times (contrast not shown) (Table 9). In 2003, all treatments significantly increased soil pH in the surface inch when compared to the control. In addition, all treatments except the one time 1000 lb ECC/a treatments increased soil pH in the 1- to 2-inch depth when compared to the control (Table 10). The only significant pH change below the surface 2 inches was with the 4000 lb ECC Ag Lime/a treatment, which increased soil pH by 0.29 when compared to the control.

Grain yield was calculated for 2000, 2001, 2002, and 2003 (Table 11). No significant differences in grain yields were detected. In 2001, yields were below normal due to lack of moisture during the growing season. The average yield at Site A was only 4 bu/a, while at Site B the average grain yield was 19 bu/a. Potential treatment effect at site B in 2002 may have been masked by banding of phosphorus at time of wheat planting.

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

Table 5. Observed 1:1 soil pH at site A in 2001.

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

* Treatment was applied annually for four years.

Table 6. Observed 1:1 soil pH at site A in 2002.

	Treatments							
	Ag Lime (lb ECC/a)					Pell Lime (lb ECC/a)		
Depth	0	1000	1000*	2000	4000	1000	1000*	LSD (0.10)
- in -	- - - - - - - - - - - - pH - - - - - - - - - - - -					- - - - - - - - pH - - - - - - - -		
0-1	5.33	5.97	6.04	6.18	6.28	6.18	6.34	0.29
1-2	5.50	5.68	5.56	5.46	5.85	5.60	5.60	NS
2-3	5.61	5.70	5.61	5.84	5.79	5.63	5.83	NS
3-4	5.70	5.77	5.61	5.73	5.82	5.63	5.77	NS
4-5	5.75	5.84	5.74	5.82	5.91	5.59	5.88	NS
5-6	5.88	6.02	5.70	5.85	6.07	5.79	6.03	NS

* Treatment was applied annually for four years.

Table 7. Observed 1:1 soil pH at site A in 2003.

	Treatments							
	Ag Lime (lb ECC/a)					Pell Lime (lb ECC/a)		
Depth	0	1000	1000*	2000	4000	1000	1000*	LSD (0.10)
- in -	- - - - - - - - - - - - pH - - - - - - - - - - - -					- - - - - - - - pH - - - - - - - -		
0-1	5.74	6.15	6.42	6.42	6.63	6.21	6.69	0.48
1-2	5.47	5.62	5.65	5.60	5.90	5.67	5.78	NS
2-3	5.54	5.61	5.57	5.54	5.73	5.55	5.65	NS
3-4	5.54	5.36	5.55	5.52	5.66	5.57	5.61	NS
4-5	5.57	5.43	5.60	5.51	5.69	5.59	5.68	NS
5-6	5.60	5.78	5.72	5.54	5.76	5.84	5.88	NS

* Treatment was applied annually for four years.

Table 8. Observed 1:1 soil pH at site B in 2001.

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

* Treatment was applied annually for four years

Table 9. Observed 1:1 soil pH at site B in 2002.

	Treatments							
	Ag Lime (lb ECC/a)					Pell Lime (lb ECC/a)		
Depth	0	1000	1000*	2000	4000	1000	1000*	LSD (0.10)
- in -	- - - - - - - - - - - - pH - - - - - - - - - - - -					- - - - - - - - pH - - - - - - - -		
0-1	4.97	5.60	5.39	5.47	5.61	5.73	5.83	0.54
1-2	4.74	4.92	4.90	4.92	4.93	4.87	4.76	NS
2-3	4.86	4.70	4.66	4.78	4.93	4.80	4.78	NS
3-4	4.75	4.77	4.85	4.64	4.85	4.72	4.58	NS
4-5	4.95	4.72	4.85	4.89	4.95	4.86	4.92	NS
5-6	4.97	4.93	5.05	4.99	4.92	5.03	4.82	NS

* Treatment was applied annually for four years.

Table 10. Observed 1:1 soil pH at site B in 2003.

	Treatments							
	Ag Lime (lb ECC/a)					Pell Lime (lb ECC/a)		
Depth	0	1000	1000*	2000	4000	1000	1000*	LSD (0.10)
- in -	- - - - - - - - - - - - pH - - - - - - - - - - - -					- - - - - - - - pH - - - - - - - -		
0-1	4.88	5.55	5.62	6.13	6.51	5.89	6.55	0.34
1-2	4.65	4.74	4.83	5.07	5.37	4.94	5.41	0.32
2-3	4.70	4.69	4.65	4.70	4.90	4.73	4.99	NS
3-4	4.71	4.93	4.60	4.66	4.76	4.69	4.89	NS
4-5	4.79	5.03	4.73	4.69	4.77	4.79	4.86	Ns
5-6	4.85	5.15	4.86	4.89	4.86	4.96	5.01	NS

* Treatment was applied annually for four years.

Table 11. Grain yield from 2000-2003.

		Treatments							
		Ag Lime (lb ECC/a)					Pell Lime (lb ECC/a)		
Site	Crop	0	1000	1000*	2000	4000	1000	1000*	LSD (0.10)
		- - - - - - - - - - - bu/a - - - - - - - - - - -					- - - - - - - bu/a - - - - - - -		
2000									
A	Soybean	19	24	26	22	28	20	20	NS
B	Sorghum	126	115	136	128	127	124	121	NS
2001									
A	Soybean	4	4	5	4	3	5	5	NS
B	Soybean	19	20	19	19	19	19	19	NS
2002									
A	Wheat	34	34	34	34	34	33	34	NS
B	Wheat	48	47	48	52	49	51	49	NS
B**	Soybean	45	49	46	50	51	50	51	NS
2003									
A	Soybean	9	8	9	8	9	9	9	NS
B	Grain sorghum	86	88	93	86	50	83	88	NS

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

EVALUATION OF PELL LIME AMENDMENTS TO CORRECT ACIDIC SOILS

C.B. Godsey, R.E. Lamond, and L.J. Ferdinand

Summary

The acidifying effect of surface-applied nitrogen (N) fertilizers in no-tillage cropping systems may create problems for producers. Lime treatments were applied in the spring of 2002 at two field sites. Application of lime significantly increased soil pH in the surface 2-inches at the Marshall County site (no-till) and surface 3-inches at the Osage County site (conventional-till). Movement of the lime may have been limited by the lack of precipitation. Grain yields for 2002 and 2003 have not indicated a significant treatment effect.

Introduction

Throughout eastern and central Kansas producers are faced with managing acidic soils. Past research has shown that surface-applied N in no-tillage systems often decreases soil pH, which leads to elevated Al concentrations in the soil. This study was initiated to evaluate liming rates, effectiveness of liming materials, and cost effectiveness of using liming materials.

Procedures

In 2002, two field sites (Marshall County and Osage County) in Kansas that had below optimal soil pH (pH < 6.0) were identified. The Marshall County site was no-till, and the Osage County site was a conventional-till system. Nine treatments, including a check, consisted of four rates of Ag Lime and Pell Lime (200 lbs ECC/a, one-quarter, one-half, and full rate of the recommended lime application rate) (Table 12). All treatments were one-time applications except the 200 lbs ECC/a treatments, which will be applied annually. Applications were first made in spring 2002, before planting. Treatments were replicated three times in a randomized complete block design. Soil samples from each plot were collected in spring 2003 at 1-inch increments to a depth of 6 inches and analyzed for 1:1 soil pH. Grain yields were calculated for 2002 and 2003.

Results

Soil pH from samples collected before treatment application from the Marshall County site indicated an average soil pH of 5.3, and initial soil pH at the Osage County site was 5.0.

In 2003, a significant treatment effect was observed in the surface 2 inches at the Marshall County site (no-till) (Table 13). All lime application rates greater than 200 lbs ECC/a significantly increased soil pH by an average of 0.75 in the surface inch when compared to the control (Table 13). Soil pH in the second depth was significantly increased with addition of the half rate of Pell Lime and both treatments of the full recommended rate when compared to all other treatments.

The most notable response was the addition of Pell Lime significantly increased soil pH in the surface inch when compared to Ag Lime treatments (Pr>F = 0.04). Pell Lime increased soil pH an average of 0.20 over Ag Lime treatments in the surface inch (Table 13). No significant differences between liming materials were observed below the surface inch.

Soil samples collected from the Osage County site (conventional-till) indicated neutralization of soil acidity in the surface 3 inches (Table 14). The addition of the one-half and full recommended rates significantly increased soil pH when compared to all other treatments (Table 14). Tillage appears to have increased the effectiveness of the lime applications. A linear response to the addition of both Ag and Pell Lime was observed in the surface 3 inches at the Osage County site.

No significant differences in grain yields were detected (Table 15). This research will be continued with annual soil sampling done in 1-inch depth increments.

Table 12. Lime application rates when study was initiated.

Rate	Marshall County	Osage County
	- - - - - - - - - - - - ECC/a - - - - - - - - - - - -	
200	200	200
1/4	1875	1000
1/2	3750	2000
Full	7500	4000

Table 13. Observed 1:1 soil pH at the Marshall County site in 2003.

	Treatments									
	Ag Lime					Pell Lime				
Depth	0	200[1]	1/4[2]	1/2[3]	Full[4]	200	1/4	1/2	Full	LSD (0.10)
- in -	- - - - - - - - - - - pH - - - - - - - - - - -							- - - - - - - - pH - - - - - - - -		
0-1	5.40	5.71	5.84	5.92	6.21	5.56	5.99	6.54	6.40	0.40
1-2	5.20	5.37	5.30	5.40	5.61	5.19	5.37	5.82	5.55	0.34
2-3	5.20	5.36	5.30	5.29	5.44	5.19	5.34	5.57	5.43	NS
3-4	5.20	5.43	5.35	5.29	5.36	5.16	5.36	5.54	5.41	NS
4-5	5.22	5.41	5.42	5.29	5.40	5.28	5.43	5.46	5.47	NS
5-6	5.45	5.52	5.48	5.39	5.57	5.40	5.55	5.53	5.62	NS

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

Table 14. Observed 1:1 soil pH at the Osage County site in 2003.

	Treatments									
	Ag Lime					Pell Lime				
Depth	0	200[1]	1/4[2]	1/2[3]	Full[4]	200	1/4	1/2	Full	LSD (0.10)
- in -	- - - - - - - - - - - pH - - - - - - - - - - -					- - - - - - - - - - - pH - - - - - - - - - - -				
0-1	5.06	4.91	4.85	5.16	5.52	4.70	4.91	5.27	5.40	0.38
1-2	5.05	4.87	5.17	5.48	5.94	7.89	5.07	5.32	5.51	0.30
2-3	5.09	5.03	5.08	5.45	5.74	4.98	5.03	5.42	5.59	0.51
3-4	5.16	5.19	5.07	5.22	5.13	5.02	5.05	5.31	5.13	NS
4-5	5.17	5.37	5.00	5.11	5.07	5.32	5.42	5.33	5.05	NS
5-6	5.25	5.54	5.45	5.50	5.40	5.77	5.60	5.52	5.34	NS

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

Table 15. Grain yield from 2000-2003.

		Treatments									
		Ag Lime					Pell Lime				
Site	Crop	0	200[1]	1/4[2]	1/2[3]	Full[4]	200	1/4	1/2	Full	LSD (0.10)
		- - - - - - - - - - bu/a - - - - - - - - - -					- - - - - - - - - - - - - bu/a - - - - - - - - - - - - -				
2002											
Marshall Co.											
	Soybean	17	17	16	15	20	19	16	17	16	NS
Osage Co.											
	Corn	121	132	151	125	143	130	138	128	122	NS
2003											
Marshall Co.											
	Corn	63	74	63	64	56	65	63	47	53	NS
Osage Co.											
	Corn	109	116	112	90	120	100	109	123	105	NS

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

NITRATE LEACHING LOSSES IN IRRIGATED CORN PRODUCTION ON A COARSE-TEXTURED SOIL

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

Summary

Drainage and soil-water nitrate-N concentrations at the 5-foot depth were monitored for three nitrogen (N) treatments to provide an estimate of nitrate leaching-losses. In 2002, these data indicated that as much as 36 lbs/a of nitrate-N could be lost to leaching from June through August. This loss represents residual nitrogen from the previous year. In 2003, wet soil conditions and large-scale rainfall events provided uncertainty in seasonal drainage estimates. Data indicate that losses from a single large-scale rainfall event may be substantial. Less nitrate leaching loss was observed under split N application. However, plant data indicated no improvement in N uptake with two-way split N application. Thus, the potential for nitrate-N leaching losses under two-way split application without a change in N application rate is expected to be nearly equal to that of full preseason N application.

Introduction

Nearly 85% of the rural Kansas population relies on groundwater for drinking water. Nitrate contamination of this groundwater is a problem for human health, and the costs for nitrate removal are prohibitive. Coarse-textured (sandy), irrigated soils present a potential source for nitrate leaching because water inputs from irrigation and rainfall drain readily, and large fertilizer inputs are typically required to maximize yields. Beyond groundwater contamination, nitrate leaching may also result in a significant loss of producer inputs. Though this problem is well known, limited research has been conducted to assess the amount of nitrate leaching under typical management practices. Before management practices can be identified to reduce leaching, estimates of leaching potential are needed. The objectives of this study include 1) quantification of nitrate leaching in irrigated corn production on a coarse-textured soil, and 2) comparison of yield and nitrate leaching-losses under full preseason and split N fertilizer application scenarios.

Procedures

A multi-year study was initiated in spring 2002 on private land in the Republican River Valley near the North Central Experiment Field (Scandia Unit). The soil at the field site is a Eudora loam. Three nitrogen treatments were established: 0, 100/100 (split), and 200 (pre-season) lbs N/a. Nitrogen fertilizer was surface-applied as dry ammonium nitrate (AN) and incorporated before planting. Corn (Asgrow Rx 740) was planted May 1, 2002, and May 5, 2003. For the 100/100 split N treatment, an additional 100 lbs N/a was surface-applied as dry AN and incorporated with cultivation. Irrigation was applied, following typical management practices of the producer.

In each field plot, pre- and post-season soil samples were collected to the 6-foot depth to determine soil nitrate-N concentration. Tensiometers and a neutron probe were used to periodically record soil water potential and soil water content. Ceramic-cup solution samplers were used to collect water samples to determine nitrate-N concentrations in the soil solution at the 5-foot depth. A drainage plot was established in the field to determine the water potential vs. hydraulic conductivity relationship at the 5-foot depth. Measurements of soil nitrate concentration, soil water potential, soil solution nitrate concentration, and hydraulic conductivity were used to estimate subsurface losses of nitrate from the rootzone.

Results

Soil nitrate-N concentrations near the bottom of the profile were relatively high from previous management before N treatment initiation (2002), which indicates the potential for nitrate leaching (Figure 3). However, one year of treatment application resulted in drastic changes in nitrate distribution within the profile. Before N treatment application in 2003, much of the concentration bulge at the 40-inch depth was lost to leaching or crop uptake for the zero N treatment. The concentration bulge at depth increased for both the full and split N treatments. The build-up of nitrate at depth represents nitrogen available for leaching that is beyond the manageable rootzone.

For 2002, nitrate concentrations in the soil water reflected residual nitrate from previous producer management (Figure 4). Thus, there was little treatment difference in plant performance. In 2003, nitrate-N concentrations differed by treatment. The highest concentrations were observed for the full N treatment, followed by the split and zero N treatments, respectively. In both 2002 and 2003, water samples for all treatments showed a temporary change in concentration during late July and early August. Concentrations before July represent N fertilizer management from the previous year. Concentrations after August represent breakthrough of N fertilizer applied in May.

Soil profile water content decreased from May through September in 2002 (Figure 5). Thus, drainage was limited after the early portion of the growing season (Figure 6). Nonetheless, profile moisture did recover by November (Figure 5), providing the potential for off-season leaching. In 2003, the profile was relatively wet in April and remained wet through October (Figure 5). This, coupled with large summer rainfall events, provided potential for drainage and nitrate leaching throughout the season (Figure 6).

Determining the accurate amount of drainage to estimate nitrate leaching is difficult in coarse-textured soils, because some large-scale drainage events may last only a few hours. Data collected in 2003 suggest that nitrate-N losses from a single large-scale rainfall event could be as high as 16 lbs/a. Nitrate-N losses from drainage and concentration estimates for each N treatment in 2002 are provided in Table 16.

Comparison of losses by treatment should be considered cautiously. Soil properties in the plots where the split N treatment were applied tended to limit downward drainage. This was a result of spatial variability in soil hydraulic properties rather than the N treatment. In 2002, residual N from previous management influenced the amount of nitrate-N available for leaching during the growing season. Thus, losses for the full and zero N treatments were similar. The split N treatment provided less drainage therefore, less nitrate-leaching loss. This is despite soil-water nitrate-N concentrations that were similar to the other N treatments.

In 2003, sporadic drainage provided more uncertainty in leaching estimates. For the full pre-season N application, nitrate leaching losses, based on drainage and concentration data, were equivalent to approximately 153 lbs/a. This result is only preliminary, because post-season soil samples were not yet available for N balance at the time of this report. The split N treatment showed a net gain in nitrate-N at the 5-foot depth, which resulted from net measured upward water movement at the 5-foot depth. This result is likely inaccurate because of short-duration downward drainage events that could not be captured by the measurement technique. The zero N treatment also showed a slight gain in nitrate-N at the 5-foot depth.

Comparison of N treatments is also possible through plant data collected each year. In 2002, grain yields and grain N contents were not statistically different for the three N treatments (Table 17). Grain and dry-matter yields where larger in 2003 than in 2002 from superior growing conditions and higher plant populations. In 2003, grain yield, dry-matter production and tissue N contents for the zero N treatment were significantly different than other treatments (Table 18). There was no significant difference for the full and split N treatments. This indicates no improvement in N uptake efficiency under the 100/100 split N application. It is expected that residual nitrate-N available for leaching should be similar for both full and split N treatments. Given that drainage tended to be less in the split treatment plots, results presented in Table 16 should not be assumed to indicate any improvement in N leaching-losses under a two-way split N application without a reduction in the application rate.

Table 16. Nitrate-N leaching-losses at the 5-foot depth near Scandia, KS (2002).

	Net Nitrate-N Leaching Loss		
Month	Zero N	Full Pre-Season N	Split N
		lbs/a	
June	29	26	8
July	11	6	4
August†	-4	-1	-1
2002 total‡	36	31	11

† 1 to 23 August.
‡ During observation.

Table 17. Grain and dry-matter yield and nitrogen content near Scandia, KS, 2002.

	Grain		Dry Matter†	
Treatment	Yield	N Content	Yield	N Content
	bu/a	%	tons/a	%
Zero N	146	1.4	3.2*	0.7*
Full Pre-Season N	163	1.4	3.8	1.0
Split N	164	1.4	3.6	0.9

† Above-ground mass excluding grain and cob.
* Significantly different at 0.05 probability level.

Table 18. Grain and dry-matter yield and nitrogen content near Scandia, KS, 2003.

	Grain		Dry Matter†	
Treatment	Yield	N Content	Yield	N Content
	bu/a	%	tons/a	%
Zero N	109*	1.1*	4.2*	0.5*
Full Pre-Season N	187	1.4	5.3	0.8
Split N	191	1.4	5.5	0.7

† Above-ground mass excluding grain and cob.
* Significantly different at 0.05 probability level.

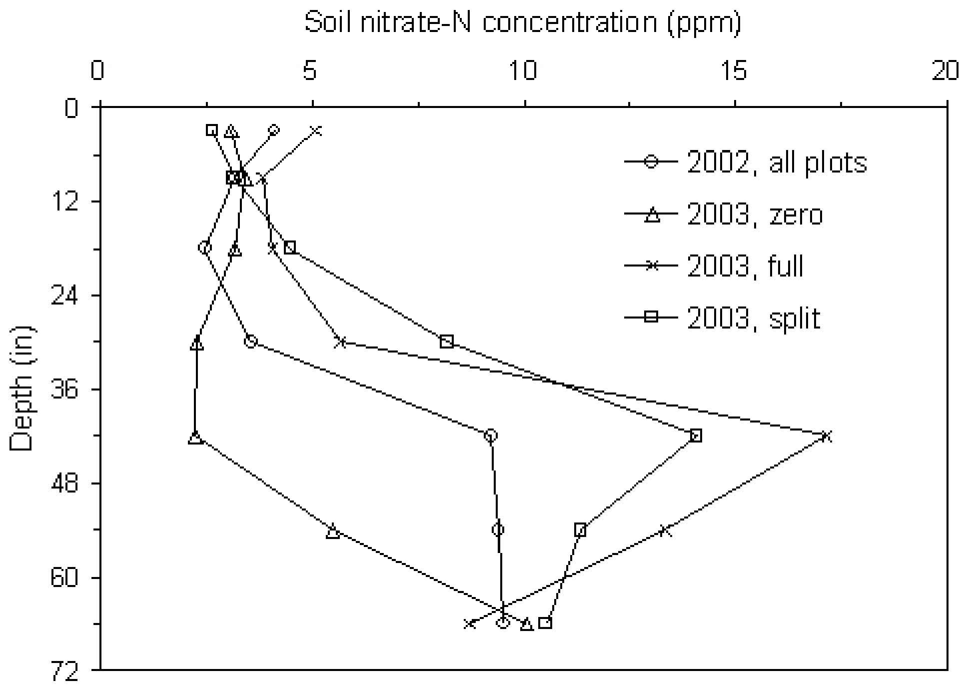


Figure 3. Soil profile nitrate-N concentrations from pre-season soil sampling near Scandia, KS (2002 and 2003).

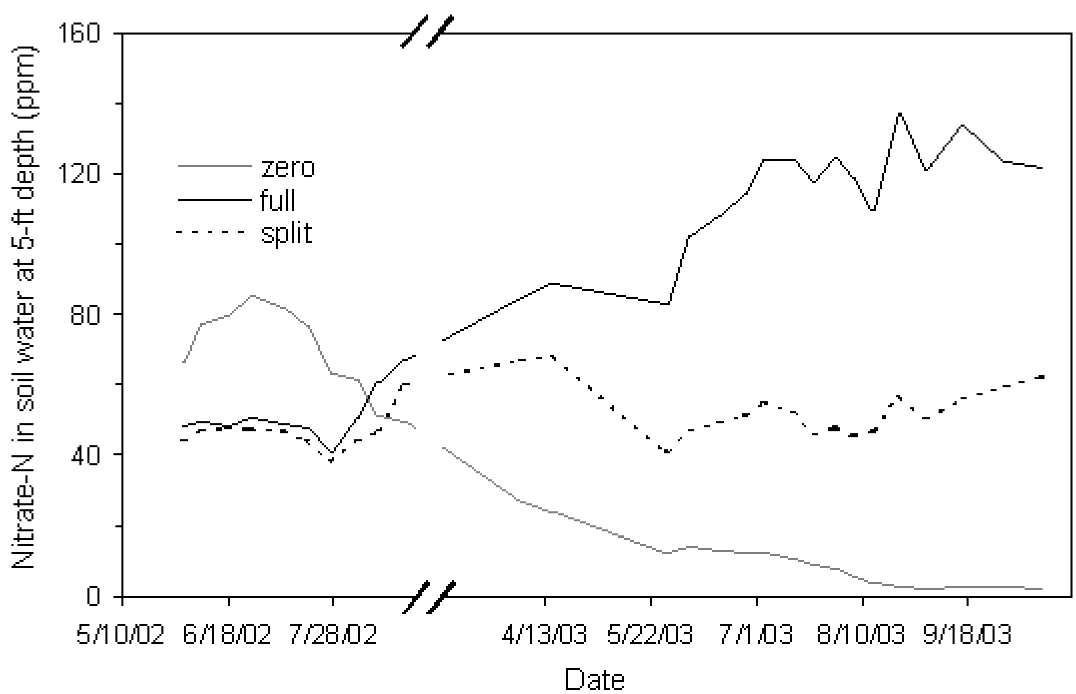
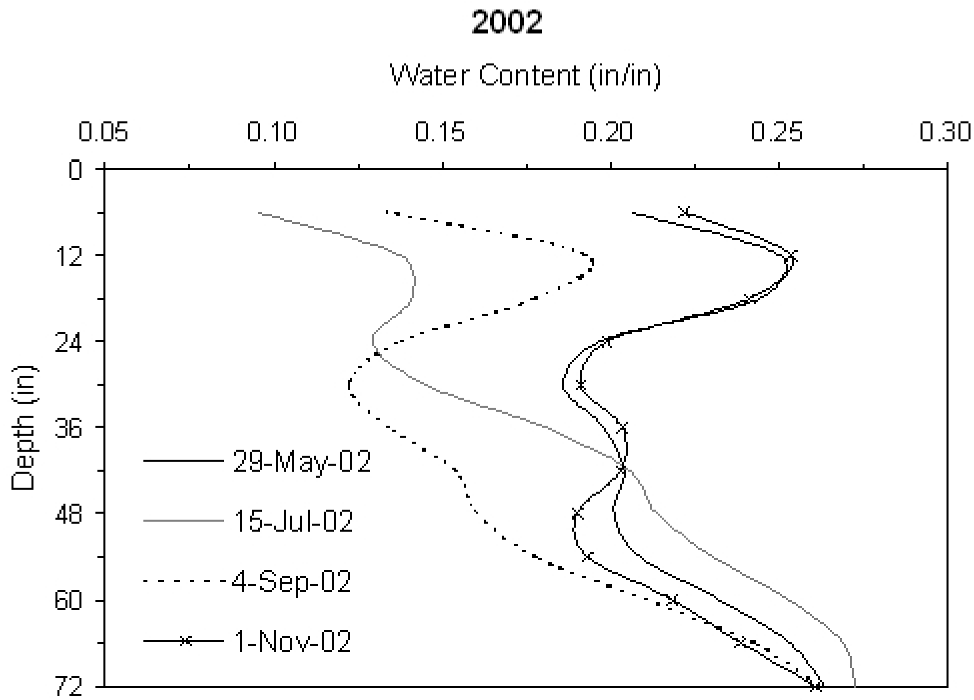


Figure 4. Nitrate-N in soil water at the 5-foot depth near Scandia, KS (2002 and 2003).



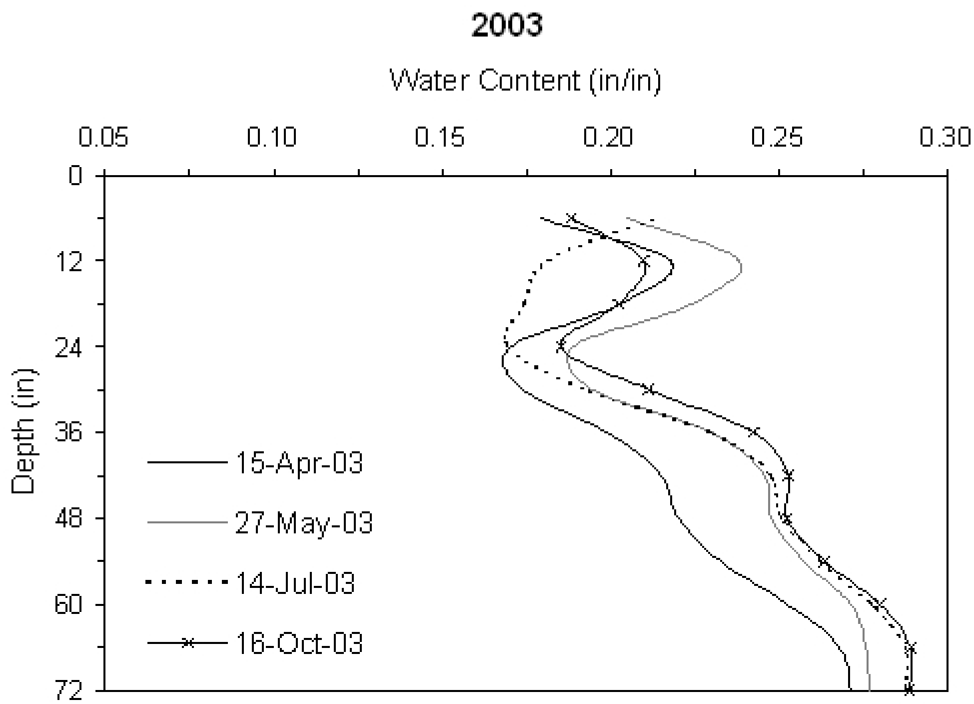


Figure 5. Water content profiles near Scandia, KS (2002 and 2003).

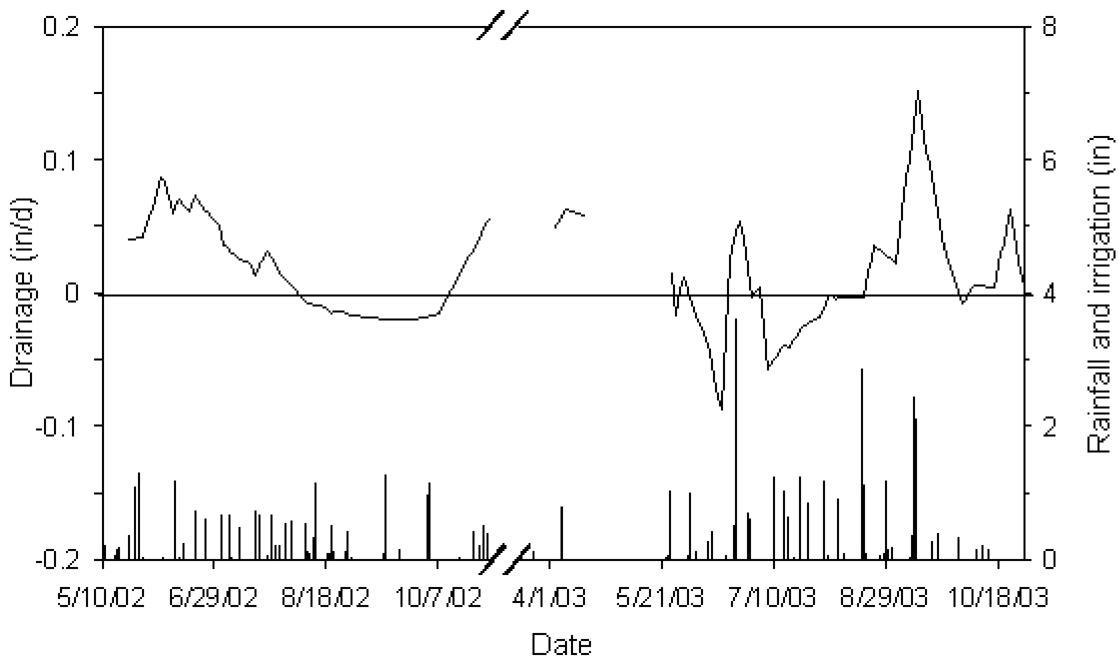


Figure 6. Drainage at the 5-foot depth near Scandia, KS (2002 and 2003). A positive drainage value indicates downward water movement. Height of vertical bars show depth of daily rainfall and/or irrigation.

EFFECTS OF PHOSPHORUS AND POTASSIUM APPLICATION ON CORN YIELD AND GRAIN NUTRIENT CONTENT

J.R. Massey, J.C. Herman, and D.F. Leikam

Summary

The development of phosphorus (P) and potassium (K) fertility programs for specific fields depends on the long term goals and objectives of each individual producer. Crop sufficiency based fertility programs focus on the estimated rate of nutrient to apply for a specific individual crop year to obtain optimum economic returns for that year. Build-maintenance programs focus on managing controllable factors (P and K soil test levels) over a longer time frame to minimize the possibility that P and/or K nutrition will adversely affect crop yields and profitability. Both of the approaches may be right for individual producers, and both are dependant on specific crop and soil test information.

Corn and grain sorghum studies have been initiated across the state to help refine the following information: 1) average crop response to various rates of P and K application at various soil test levels, 2) average percent sufficiency (for maximum yield) at various soil test levels, 3) amounts of P and K nutrient application/crop removal to change soil test levels and 4) the amounts of P and K removed in the harvested grain of grain sorghum and corn.

Introduction

This is the only 2003 study for which grain yields and nutrient contents have been completed. The rest of the locations will be covered in next year's proceedings. The information from various sites, across multiple years, will be used to refine K-State nutrient recommendations in the future.

Procedures

Grain sorghum and corn studies were established in several counties: Decatur, Gove, Ford, Brown, Shawnee, Saline, Ellis and Cherokee. Soil samples (0- to 6-inches) were collected from individual plots before fertilizer application. After all sites have been harvested, individual plots will be sampled again to measure change in soil test level. Phosphorus soil test values for Cherokee County ranged from 16 to 45 ppm Bray P1 for individual plots and averaged 29 ppm. Potassium soil test values varied from 114 to 181 ppm exchangeable K for individual plots, and averaged 136 ppm.

Phosphorus application rates for each P study were 0, 20, 40, 80 and 120 lb P_2O_5/a. Potassium application rates were 0, 40, 80 and 120 lb K_2O/a at each site with a K variable. All fertilizer treatments were broadcast applied. Treatments were incorporated on some fields (including the Cherokee County site), while other studies were located in no-till fields that did not allow for incorporation.

Results

The results of the Cherokee County P study are summarized in Table 19. While grain yields were numerically higher with increasing P application rate, the differences were only significant at the 37% level. Grain moisture and P and K contents of the grain were not affected by P application rate. In the accompanying K study, there were no meaningful differences due to K application rate (Table 20).

While no statistically significant differences were measured at this Cherokee County site, these results become valuable as part of the overall database to be developed over the next few years.

Table 19. Effect of phosphorus application to corn, Cherokee County, KS, 2003.

		Corn Grain			
P_2O_5 Rate	K_2O Rate	Yield	Moisture	P Content	K Content
- - - lb/a - - -		bu/a	%	- - - - - lb P_2O_5/bu - - - - -	
0	80	117	15.7	0.33	0.19
20	80	107	15.8	0.33	0.19
40	80	121	16.1	0.33	0.18
80	80	129	15.8	0.35	0.18
120	80	127	15.8	0.33	0.18
LSD (0.05)		NS	NS	NS	NS
Significance Level		0.37	--	--	--

Table 20. Effect of potassium application to corn, Cherokee County, KS, 2003.

		Corn Grain			
P_2O_5 Rate	K_2O Rate	Yield	Moisture	P Content	K Content
- - - - - - lb/a - - - - -		bu/a	%	- - - - - - - lb P_2O_5/bu - - - - - - -	
80	0	123	15.8	0.35	0.20
80	40	129	16.4	0.34	0.19
80	80	129	15.8	0.35	0.18
80	120	123	15.2	0.33	0.19
LSD (0.05)		NS	0.8	NS	NS
Significance Level		--	0.05	--	0.23

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