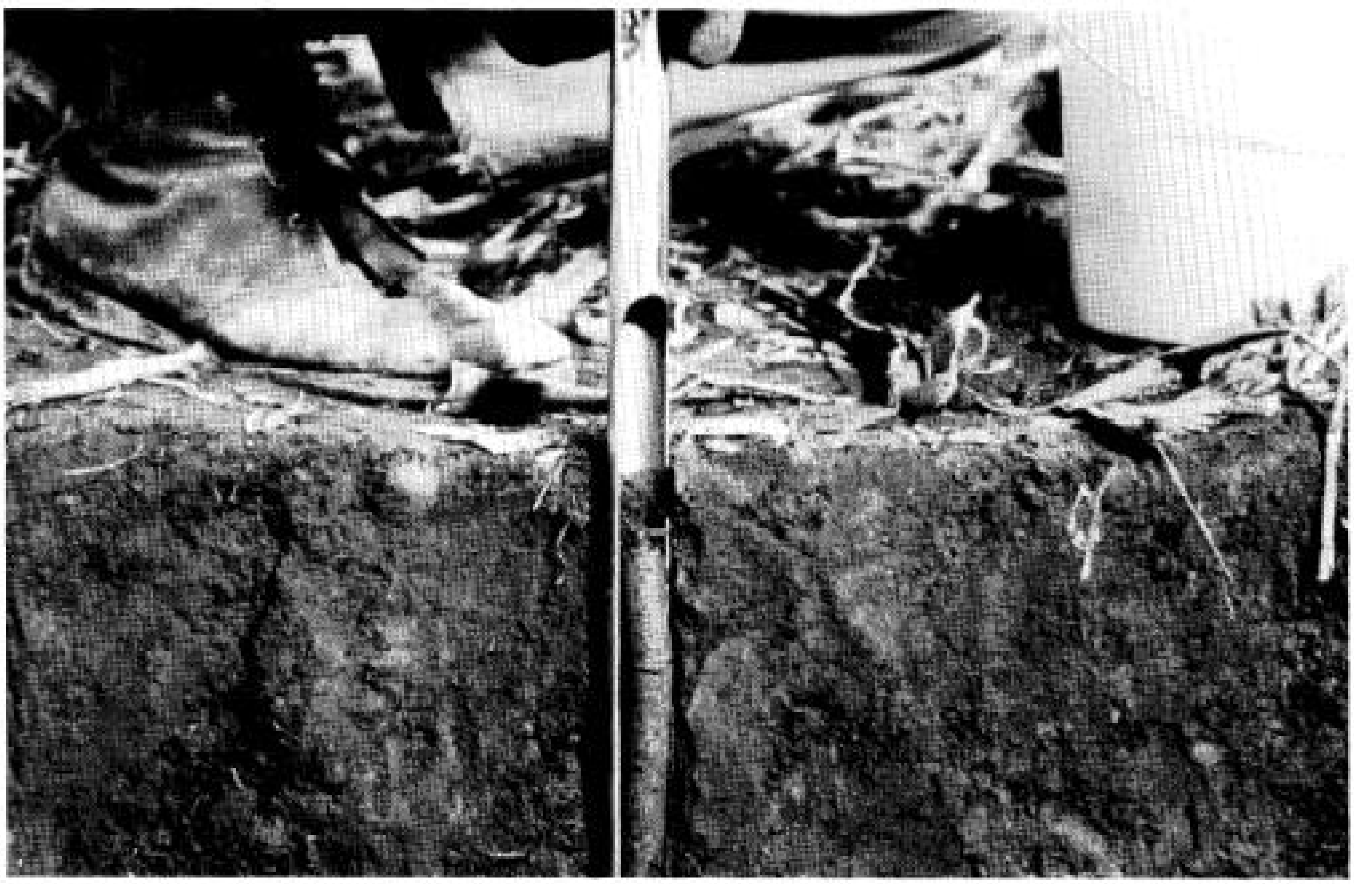
REPORT OF PROGRESS 778

KANSAS FERTILIZER RESEARCH 1996



AGRICULTURAL EXPERIMENT STATION
Kansas State University, Manhattan
Marc A. Johnson, Director

INTRODUCTION

The 1996 edition of the Kansas Fertilizer Research Report of Progress is a compilation of data collected by researchers over all of Kansas. Information included was contributed by staff members of the Department of Agronomy and Kansas Agricultural Experiment Station and agronomists at the various Agronomy Experiment Fields and Agricultural Research or Research-Extension Centers.

This report provides a summary of the latest research results in soil fertility and as such does not constitute publication of the finalized form of the various investigations. No part of this report may be duplicated or reproduced without the written consent of the individual researchers involved.

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

Among concerns and agencies providing materials, equipment, laboratory analyses, and financial support were: Agrium, Inc.; Allied-Signal, Inc.; Amilar International; Cargill, Inc.; Deere and Company; Dow-Elanco Chemical Company; Enviro Products Corp.; Environmental Protection Agency; FMC Corporation; Farmland Industries, Inc.; Fluid Fertilizer Foundation; Foundation for Agronomic Research; Great Salt Lake Minerals Corp.; IMC-Global Co.; Kansas Corn Commission; Kansas Department of Health and Environment; Kansas Fertilizer Research Fund; Kansas Grain Sorghum Commission; Kansas State University Agricultural Experiment Station; Pioneer Hybrid, Int.; The Potash and Phosphate Institute; State Conservation Commission; Kansas State Board of Agriculture; NC+ Hybrids, Inc.; The Sulphur Institute; USDA-ARS; and Wilfarm L.L.C.

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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.

Contribution No. 97-227-S from the Kansas Agricultural Experiment Station.

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Precipitation Data (Inches)

1995	Manhattan	S.W.KS RES-EXT. CTR. Tribune	S.E.KS AG.RES.CTR. Parsons	E.CEN EXP.FLD. Ottawa
August	2.94	1.68	4.02	3.51
September	5.39	0.91	1.77	3.77
October	0.62	0.04	0.25	0.27
November	0.58	0.05	0.16	1.00
December	0.35	0.00	2.32	1.47
Total 1995	41.77	18.64	40.17	36.96
Dept. Normal	7.95	2.68	1.15	-1.90
1996				
January	0.17	0.16	0.61	1.15
February	0.13	0.24	0.14	0.34
March	1.50	1.08	1.09	1.54
April	1.79	0.28	3.13	2.52
May	7.96	4.05	4.29	7.19
June	3.77	2.82	1.97	6.20
July	5.07	4.43	3.25	5.06
August	3.22	4.67	5.10	8.43
September	3.23	3.77	8.81	3.72

1995	N.CEN EXP.FLD. Belleville	KANSAS RV. VALLEY EXP.FLD.	S.CEN. EXP.FLD. Hutchinson	AG.RES. CTR. Hays
August	4.66	3.99	3.05	1.33
September	2.57	2.28	3.84	1.31
October	0.76	0.30	0.07	0.18
November	0.54	0.53	0.05	0.19
December	0.24	0.50	0.95	0.44
Total 1995	28.19	26.65	33.31	18.47
Dept. Normal	-9.85	-8.58	-4.09	-3.33
1996				
January	0.63	0.15	0.08	0.37
February	0.00	0.22	0.02	0.08
March	0.94	0.88	1.71	1.30
April	2.40	0.74	1.57	0.70
May	7.27	3.14	4.41	7.04
June	0.88	4.18	1.25	4.33
July	6.40	2.29	3.82	5.13
August	3.51	5.10	3.78	5.06
September	6.47	2.30	4.74	3.10

WHEAT FERTILIZATION STUDIES
KANSAS STATE UNIVERSITY, DEPARTMENT OF AGRONOMY

EFFECTS OF CHLORIDE RATES AND SOURCES ON WINTER WHEAT IN KANSAS

R.E. Lamond, K. Rector, J.C. Baker, D.A. Whitney, and S.R. Duncan

Summary

Research to date on chloride (Cl) shows significant yield response in Kansas in about 60% of the studies. Chloride does seem to affect progression of some leaf diseases by suppressing or slowing infection; however, it does not eliminate diseases. Chloride responses have been noted even in the absence of disease, suggesting that some Kansas soils may not be able to supply needed amounts of Cl. Chloride fertilization significantly and consistently increases Cl concentrations in wheat leaf tissue.

Introduction

For wheat and some other cereal grains, chloride (Cl) has been reported to have an effect on plant diseases, either suppressing the disease organism or allowing the plant to be able to withstand infection. Yield increases may be due to these effects. Researchers from several states have been able to show yield increases from Cl-containing fertilizers.

The objective of these studies was to evaluate the effects of Cl fertilization on yields of hard red winter wheat in Kansas.

Procedures

Studies were continued in 1996 in Marion County (two sites) and Cowley County.

Potassium chloride (KCl) or magnesium chloride ($MgCl_2$) were topdressed at rates of 10, 20, or 30 lb Cl/a. Nitrogen was balanced at all locations.

Leaf tissue samples were taken at boot stage and analyzed for Cl content. Grain yields were determined, and grain samples were retained for analyses.

Results

Chloride significantly increased wheat grain yields at one of three sites (Table 1). Chloride fertilization also significantly increased Cl concentrations in wheat leaf tissue at all sites (Table 1). The 1995 wheat crop was affected by an excessively dry fall and winter, which reduced yields considerably. Even with reduced yields, Cl fertilization effects were fairly consistent. Potassium chloride and magnesium chloride performed similarly. Results to date suggest that Cl responses are most likely when soil Cl levels (at 0-24 in.) are less than 35 lb/a.

Table 1. Effects of chloride rates and sources on wheat, Kansas, 1996.

Cl	Cl	Marion Co. "A"		Marion Co. "B"		Cowley Co.	
Rate	Source	Yield	Cl	Yield	Cl	Yield	Cl
lb/a		bu/a	%	bu/a	%	bu/a	%
0		53.5	0.48	32.4	0.40	28.2	0.29
10	KCl	54.7	0.50	34.0	0.53	28.9	0.37
20	KCl	52.4	0.54	35.7	0.53	29.9	0.35
30	KCl	50.3	0.56	34.1	0.54	27.3	0.39
10	$MgCl_2$	50.9	0.51	37.0	0.43	27.2	0.33
20	$MgCl_2$	54.7	0.55	40.1	0.49	27.8	0.33
30	$MgCl_2$	54.5	0.63	36.2	0.51	29.1	0.35
	LSD (0.05)	NS	0.06	3.1	0.04	NS	0.04
Cultivar		AP 7510		Jagger		2163	
Soil test Cl (0-24")		14		9		9	

EVALUATION OF CHLORIDE FERTILIZATION/WHEAT CULTIVAR INTERACTIONS

R.E. Lamond, K. Rector, T.M. Maxwell, D.A. Whitney, and S.R. Duncan

Summary

Previous work on chloride (Cl) fertilization of wheat in Kansas indicated that wheat cultivars may respond differently. Researchers in South Dakota reported that cultivar was important in determining Cl need. This research, initiated in 1996, indicates that some wheat cultivars seem to respond consistently to Cl fertilization, whereas others do not, even when soil test Cl levels are low. Agripro AP 7510, 2163, 2180, 2137, Jagger, and Tomahawk were responsive to Cl fertilization, but Ogallala, Pecos, and Karl 92 were consistent nonresponders. This work will be repeated in 1997.

Introduction

Research across the Great Plains region has shown that wheat often will respond to chloride (Cl) fertilization. However, several researchers have reported that wheat cultivars respond differently.

The objective of this work was to evaluate the effects of Cl fertilization on yields of 16 winter wheat cultivars commonly grown in Kansas.

Procedures

Studies were initiated in Saline and Marion counties to evaluate Cl fertilization/wheat cultivar interactions. Sixteen commonly grown winter wheat cultivars were seeded in early October. Chloride was applied as potassium chloride (KCl) on half of each variety at a rate of 40 lbs Cl/a as a February topdress. Treatments were replicated six times. Nitrogen was balanced on all treatments.

Leaf tissue samples were taken at boot stage and analyzed for Cl content. Grain yields were determined as well as grain test weights and thousand kernel weights (TKW).

Results

Chloride fertilization significantly increased yields of some cultivars at both sites (Tables 2 and 3). Wheat cultivars that showed yield increases with Cl fertilization at both sites included: AP 7510, 2163, 2180, 2137, Jagger, and Tomahawk. Non-responding cultivars included: Ogallala, Pecos, and Karl 92. Other cultivars were inconsistent. Chloride fertilization consistently increased leaf tissue Cl concentrations of all cultivars. This research is part of a regional project including sites in Texas, South Dakota, North Dakota, Montana, and Canada. After 2 years, data will be summarized and reported.

Table 2. Chloride fertilization on wheat, Saline Co., Kansas, 1996.

	Yield		Tissue Cl		TKW		Test Wt.	
Cultivar	+Cl	-Cl	+Cl	-Cl	+Cl	-Cl	+Cl	-Cl
	bu/a		%		g		lb/bu	
AP 7510	65.7	63.0	.60	.49	29.9	30.7	58.9	58.9
Coronado	42.4	44.6	.61	.49	38.7	37.4	53.3	54.7
Custer	56.7	56.4	.64	.57	37.0	34.8	55.5	56.5
Cimarron	36.7	36.4	.64	.53	32.7	34.8	57.7	58.2
2163	59.9	56.6	.68	.47	33.3	31.5	60.0	55.0
2180	44.0	36.4	.60	.48	32.7	32.2	55.8	55.5
Ogallala	55.3	56.8	.52	.43	28.1	29.4	58.8	58.5
Rowdy	33.7	30.5	.59	.50	32.0	29.2	54.3	55.2
Tam 107	64.2	63.6	.54	.47	36.8	37.0	60.3	60.0
Tam 200	37.6	36.2	.67	.60	30.5	31.2	57.0	56.3
2137	66.8	64.8	.55	.39	35.2	36.4	60.8	59.8
7853	53.9	49.5	.51	.40	41.1	39.4	62.2	61.0
Pecos	55.1	57.3	.60	.49	31.2	32.6	56.8	58.3
Tomahawk	63.5	59.5	.55	.44	35.4	35.1	61.0	59.8
Jagger	56.8	52.8	.60	.53	34.2	33.4	60.2	57.5
Karl 92	53.3	51.3	.51	.39	33.9	34.2	59.0	59.0

		Between Columns	Within Columns
LSD's (0.05)	Yield	1.6	4.6
	Tissue Cl	.02	.06
	TKW	0.8	2.2
	Test Wt.	1.1	3.2

Soil Test Cl: 14 lb/a (0-24")

Table 3. Chloride fertilization on wheat, Marion Co., Kansas, 1996.

	Yield		Tissue Cl		TKW		Test Wt.	
Cultivar	+Cl	-Cl	+Cl	-Cl	+Cl	-Cl	+Cl	-Cl
	bu/a		%		g		lb/bu	
AP 7510	51.5	45.5	.49	.20	25.7	28.8	56.7	53.4
Coronado	33.6	31.8	.53	.26	31.1	29.7	52.5	51.0
Custer	48.1	45.5	.60	.28	31.4	30.9	57.5	58.5
Cimarron	39.1	40.4	.55	.30	31.0	32.2	57.2	57.7
2163	58.4	55.4	.66	.27	32.9	31.9	57.5	57.0
2180	44.3	42.7	.57	.26	28.7	28.5	53.7	55.3
Ogallala	49.9	51.7	.38	.23	27.3	26.8	57.7	58.2
Rowdy	26.6	26.3	.47	.30	28.2	26.6	50.5	46.5
Tam 107	56.3	55.9	.51	.24	36.0	33.4	57.7	50.5
Tam 200	19.9	19.8	.59	.32	23.9	26.9	47.2	45.0
2137	63.1	63.1	.59	.25	33.2	34.4	59.7	59.8
7853	48.7	49.7	.45	.24	36.5	36.6	58.8	59.3
Pecos	48.3	50.0	.60	.24	27.9	30.9	57.8	58.7
Tomahawk	53.2	52.0	.54	.23	32.2	31.5	57.8	57.8
Jagger	41.0	39.2	.56	.32	33.3	30.2	55.3	54.1
Karl 92	53.9	54.5	.50	.23	33.5	32.3	60.0	58.7

		Between Columns	Within Columns
LSD's (0.05)	Yield	2.3	6.7
	Tissue Cl	.02	.06
	TKW	1.0	2.7
	Test Wt.	1.1	3.0

Soil Test Cl: 7 lb/a (0-24")

ZINC FERTILIZATION ON WHEAT

R.E. Lamond and V.L. Martin

Summary

Previous work in Kansas has shown that wheat does not respond to zinc (Zn) fertilization, even when DTPA Zn soil test levels are low. Current KSU recommendations do not suggest applying Zn to wheat. This study evaluated Zn with three wheat varieties on a soil that tested very low in Zn. Cimarron and Triumph 64 responded to Zn in 1994, whereas 2163 did not. In 1995 and 1996, Zn effects on wheat yields were nonsignificant.

Introduction

Relative to corn or soybeans, wheat does not respond to Zn, and Zn fertilization of wheat in Kansas has not been recommended. In recent years, suspected Zn deficiency for certain wheat varieties has been reported. This study was initiated to evaluate Zn fertilization on three wheat varieties on a low Zn test soil.

Procedures

Zinc rates (0, 2 lb/a) and time of application (fall - just after seeding, spring) were evaluated with three wheat varieties (Cimarron, Triumph 64, and 2163) at the Sandyland Experiment Field in Stafford County. Cimarron and Triumph 64 were selected because they had shown possible Zn deficiency symptoms in previous years at this site. The site has a very sandy, low organic matter soil with a DTPA Zn test of less than 0.5 ppm, which is considered deficient. Zinc was applied as Zn chelate (9% Zn). Leaf samples were taken, and Zn concentrations determined. Grain yields also were determined.

Results

Results of this study are summarized in Table 4. Visual responses to Zn were not readily apparent anytime during the growing season, and the Zn deficiency symptoms that had been observed, particularly on Cimarron, did not show up in 1996. Zinc fertilization did not significantly affect grain yields in 1996.

Results from 3 years of work show that Zn fertilization had little effect on yields of these three varieties.

Table 4. Zinc fertilization on wheat in south central Kansas, 1996.

Zn Rate/Time*	Variety	Grain Yield	3-Year Avg. Yield
lb/a		bu/a	bu/a
0	Cimarron	33.0	32
2-Fall	Cimarron	31.3	33
2-Spring	Cimarron	29.3	31
0	Triumph 64	35.6	29
2-Fall	Triumph 64	32.7	30
2-Spring	Triumph 64	35.1	32
0	2163	39.7	35
2-Fall	2163	41.4	36
2-Spring	2163	40.4	36
	LSD (0.05)	4.6	--
Mean Values:			
Zn	0	36.1	32
Rate/Time	2-Fall	35.1	33
	2-Spring	34.9	33
	LSD (0.05)	NS	--
Variety	Cimarron	31.2	32
	Triumph 64	34.5	30
	2163	40.5	36
	LSD (0.05)	3.8	--

*Zn applied as Zn chelate, broadcast
Zinc by variety interactions were nonsignificant

SULFUR FERTILIZATION OF HARD RED WINTER WHEAT

S.R. Duncan, R.E. Lamond, D.A. Whitney, G. McCormack, and J.C. Baker

Summary

Past studies on winter wheat in Kansas have shown mixed responses to sulfur (S) fertilization. Generally, S is not recommended on soils with an organic matter (OM) content of greater than 1%. Many of the soils in south central Kansas do have OM levels near or below the 1% level. Results from this work indicate that winter wheat did not respond to S, even on soils with less than 1% OM The climatic conditions of the 1995-96 growing season probably had a greater influence on yields than any part of the fertility program, including S.

Introduction

A significant acreage of wheat in south central Kansas is grown on soils with organic matter (OM) levels near or below 1%. A large part of the wheat growing season is during a period when soil temperatures are below 50EF, so available S in the soil solution is low. Results of recent research on other cool-season grasses have shown consistent and significant forage yield increases with the addition of S to the fertility program. Wheat in a 1994-95 Kingman County Extension Demonstration plot on a soil with 0.7% OM had a dramatic visual response to S. Though plots were non-replicated, yields were doubled from 16 bu/a without S to 32 bu/a with S. These studies were established to evaluate the effects of S on winter wheat yields and grain quality.

Procedures

This study began in 1996 with plot establishment on seven sites in south central Kansas: Barton; Cowley; Kingman; and Pratt (two sites - one dryland, one irrigated) counties and at two sites, one dryland and one irrigated, on the Sandyland Experiment Field in Stafford County. Organic matter content and soil test information are summarized in Table 5. The S treatments of 0, 5, 10, and 20 lb/a were established in Kingman and Cowley counties in October, 1995. The same treatments were applied to the rest of the plots in March, 1996. All plots were fertilized with the same program used by the farmer or the Experiment Field. Grain was harvested in June, and samples were saved for analyses.

Results

Grain yield and protein from the different treatments are reported in Table 6. The plots in Barton County suffered severe stand reductions because of adverse climatic conditions and, therefore, were abandoned. No yield response to any rate of S was seen in any of the plots. Very low soil moisture and precipitation received from the preplanting period until early June, plus rapid and extreme temperature fluctuations from January through late March, probably affected yields to the point that fertility was not a yield controlling factor. Plants did not produce much top growth until late in the growing season. By that time, soil temperatures were above 50EF, so S was being mineralized from OM and released into the soil solution. The long, relatively cool flowering and fill period allowed for development and fill of large heads and late spring tillers.

These studies will be continued in the 1996-97 growing season.

Table 5. Soil test results† from sulfur fertilization on winter wheat study sites in south central Kansas.

Site ‡	Soil Series and Type	pH	Recommended ECC	Bray 1 P	K	SO_4-S	Organic Matter
			lb/a	------------ ppm	------------		%
Barton (D)	Pratt-Carwile loamy fine sand	4.7	2,000	39	120	0.8	0.6
Cowley (D)	Vanoss silt loam	4.5	3,000	56	175	5.0	1.3
Kingman (D)	Shellabarger sandy loam	5.7	1,000	31	70	1.2	0.7
Pratt (D)	Farnum loam	6.5	---	34	155	0.0	1.2
Pratt (I)	Farnum loam	7.1	---	29	70	3.5	1.7
Sandyland (D)	Carwile fine sandy loam	5.3	2,000	83	230	4.7	1.3
Sandyland (I)	Carwile fine sandy loam	6.2	500	31	95	5.3	1.1

† Soil tests were analyzed at the Kansas State University Soil Testing Lab, Manhattan, KS.
‡ (D) = Dryland, (I) = Irrigated.

Table 6. Wheat grain yields and protein from sulfur fertilization studies in south central Kansas.

	Site									
	Cowley (D)†		Kingman (D)†		Pratt (D)†		Pratt (I)†		Sandyland (D)†	Sandyland (I)†
S Rate	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Protein	Yield	Yield
lb/a	bu/a	lb/bu	bu/a	lb/bu	bu/a	lb/bu	bu/a	lb/bu	bu/a	bu/a
0	49	11.3	12	15.0	49	13.4	62	14.0	66	35
5	50	11.5	10	15.0	50	14.1	62	14.4	63	33
10	49	11.6	10	15.9	48	14.1	65	14.2	65	32
20	47	11.5	12	14.5	48	13.7	62	14.4	59	36
LSD (0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

† (D) = Dryland, (I) = Irrigated.

GRASS FERTILIZATION STUDIES
KANSAS STATE UNIVERSITY - DEPARTMENT OF AGRONOMY

NITROGEN RATES AND SOURCES FOR BROMEGRASS

R.E. Lamond, W.L. Thomas, T.L. Wesley, M.A. Davied, and D.A. Whitney

Summary

Previous work at Kansas State University has shown that, in most cases, commonly used nitrogen (N) fertilizers perform similarly when topdressed on bromegrass. Those trials were all topdressed during the recommended time, November through February. If topdressing is delayed, concern increases about N loss from surface-applied urea-containing fertilizers. This study evaluated effects of topdressing in March. Urea and UAN performed poorly compared to urea + NBPT (a urease inhibitor) or ammonium nitrate. NBPT is now commercially available under the trade name AgrotaiN®.

Introduction

When urea-containing fertilizers (urea, UAN) are surface applied, potential exists for volatilization loss of N as urea is hydrolyzed. When these materials are topdressed on bromegrass during the recommended time frame (November-February), volatilization is usually not a major concern, because soil and air temperatures are cool. When topdressing is delayed, concern about volatilization increases. This study was initiated in 1994 and continued in 1996 to evaluate N sources and a urease inhibitor, NBPT, on bromegrass when topdressed in March.

Procedures

Nitrogen rates (0, 45, 90 lb N/a) and sources ammonium nitrate, urea, urea + NBPT, and UAN were evaluated on established bromegrass at the North Agronomy Farm. All N was surface broadcast in mid March. The study was harvested in late May. Forage yields were determined, and forage was analyzed for protein content.

Results

Forage yields in 1996 were average (Table 1). Excellent responses to N were noted up to the 90 lb N/a rate. Comparing 3-year average yields shows that ammonium nitrate and urea + NBPT have outperformed urea and UAN. Under these conditions, the urease inhibitor improved the efficiency of urea. These results suggest that, if topdressing on brome is delayed, use of ammonium nitrate or urea with a urease inhibitor could improve performance.

Table 1. Nitrogen rates and sources on bromegrass, Riley Co., Kansas, 1996.

N Rate	N Source	Forage Yield	Forage Protein	3-Year Avg Yield
lb/a		lb/a	%	lb/a
0		2990	10.0	3880
45	Urea	4980	12.3	6000
90	Urea	5390	15.5	7050
45	Urea + NBPT	5150	13.5	6470
90	Urea + NBPT	5890	16.4	8000
45	Am. Nitrate	5120	12.6	6500
90	Am. Nitrate	5460	14.7	7560
45	UAN	4270	11.1	5470
90	UAN	5540	13.6	6770
LSD (0.05)		810	1.8	--
Mean Values:				
N	45	4880	12.3	6110
Rate	90	5570	15.1	7350
LSD (0.05)		230	0.9	--
N	Urea	5180	13.9	6550
Source	Urea + NBPT	5520	15.0	7230
	Am. Nitrate	5290	13.7	7040
	UAN	4910	12.4	6120
LSD (0.05)		320	1.1	--

BROMEGRASS FERTILIZATION STUDIES

R.E. Lamond, G.L. Keeler, J. Holthaus, H.C. George, M.A. Davied, and S.A. Staggenborg

Summary

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

Introduction

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

Procedures

Studies were continued in 1996 in Douglas County (two sites), Miami County, and Jackson County (two sites) to evaluate N, P, and S. All sites were low in available P. All fertilizer was applied in February , and plots were harvested in early June at all sites. Forage samples were retained for analyses.

Results

The 1996 results are summarized in Table 2. Yields were average, and good responses to N and P were noted. Nitrogen response was optimized only when P was applied. Addition of S tended to produce higher yields, though the increases were not always statistically significant.

These studies will be continued in 1997.

Table 2. Fertility management on bromegrass in eastern Kansas, 1996.

			Forage Yield				
N	P_2O_5	S	Douglas Co. A	Douglas Co B	Miami Co.	Jackson Co. A	Jackson Co. B
	lbs/a		- - - - - - - - - - lbs/a - - - - - - - - - -				
0	0	0	1830	1140	1680	1900	3640
40	0	0	1920	2140	2640	4020	6090
80	0	0	1750	2940	3430	5370	6610
120	0	0	2350	2520	2120	6800	6750
40	30	0	3123	3630	3050	4690	6160
80	30	0	3290	4370	3290	5800	7130
120	30	0	3490	5450	3510	6580	7730
80	30	20	3670	5390	3960	6530	7480
LSD (0.05)			790	750	1330	620	770
Mean Values							
N	40		2520	2890	2840	4350	6130
Rate	80		2520	3650	3360	5590	6870
	120		2920	3980	2820	6690	7240
LSD (0.05)			NS	550	NS	490	560
P_2O_5	0		2010	2530	2730	5400	6480
Rate	30		3420	4490	3280	5690	7010
LSD (0.05)			490	450	NS	NS	460
Soil Test P (lb/a)			7	7	6	30	18

SULFUR FERTILIZATION ON FESCUE AND BROMEGRASS

M.A. Davied, R.E. Lamond, G.L. Kilgore, D.A. Whitney, and J.O. Fritz

Summary

Previous work at Kansas State University has indicated that sulfur (S) fertilization consistently increased bromegrass forage yields. Much less work has been done on another widely utilized cool-season grass--tall fescue. This research evaluated S rates and sources on tall fescue at five sites and smooth bromegrass at two sites in southeast Kansas. In 1996, S fertilization increased forage production at all fescue sites and one of the brome sites, but only three of the fescue sites had statistically significant yield increases. As in 1995, S fertilization had little effect on fescue quality. Sulfur fertilization may be a good management practice to increase forage yields, if soil test S levels are low and temperatures are cool during the rapid growth and development period of fescue.

Introduction

Work done in the late 1980's and early 1990's concluded that S fertilization consistently increased forage yields and sometimes improved forage quality of smooth bromegrass in northeast Kansas. In southeast Kansas, however, tall fescue is the predominant cool-season grass. Much less work has been done on S fertilization of tall fescue, so in 1995 we began work that was continued in 1996 to evaluate S fertilization on fescue in southeast Kansas.

Procedures

Sulfur rates of 10 and 20 lb/a as either ammonium sulfate or elemental sulfur were evaluated at five sites on established tall fescue and two sites on established bromegrass. Nitrogen (N), phosphorus (P), and potassium (K) were balanced on all treatments at 100, 40, and 40 lb/a, respectively. A treatment receiving these rates of N, P, and K without S and a nonfertilized check treatment also were included. All fertilizer was topdressed in February, and the sites were harvested on May 23. Forage yields were determined, and forage was analyzed for protein, in vitro dry matter disappearance (IVDMD), and nutrient content.

Results

Forage yields were lower in 1996 when compared to 1995 but were once again significantly increased by N-P-K fertilization. Sulfur fertilization significantly increased fescue forage yields at three to five sites but had little effect on bromegrass production (Table 3). Responsive sites tended to correlate well to low soil test S levels (Table 4). As in 1995, S had little effect on forage protein and IVDMD. Tissue S content was increased significantly at all sites when ammonium sulfate was the S source. These results indicate that fescue may not be as responsive to S fertilization as bromegrass.

Table 3. Sulfur fertilization on tall fescue (sites 1-5) and bromegrass (sites 6-7) in southeast Kansas, 1996.

N	P	K	S	S Source	Forage Yield	Forage Protein	Forage S	Forage IVDMD
- - - - lb/a - - - -					lb/a	- - - - - - % - - - - - -		
SITE 1								
0	0	0	0	--	2046	11.7	0.20	40.6
100	40	40	0	--	5279	15.8	0.23	46.5
100	40	40	10	Am. Sul.	5381	15.6	0.24	47.9
100	40	40	20	Am. Sul.	5444	17.6	0.26	46.9
100	40	40	10	Elmt. S	5877	16.0	0.22	45.3
100	40	40	20	Elmt. S	5997	13.9	0.21	44.0
LSD (0.05)					962	2.5	0.02	2.9
SITE 2								
0	0	0	0	--	1856	11.8	0.21	48.7
100	40	40	0	--	4776	16.8	0.22	50.4
100	40	40	10	Am. Sul.	5496	16.6	0.24	49.3
100	40	40	20	Am. Sul.	4956	17.6	0.24	46.1
100	40	40	10	Elmt. S	4919	16.6	0.22	49.7
100	40	40	20	Elmt. S	4942	16.6	0.21	51.1
LSD (0.05)					664	1.4	0.02	4.9
SITE 3								
0	0	0	0	--	1149	11.2	0.24	54.8
100	40	40	0	--	2740	18.1	0.24	59.7
100	40	40	10	Am. Sul.	2962	17.5	0.27	56.4
100	40	40	20	Am. Sul.	2952	18.1	0.29	57.9
100	40	40	10	Elmt. S	2701	18.8	0.23	58.8
100	40	40	20	Elmt. S	2724	17.5	0.24	56.0
LSD (0.05)					600	2.9	0.03	3.7
SITE 4								
0	0	0	0	--	1291	12.1	0.26	46.0
100	40	40	0	--	4166	15.8	0.19	47.5
100	40	40	10	Am. Sul.	4578	16.5	0.26	47.1
100	40	40	20	Am. Sul.	4577	15.8	0.26	46.1
100	40	40	10	Elmt. S	4529	16.2	0.20	47.0
100	40	40	20	Elmt. S	4575	16.7	0.21	44.7
LSD (0.05)					404	1.8	0.03	NS

(Continued)

Table 3. Sulfur fertilization on tall fescue (sites 1-5) and bromegrass (sites 6-7) in southeast Kansas, 1996.

				S	Forage			
N	P	K	S	Source	Yield	Protein	S	IVDMD
- - - - lb/a - - - -					lb/a	- - - - - - % - - - - - -		
SITE 5								
0	0	0	0	--	1278	11.2	0.22	44.6
100	40	40	0	--	4264	14.5	0.21	45.1
100	40	40	10	Am. Sul.	4573	13.9	0.22	46.1
100	40	40	20	Am. Sul.	4408	13.5	0.24	46.2
100	40	40	10	Elmt. S	4734	14.6	0.22	46.3
100	40	40	20	Elmt. S	4238	14.8	0.21	44.3
LSD (0.05)					391	1.8	0.03	NS
SITE 6								
0	0	0	0	--	2503	11.5	0.17	51.8
100	40	40	0	--	5286	17.6	0.16	50.9
100	40	40	10	Am. Sul.	5202	16.6	0.18	51.9
100	40	40	20	Am. Sul.	5054	18.2	0.19	50.3
100	40	40	10	Elmt. S	5212	15.7	0.14	51.4
100	40	40	20	Elmt. S	4930	17.0	0.15	52.2
LSD (0.05)					399	2.1	0.03	NS
SITE 7								
0	0	0	0	--	504	12.1	0.19	47.3
100	40	40	0	--	2456	19.3	0.20	41.3
100	40	40	10	Am. Sul.	2694	19.0	0.22	52.0
100	40	40	20	Am. Sul.	2834	17.8	0.23	45.4
100	40	40	10	Elmt. S	2820	19.2	0.20	41.7
100	40	40	20	Elmt. S	2627	18.1	0.21	44.1
LSD (0.05)					427	1.9	0.02	5.9

Table 4. Soil test information for the established research sites of fall fescue and bromegrass.

Site	Depth	pH	Bray-1 P	K	SO_4-S	OM
	inch		ppm	ppm	ppm	%
1	0-6	5.7	10.0	125	4.5	5.3
	6-24	5.6	3.5	90	12.6	
2	0-6	5.6	12.5	80	3.3	4.9
	6-24	5.7	4.0	90	7.2	
3	0-6	7.3	3.5	245	6.5	5.8
	6-24	7.7	4.0	165	9.9	
4	0-6	7.3	11.0	110	0.7	3.7
	6-24	6.9	5.5	140	1.1	
5	0-6	5.9	7.5	115	3.3	5.3
	6-24	6.5	2.5	80	7.3	
6	0-6	5.9	9.0	125	4.2	3.2
	6-24	6.1	4.0	135	10.4	
7	0-6	7.7	7.0	255	5.3	4.7
	6-24	7.9	1.0	205	52.5	

BROMEGRASS FERTILIZATION IN SOUTH CENTRAL KANSAS

S.R. Duncan, J.C. Baker, J.W. Gattshall, D.E. Kehler, and S.R. Tonn

Summary

Nitrogen (N) is the first limiting nutrient in smooth bromegrass production programs. Whether the production program is haying or grazing only, or a combination of both, large amounts of phosphorus (P) are withdrawn from the soil fertility bank. Our results support studies conducted east of the Flint Hills in which bromegrass showed a positive yield response to P fertilization, especially on low P testing soils. In this study, however, higher N amounts were required before forage yield responded to fertilizer P in years of adequate or below-average precipitation. Sulfur (S) and potassium (K) applications did not consistently affect bromegrass yields.

Introduction

Smooth bromegrass is rated as moderately adapted with corresponding production potential in south central (SC) Kansas (west of the Flint Hills and south of Interstate 70). Bromegrass is most often found on soils that were planted to cereal grains until erosion and/or continued low production led to sod-forming grass establishment. In this area of high cattle numbers, both cows-calves and stockers, smooth brome fills the need for high quality hay and/or pasture during periods when native pastures are nonproductive. Low soil test phosphorus (P) levels are common on these acres. Studies in Kansas also have shown profitable forage yield responses to potassium (K) and sulfur (S) fertilization. Our purpose in establishing these studies was to demonstrate the value of soil testing to bromegrass producers and to evaluate N-P-K-S fertilization.

Procedures

Studies were established in 1994 in Cowley, Dickinson, and Marion counties to evaluate bromegrass forage yield response to N, P and S fertilization. In 1995, K fertilizer was added to the treatments on sites established in Cowley, Dickinson and Butler counties. Sulfur was dropped from the 1996 study in Cowley County. Most sites, with the exception of the Butler County plot, had very low to medium available P soil test results (Table 1). In all studies, fertilizer was applied in the second or third week of December and plots were harvested in the first week of June.

Results

Yields from all studies are reported in Table 5. Yields ranged from poor in 1996 to good to excellent in 1994 and 1995. Bromegrass yield response to N was much more pronounced and consistent than response to P, K, or S fertilization. As N rates increased from 0 to 120 lb/a in 40 lb increments, forage yields trended upwards, though not always significantly (Figs. 1, 2, 3). The first 40 lb increase of N nearly doubled forage yields at most sites, except Dickinson County, 1995. The second and third 40 lb increase of N resulted in trends of increased forage yields, too. However, the increased yields from 40 to 80 lb N/a were statistically significant only in Dickinson County in 1994 and in Cowley and Butler counties in 1995. Only in the 1995 Butler County plots did increasing N rate from 80 to 120 lb/a return a significant yield increase. Butler County was the only site with high soil test P levels (36 ppm), resulting in N being the controlling factor in a year when precipitation and soil moisture during the bromegrass growing season were more than adequate.

At all sites, the addition of 40 lb P/a tended to enhance forage yields when N rates were increased from 40 to 80 lb/a, though this increase was significant at only three of those sites, Cowley and Dickinson counties in 1994 and Cowley County in 1995 (Table 5). When 40 lbs of P were applied and N rates were raised from 80 to 120 lb/a, forage yields again tended to increase, but only at the Butler County site in 1995 was the increase significant.

Less than 2 in. of precipitation accumulated at the Cowley County 1996 site from fertilization through harvest. Surface and subsoil moisture were rated short to very short when the study began. Regardless, the bromegrass still responded to fertilization. When 40 lb/a P was combined with 80 or 120 lb/a N, a positive yield trend was evident (Table 5) and reinforced previous reports that P increases water use efficiency and N utilization.

Forage yield responses to 20 lb/a S were not consistent, though trends were positive at all 1995 sites (Table 5). In 1994, the yield trends with S were neutral to slightly negative. The S treatment was dropped from the study in 1996, but continued S work is planned. Potassium applied at 40 lb/a also resulted in slightly positive yield trends at three of four sites. The only site to which an application of K might have been recommended was the 1995 Cowley County site (soil test K = 100 ppm), where yields with and without K were virtually identical (Table 5).

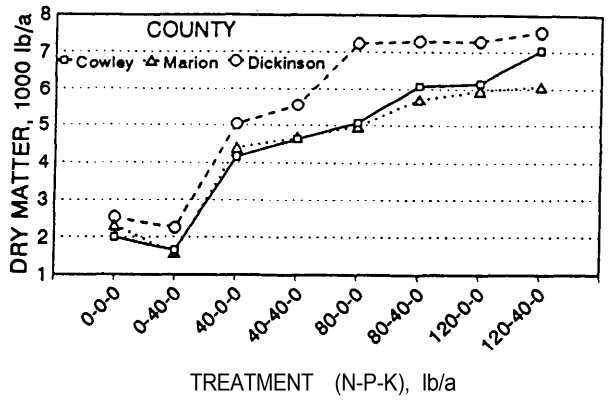
Nitrogen is the limiting nutrient for bromegrass producers in SC Kansas. Phosphorus at 40 lb/a enhanced forage yields when applied with at least 80 lb/a N, which is a reasonable N recommendation for this area. On sites where the results from the Kansas State University Soil Testing Lab indicated the need for P in addition to N for optimum forage production, the yield responses measured were profitable. On high P soils where no P would have been recommended, the addition of P with N had no effect on forage yields.

Table 5. Bromegrass fertilization studies in four counties of south central Kansas, 1994-96.

	1994			1995			1996
N–P–K–S	Cowley	Marion	Dickinson	Cowley	Butler	Dickinson	Cowley
lb/a	------------------------------------- yield, lb dry matter/a -------------------------------------						
0-0-0-0	2000	2316	2531	3206	1862	4194	1597
0-40-0-0	1655	1584	2249	3105	2288	4768	1716
40-0-0-0	4158	4392	5041	4901	4211	4804	2990
40-40-0-0	4633	4679	5554	5013	4376	5049	2669
80-0-0-0	5069	4959	7224	6067	6424	5245	2770
80-40-0-0	6077	5712	7292	6106	5488	6209	3287
80-40-0-20	5723	5088	7119	6444	6139	7638	---
80-40-40-0	---	---	---	6104	6581	7858	3633
120-0-0-0	6159	5962	7286	5427	8253	5353	3335
120-40-0-0	7050	6069	7540	6916	7740	6483	3822
LSD (0.05)	1112	1051	1156	874	1169	1923	621
Soil P (Bray 1) ppm†	4	10	14	7	36	5	14

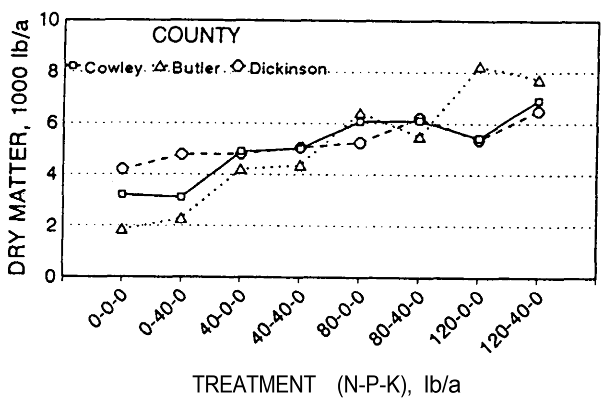
† Results from the Kansas State University Soil Testing Lab.

Fig. 1. Fertilizer rate effects on smooth bromegrass yields, 1994.



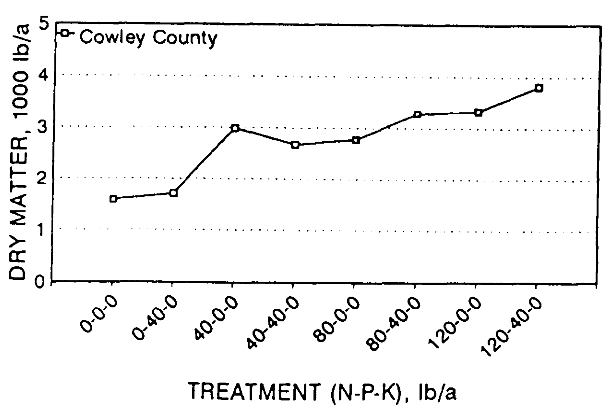
Soil P (Bray 1): CL Co. = 4 ppm: MN Co. = 10 ppm: DK Co. = 14 ppm.

Fig. 2. Fertilizer rate effects on smooth bromegrass yields, 1995.



Soil P (Bray 1): CL Co. = 7 ppm: BU Co. = 36 ppm: DK Co. = 5 ppm.

Fig. 3. Fertilizer rate effects on smooth bromegrass yields, 1996.



Soil P (Bray 1) CL Co = 14 ppm.

SOIL FERTILITY RESEARCH
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TILLAGE AND NITROGEN EFFECTS ON DRYLAND CROP PRODUCTION

A. J. Schlegel, D. L. Frickel, and C. R. Thompson

Summary

Grain yields of wheat and grain sorghum were the same with reduced and no tillage. Production costs were less with reduced than no tillage. Grain yields were increased 70 to 90% by nitrogen (N) fertilization. Fertilizer N requirements were greater than 50 lb N/a. Fertilization of previous crop increased yield of subsequent crop by over 30%. Nitrogen applications tended to increase fallow efficiency. Available soil water at planting was not affected by N rate or tillage.

Introduction

The principal dryland crop in the central Great Plains is winter wheat grown in a wheat- fallow system. However, producers are changing to more intensive cropping systems, such as wheat-sorghum-fallow, because of the potential for increased profitability. To be feasible, these intensive cropping systems must include reduced- or no-tillage practices to better utilize limited precipitation and maintain crop productivity. Nitrogen (N) fertilizer is routinely applied to dryland crops in this region to optimize grain yields. This study was conducted to 1.) quantify wheat and grain sorghum response to N fertilization in a wheat-sorghum-fallow rotation under reduced- and no-tillage systems, 2.) determine the residual effect of N fertilization on subsequent crops, and 3.) determine the effect of tillage practices on N response.

Procedures

This research was initiated in 1991 in west-central Kansas at the Southwest Research- Extension Center near Tribune on a Richfield silt loam soil. The experimental design was a split plot with tillage as main plots and N treatments as subplots. The two tillage systems were reduced (RT) and no tillage (NT). The RT system utilized a combination of herbicides, and tillage for weed control during fallow whereas NT relied solely on herbicides. A generalized weed control program for each system is outlined in Table 1. A blade plow (sweep) was used for all tillage operations, which is typical for this region. Weed control costs were about 20% greater with no-till than reduced tillage. The N treatments were 25, 50, and 100 lb N/a applied to either wheat or grain sorghum and 25 and 50 lb N/a applied to both crops along with an untreated control. Nitrogen fertilizer as urea was surface broadcast in the early spring on growing wheat and near planting time of grain sorghum. Plot size was 20 by 60 ft. The center of each plot was machine harvested, and grain yields were adjusted to 12.5% moisture.

Grain yields reported are averaged across 1993-96 for wheat and 1993-95 for sorghum. Soil water to a depth of 8 ft was measured at planting and harvest in three N treatments (25 and 50 lb N/a applied to both crops and the control) in both tillage systems. Along with precipitation records, this allowed calculation of crop water use, soil water accumulation during fallow, and fallow efficiency. Precipitation during the study period was 20% greater than the normal of 16 inch/yr. Residual soil N content at the start of the study was less than 10 ppm N (nitrate plus ammonia in a 2-foot profile).

Results

Nitrogen fertilization increased wheat yields up to 90% or 26 bu/a (Table 2). Application of 50 lb N/a was not sufficient to maximize yields, because wheat yields were 9 bu/a greater with 100 than with 50 lb N/a.

Nitrogen applied to the previous sorghum crop had a positive residual effect on subsequent wheat yield. For example, when sorghum received 100 lb N/a, wheat yields were 10 bu/a greater than the control. Tillage had no effect on wheat yield, and no N x tillage interaction occurred.

Grain sorghum yields were increased up to 70% or 27 bu/a by 100 lb N/a applied to sorghum (Table 2). Again, N requirements were greater than 50 lb N/a, because sorghum yields were 7 bu/a greater with 100 than with 50 lb N/a. The residual effect of fertilizer N applied to wheat increased sorghum yields up to 13 bu/a. Tillage had no effect on grain yield, and no N x tillage interaction occurred. Weed control costs were greater with no-till than reduced tillage (Table 1).

Nitrogen applications tended to increase crop water use, decrease soil water at harvest, and increase fallow efficiency (Tables 3 and 4). This corresponds to increased residue production in the fertilized treatments (data not shown). Tillage had little effect on residue production and generally little effect on soil water storage or use. However, for both crops, soil water was present deeper in the profile with no-till than with reduced tillage (data not shown).

Table 1. Weed control programs and costs for reduced and no tillage in a wheat-sorghum-fallow rotation, Tribune, KS.

Item	RT-W	RT-S	NT-W	NT-S
Herbicides				
Atrazine @$3.25/lb	0	2.0	0	2.0
Landmaster @$0.133/oz.	40	80	160	120
Ally/2,4-D/Banvel @$5/a	1	0	1	0
Dual @$15.88/qt.	0	1	0	1
Applications @ $3.15 each	2	3	5	4
Herbicide, $/planted/a	$16.61	$42.45	$42.00	$50.92
Tillage				
Sweep plow @ $4.27/a	3	1	0	0
Tillage, $/planted/a	$12.81	$4.27	$0.00	$0.00

Table 2. Grain yield response to N fertilizer and tillage in a wheat-sorghum-fallow rotation, Tribune, KS, 1993-96.

		Wheat					Grain Sorghum			
Treatment		1993	1994	1995	1996	Avg	1996	1994	1995	Avg
N Rate										
Wheat	Sorghum					lb/a				
0	0	44	20	25	28	29	37	57	24	39
0	25	42	20	29	24	29	45	71	32	49
0	50	46	19	27	30	30	49	82	47	59
0	100	53	30	35	37	39	58	88	51	66
25	0	45	28	33	32	34	42	56	23	40
25	25	56	30	35	36	39	46	77	31	51
50	0	57	41	43	43	46	50	59	26	45
50	50	60	45	48	41	48	63	72	41	59
100	0	66	48	55	51	55	66	66	24	52
LSD (.05)		11	5	5	9	4	6	10	8	4
Tillage										
Reduced		52	32	36	35	39	56	70	32	52
No till		53	31	37	36	39	46	70	34	50
LSD (.05)		12	5	3	5	5	7	13	13	9
ANOVA										
N		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Tillage		0.794	0.617	0.923	0.627	0.876	0.021	0.932	0.572	0.459
N x Till		0.929	0.938	0.728	0.641	0.675	0.676	0.354	0.316	0.253

Table 3. Analysis of variance for selected variables, Tribune, KS.

Crop and Tillage	Grain Yield	Crop Residue	Available Water Planting	Fallow Efficiency	Crop Water Use
Wheat					
Tillage	0.876	0.548	0.157	0.297	0.073
N treatment	0.001	0.001	0.274	0.022	0.001
Till x N trt	0.675	0.694	0.237	0.967	0.110
Sorghum					
Tillage	0.459	0.416	0.493	0.719	0.477
N treatment	0.001	0.005	0.944	0.029	0.486
Till x N trt	0.253	0.068	0.599	0.460	0.435

Table 4. Main effect means N fertilization and tillage study, Tribune, KS.

		Available Water			
Crop	Treatment	Plant	Harvest	Fallow Efficiency	Crop Water Use
		inch/8 ft profile		%	inch
Wheat					
Tillage					
	Reduced	10.0	6.3	16	20.3
	No-till	11.1	5.8	23	21.7
	LSD.05	1.5	1.7	14	1.6
N Rate					
	0 lb/a	10.8	6.7	19	20.5
	25	10.2	6.5	15	20.2
	50	10.7	4.9	25	22.2
	LSD.05	0.8	1.2	7	1.0
Sorghum					
Tillage					
	Reduced	10.7	5.1	34	15.3
	No-till	11.2	6.1	34	14.8
	LSD.05	1.5	0.9	4	1.5
N Rate					
	0 lb/a	11.0	6.1	30	14.7
	25	10.9	5.3	34	15.3
	50	11.0	5.5	38	15.1
	LSD.05	1.0	1.0	6	1.1

LONG-TERM FERTILIZATION OF IRRIGATED CORN

A.J. Schlegel

Summary

Long-term research shows that phosphorus (P) and nitrogen (N) fertilizer must be applied for optimum grain yields of irrigated corn in western Kansas. In this study, N and P fertilization increased corn yields more than 100 bu/a. Application of 160 lb N/a tended to be sufficient to maximize corn yields. Phosphorus increased corn yields by 75 bu/a when applied with at least 120 lb N/a. Application of 40 lb P_2O_5/a was adequate, and higher rates were not necessary.

Introduction

This study was initiated in 1961 to determine responses of continuous corn grown under flood irrigation to nitrogen (N), phosphorus (P), and potassium (K) fertilization. The study is conducted on a Ulysses silt loam soil with an inherently high K content. No yield benefit from K fertilization was observed in 30 years and soil K levels remained high, so the K treatment was discontinued in 1992. However, a yield increase from P fertilization has been observed since 1965 and there was concern that the level of P fertilization may not be adequate. So, beginning in 1992, a higher P rate was added to the study which replaced the K treatment.

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 prior to planting and incorporated. The corn hybrids were Pioneer 3379 (1992-94) and Pioneer 3225 (1995-96) planted at 32,000 seeds/a in late April or early May. All plots were furrow irrigated to minimize water stress. The center two rows of all plots were machine harvested after physiological maturity. Grain yields were adjusted to 15.5% moisture.

Results

Nitrogen and P fertilization increased corn yields averaged across the 5-year period by over 100 bu/a (Table 5). In 1995, hail during the growing season reduced overall yields about 40%, but yields still were increased up to 80 bu/a by N and P fertilization. The apparent N fertilizer requirement was about 160 lb/a. Application of 40 lb P_2O_5/a increased yields about 75 bu/a when applied with at least 120 lb N/a. A higher rate of P was not necessary, because no significant yield difference occurred between applications of 40 and 80 lb P_2O_5/a.

Table 5. Effect of of N and P fertilizers on irrigated corn, Tribune, KS, 1992-96.

		Grain Yield					
Nitrogen	P_2O_5	1992	1993	1994	1995	1996	Mean
- - - - lb/a - - - -				- - - - - - - bu/a - - - - - - - -			
0	0	73	43	47	22	58	49
0	40	88	50	43	27	64	54
0	80	80	52	48	26	73	56
40	0	90	62	66	34	87	68
40	40	128	103	104	68	111	103
40	80	128	104	105	65	106	102
80	0	91	68	66	34	95	71
80	40	157	138	129	94	164	136
80	80	140	144	127	93	159	133
120	0	98	71	70	39	97	75
120	40	162	151	147	100	185	149
120	80	157	153	154	111	183	152
160	0	115	88	78	44	103	86
160	40	169	175	162	103	185	159
160	80	178	174	167	100	195	163
200	0	111	82	80	62	110	89
200	40	187	169	171	106	180	163
200	80	165	181	174	109	190	164
ANOVA							
Nitrogen		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
quad.		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
linear		0.001	0.001	0.001	0.001	0.001	0.001
quad.		0.001	0.001	0.001	0.001	0.001	0.001
N x P		0.013	0.001	0.001	0.001	0.001	0.001
MEANS							
Nitrogen	0 lb/a	80	48	46	25	65	53
	40	116	90	92	56	102	91
	80	129	116	107	74	139	113
	120	139	125	124	83	155	125
	160	154	146	136	82	161	136
	200	154	144	142	92	160	138
	LSD .05	14	7	13	7	10	5
P_20_5	0 lb/a	96	69	68	39	92	73
	40	149	131	126	83	148	127
	80	141	135	129	84	151	128
	LSD .05	10	5	9	5	7	4

SOIL FERTILITY RESEARCH
KSU AGRICULTURAL RESEARCH CENTER - HAYS

RESPONSE OF WINTER WHEAT AND GRAIN SORGHUM TO RATE AND METHOD OF AMISORB APPLICATION

C. A. Thompson

Summary

The cost effectiveness of using Amisorb will depend on the price of the product, yield increase from use of the product, commodity price at harvest, and cost of application. However, results are from only 2 years and from a confined area in Kansas. Further testing under more favorable environmental conditions is needed before the effectiveness of Amisorb on winter wheat can be determined. Studies to date indicate that it is not necessary to apply more than 1 qt/a on wheat or sorghum. Producers wishing to use Amisorb on 1997 wheat or sorghum should evaluate the product either on a strip basis within a field or on half of a small field.

Introduction

The active ingredient of Amisorb is polyaspartate, a long chain polymer (molecular weight 5000) of aspartic acid. The molecule has a high density of negative charges and a cation exchange capacity of approximately 300 milliequivalents per 100 grams of 40% active ingredient solution. The polymer is also highly hydrated.

This synthetic thermal protein has been demonstrated to increase nutrient absorption in plants. In contact with fertilizers, liquid or solids, the polymer adsorbs cations. When the plant root comes into contact with the polymer, the high concentrations of nutrients associated with the polymer apparently affect movement of nutrients into the plant. This increased nutrient uptake has resulted in greater growth of plant roots and shoots and higher plant yields.

The polymer is not a fertilizer, although it contains nitrogen (N), and does not act as a plant growth regulator. Polymer labeled with C-14 isotope in all carbons has been shown to remain outside the plant root.

Pilot studies of various crops in several states under controlled conditions have shown positive results. The objectives of the studies reported here were to determine if nutrient uptake responses as measured by increases in yields occurred (1) when Amisorb was applied to wheat with and without N fertilizer, (2) as a residual effect on sorghum following application to wheat, and (3) when Amisorb was applied directly to sorghum.

Procedures

Each study was replicated four times in a randomized complete block design. Six center rows of each eight-row plot were harvested with a plot combine. Each study was statistically analyzed using SAS.

<u>1995 Winter Wheat, On-Station</u>

This 60-treatment study was planted October 14, 1994 on a Harney silt loam soil on the KSU Agricultural Research Center–Hays. The previous crop was grain sorghum. Methods of application were (1) broadcast and incorporated and banded treatments placed (2) below and (3) with the seed at planting time. Amisorb rates were 0, 0.25, 0.50, 1.00 and 1.50 qts/a of 40% A.I. liquid. In addition, rates of 0, 20, 40, and 80 lb N/a was used with each of the Amisorb treatments. Because of extremely dry seedbed conditions, water at 450 gal/a was applied with the seed at planting.

<u>1996 Winter Wheat, On-Station</u>

Amisorb was applied (1) broadcast and incorporated prior to planting, (2) banded with the seed, (3) spring broadcast (topdressed), and (4) half in the fall broadcast preplant, and (5) banded with the seed with the remaining half in the spring broadcast. Amisorb rates of 0, 2, and 3 qts/a of 40% material were used with and without liquid N. This study was planted on October 11, 1995 on a Harney silt loam soil on the KSU Agricultural Research Center-Hays. The previous crop was grain sorghum. Because of extremely dry seedbed conditions, water at 450 gal/a was applied with the seed at planting to ensure even germination and emergence.

1996 Winter Wheat, Off-Station

Eight off-station sites were located in or near Ellis County. No Amisorb was used or rates of 1, 2, and 3 qts/a were sprayed on the wheat in early April at 20 gal/a. Preplant N at 40 to 60 lb N/a was applied by the cooperator as anhydrous ammonia. No additional N was added after planting.

1996 Grain Sorghum, Residual Study

The winter wheat study harvested in 1995 involving Amisorb placement and N rates was not tilled from wheat harvest to planting of the 1996 sorghum crop. No additional Amisorb or N was applied. Sorghum was planted on June 10, 1996 in 12-inch rows at 80,000 seeds/a.

1996 Grain Sorghum, Direct Application

Amisorb was (1) placed with the seed and (2) broadcast. Both methods of placement were incorporated with no N or 10, 20, or 30 lb N/a as UAN applied with the seed. The June 7, 1996 planting on this Harney silt loam soil received timely rains throughout the summer months, resulting in higher than normal yields.

Results

1995 Winter Wheat, On-Station

Effective precipitation in November and December provided good surface and subsurface moisture for wheat plants going into the winter. Freezes in mid and late April caused stem breakage in the wheat plants, lowered yields, and very likely affected the yield response to Amisorb.

Yield results from three application methods are shown in Figures 1-3. Regardless of application method, consistency in yield response was lacking with both Amisorb and N. Depending on the rate and method of application, both significant yield increases and decreases resulted from the use of Amisorb and N. Amisorb had no effects on plant emergence, test weight, plant height, or stem breakage (not shown).

1996 Winter Wheat, On-Station

Fall planting conditions were extremely dry. Precipitation was sparse throughout the fall and winter and up to May, 1996. From June, 1995 through April, 1996, 7.82 inches precipitation was received, or 41% of the long-time average. This was the lowest amount on record for this time period. May and June precipitation amounts were above the long-time averages.

Wheat suffered from winter injury in February and twice in March. Because of extreme drought and freeze damage, nearly 40% of the planted wheat in Ellis County was abandoned.

In spite of adverse weather conditions, yields were higher than expected. Amisorb by itself did not significantly raise yields over the control (Table 1). When Amisorb was combined with fall and spring applications of N, yields were still not significantly more than those with N applied alone.

Amisorb had little effect on test weight, and N additions lowered test weight. Heading date, plant height, and general rating were not affected by Amisorb or N. No plant lodging occurred in the study. Plant emergence and final stands were not affected by Amisorb or N fertilizer.

1996 Winter Wheat, Off-Station

Three of eight sites showed significant yield response to surface-applied Amisorb (Table 2). The largest yield response from any of the sites came from the Gottschalk farm (#1) were 1 qt/a resulted in a 5.4 bu/a increase or 30.3%. No treatment X site interaction occurred. The 1 qt/a treatment gave the highest yield at all locations, resulting in an average 3.4 bu/a or 9% increase over the control. Amisorb had no measured effect on test weight, plant height, or moisture in the grain at harvest (data not shown). No plant lodging occurred at any of the eight locations.

1996 Grain Sorghum, Residual Response

Residual effects of Amisorb applied in September, 1994 on grain sorghum yield and test weight are shown in Table 3. No significant response to any of the treatments or interactions was observed. This indicates that Amisorb at low rates does not carry over from wheat to grain sorghum in the wheat-sorghum-fallow rotation.

The P-values are reported in Table 4. The only significant contrast was the linear N rate, for which a P-value of 0.01 was obtained. Lower than normal precipitation occurred for the September, 1994 through April, 1996 period. Thus, N leaching out the root zone was minimal. In addition, 1995 wheat yields were lower than normal, indicating that not all of the N applied to wheat was used. Therefore, the significant N response (3.6 bu/a) in the 1996 grain sorghum crop was not surprising.

1996 Grain Sorghum. Direct Application

The effect of Amisorb placement and rate with four N levels is reported in Tables 5 and 6. The main response (Table 5) was from increasing N rates applied with the seed. The percent responses from 10, 20, and 30 lb N/a over the control were 7.7, 12.9, and 22.1, respectively. Only at the 10 lb N/a rate were yields from both placements of Amisorb significantly higher (8% avg) than the control. Test weights were generally higher with broadcast treatments. Plant height and days to half-bloom were not affected significantly by any of the treatments.

Yields from with-seed placement (Table 6) were significantly higher than those from broadcast. The 1 qt/a Amisorb rate with-seed placement yielded 7.6 bu more than the broadcast method. Higher Amisorb rates did not increase yields. Test weights were generally higher from broadcast placements especially at the 2 and 3 qt/a rates. Amisorb significantly increased plant height at the 1 and 2 qt/a rates. Days to half-bloom were unaffected by Amisorb.

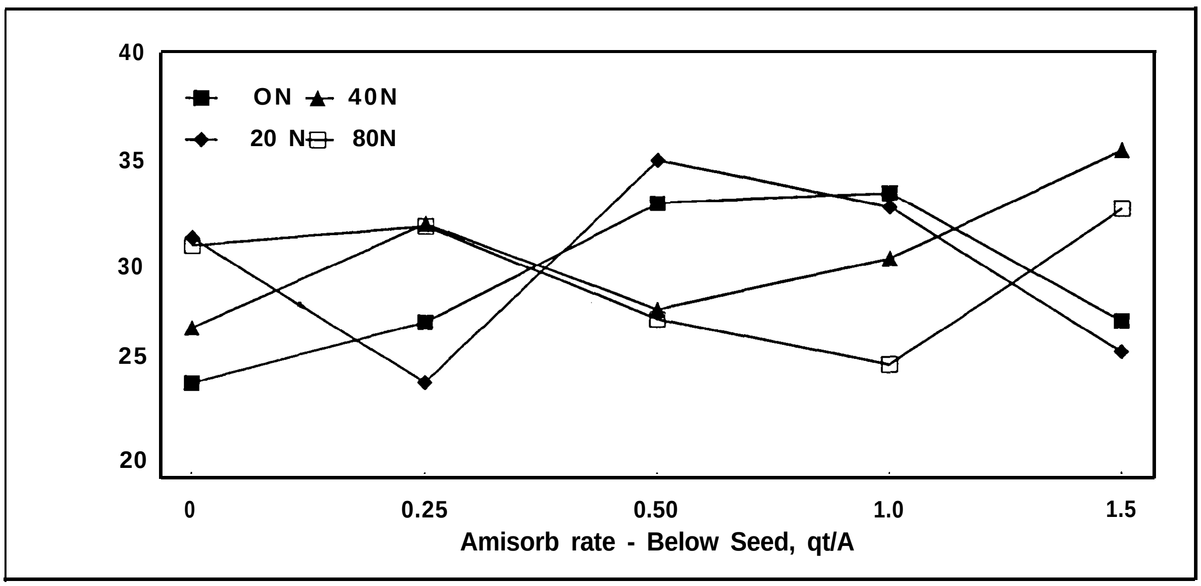


Figure 1. Effect of Amisorb banded below the seed for 1995 winter wheat planted on October 14, 1994, KSU Agricultural Research Center, Hays, KS.

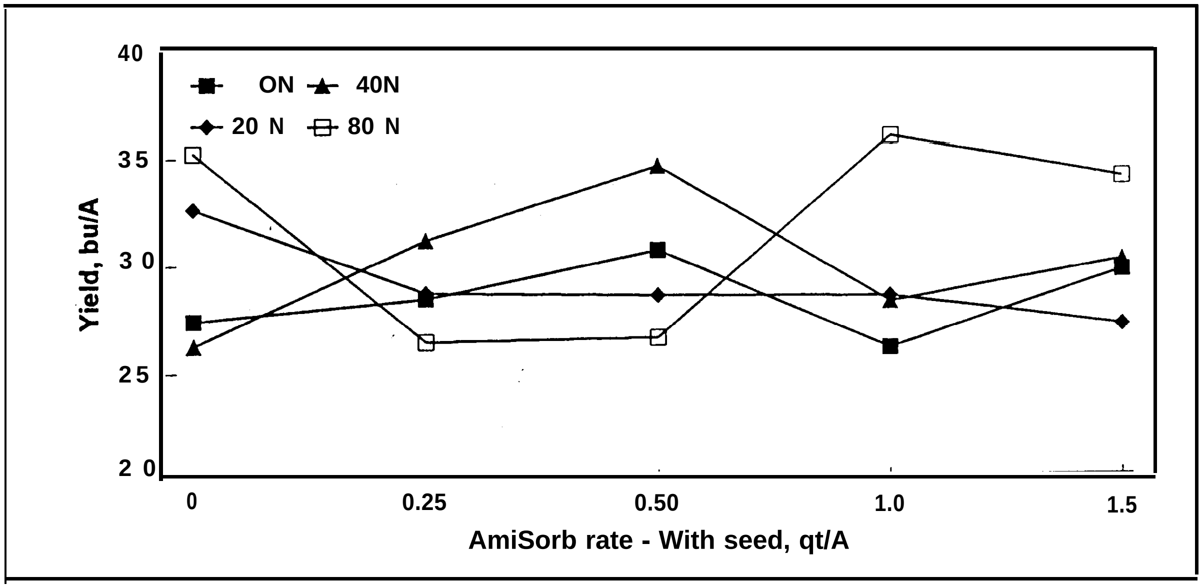


Figure 2. Effect of Amisorb banded with the seed for 1995 winter wheat planted on October 14, 1994, KSU Agricultural Research Center, Hays, KS.

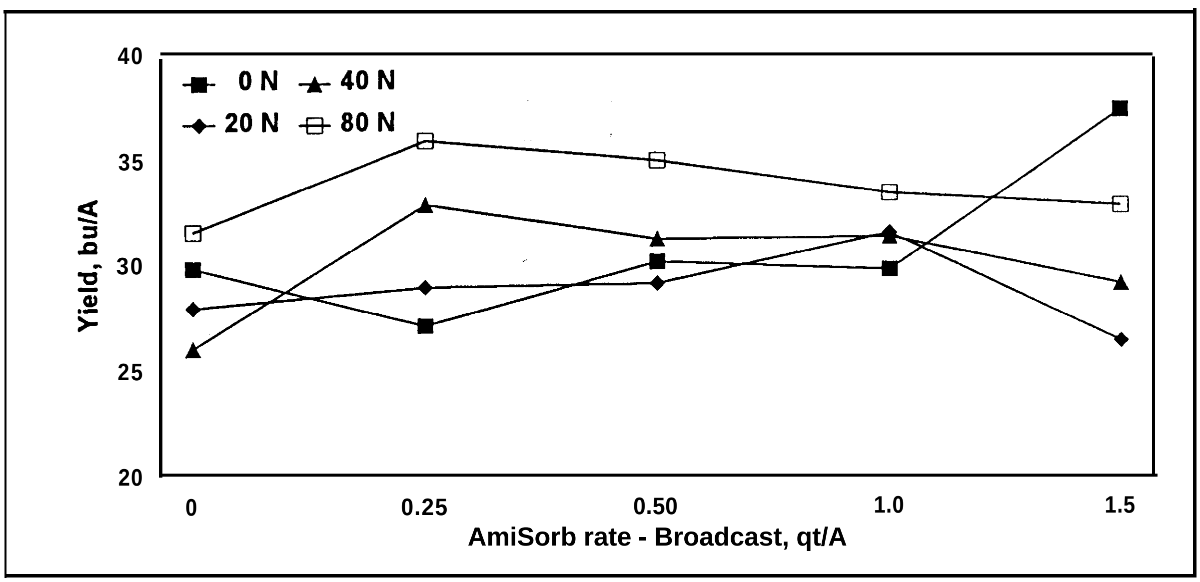


Figure 3. Effect of Amisorb broadcast and incorporated for 1995 winter wheat planted on October 14, 1994, KSU Agricultural Research Center, Hays, KS.

Table 1. Effect of rate, time, and method of Amisorb (AS) application on 1996 winter wheat, KSU Agricultural Research Center–Hays.

Treatments	Yield	TW	Heading Date	Plant Height	General Rating
	bu/a	lb/bu	Julian day	inch	(1-10)
Amisorb fall applications					
0 N	28.6	56.8	144	25.5	6.2
30 N Fa + 30 N Sp	30.4	55.8	144	25.2	5.8
Amisorb broadcast					
AS-2qt, 0 N	28.6	56.6	144	24.8	6.0
AS-2qt, 30 N Fa + 30 N Sp	32.4	55.6	144	25.2	5.8
AS-3qt, 0 N	27.8	56.0	146	24.5	5.8
AS-3qt, 30 N Fa + 30 N Sp	32.6	55.6	144	25.0	5.2
Amisorb with seed					
AS-2qt, 0 N	27.9	56.1	144	25.5	6.2
AS-2qt, 30 N Fa + 30 N Sp	30.3	55.4	144	25.0	5.8
AS-3qt, 0 N	29.2	56.4	144	26.0	5.5
AS-3qt, 30 N Fa + 30 N Sp	30.6	55.8	144	25.2	6.0
Amisorb spring applications					
0 N	28.6	55.9	144	24.8	5.5
30 N Fa + 30 N Sp	29.8	55.4	144	24.2	5.2
Amisorb broadcast					
AS-2qt, 0 N	28.2	56.6	144	24.8	6.0
AS-2qt, 30 N Fa + 30 N Sp	30.7	55.4	144	24.0	5.8
AS-3qt, 0 N	28.0	56.4	144	24.5	6.0
AS-3qt, 30 N Fa + 30 N Sp	30.6	54.9	145	24.2	5.2
Amisorb fall and spring applications					
0 N	27.8	56.7	144	24.8	5.5
30 N Fa + 30 N Sp	31.1	55.6	144	24.8	6.0
Amisorb broadcast					
AS-1qt Fa+1qt Sp, 0 N	28.5	56.5	145	24.2	6.0
AS-1qt Fa+1qt Sp, 30 N Fa + 30 N Sp	32.5	56.2	144	24.8	5.8
AS-1.5qt Fa+1.5qt Sp, 0 N	27.5	56.5	144	24.5	6.0
AS-1.5qt Fa+1.5qt Sp, 30 N Fa + 30 N Sp	32.6	55.7	145	25.5	6.2
Amisorb with seed					
AS-1qt Fa+1qt Sp, 0 N	28.1	56.4	144	24.0	6.0
AS-1qt Fa+1qt Sp, 30 N Fa + 30 N Sp	29.4	55.3	144	25.8	5.8
AS-1.5qt Fa+1.5qt Sp, 0 N	27.4	56.3	144	25.0	5.8
AS-1.5qt Fa+1.5qt Sp, 30 N Fa + 30 N Sp	29.8	55.4	144	25.5	5.8
LSD (P<.05)	3.0	0.8	NS	NS	NS
P value	<.01	<.01	.85.	.80	.31

Amisorb (AS): qt/a

Nitrogen (N): lb N/a

Table 2. Yields of winter wheat as affected by four rates of Amisorb sprayed in March, 1996 on eight winter wheat sites in or near Ellis County, KS.

Amisorb	#1	#2	#3	#4	#5	#6	#7	#8	Avg
Rate, qt/a	- - - - - - - - - - - - - - - Yield, bu/a - - - - - - - - - - - - - - -								
0	17.8	68.1	47.6	36.8	23.5	25.7	38.2	45.1	37.8
1	23.2	73.2	49.9	38.5	26.2	28.7	41.2	48.4	41.2
2	21.9	71.2	48.7	38.2	26.1	26.8	39.8	47.0	40.0
3	20.5	66.4	48.0	37.3	25.7	25.2	38.9	46.5	38.6
LSD (P<.05)	2.4	NS	NS	NS	0.7	1.0	NS	NS	1.3
P-value	<0.01	0.24	0.42	0.72	<0.01	<0.01	0.28	0.20	<0.01

Table 3. Residual effect of Amisorb placement and rate with four levels of N fertilizer on 1995 winter wheat on the following 1996 grain sorghum, Agricultural Research Center-Hays.

		Below the Seed		With the Seed		Broadcast	
Amisorb Rate	Nitrogen Rate	Yield	Test Weight	Yield	Test Weight	Yield	Test Weight
qt/a	lb N/a	bu/a	bu/a	bu/a	bu/a	bu/a	bu/a
0.00	0	94.4	59.3	92.3	58.9	96.6	58.9
0.00	20	93.8	59.0	89.2	58.6	101.0	59.0
0.00	40	98.1	59.0	93.2	58.8	99.0	59.1
0.00	80	98.1	58.8	115.0	59.1	107.8	59.0
0.25	0	85.0	58.5	96.9	59.2	97.2	58.9
0.25	20	96.5	59.0	100.0	59.4	105.0	58.8
0.25	40	102.8	59.0	101.6	59.0	96.4	58.9
0.25	80	109.2	59.0	95.4	58.4	101.8	58.8
0.50	0	91.1	58.7	99.9	59.1	100.2	59.0
0.50	20	102.5	58.6	94.0	59.1	104.4	59.2
0.50	40	84.1	58.5	97.2	59.0	104.8	59.0
0.50	80	96.2	59.1	95.1	59.1	96.4	58.8
1.00	0	99.4	58.6	93.3	58.8	96.5	58.7
1.00	20	97.0	58.8	93.4	58.8	102.2	58.8
1.00	40	96.2	58.8	88.2	58.0	101.9	58.9
1.00	80	99.5	58.9	92.1	58.8	101.5	59.0
1.50	0	99.2	58.7	87.4	58.6	96.8	59.0
1.50	20	90.3	58.3	99.3	58.8	98.3	58.4
1.50	40	99.8	58.9	97.0	58.9	93.5	57.9
1.50	80	100.6	59.0	97.8	58.6	106.0	59.0
LSD (P<.05)							
Amisorb placement		NS	NS				
Amisorb rate		NS	NS				
Nitrogen rate		3.6	NS				
Interactions		NS	NS				

Table 4. P values for the 1996 grain sorghum yields from residual 1995 winter wheat study, Agricultural Research Center-Hays.

Contrast	P Values
Linear Amisorb	0.55
Quadratic Amisorb	0.29
Cubic Amisorb	0.91
Linear N rate	0.01
Quadratic Amisorb	0.84
Cubic Amisorb	0.22

Table 5. Effect of Amisorb placement and nitrogen rates on 1996 dryland grain sorghum, Agricultural Research Center-Hays.

Amisorb Placement Method[1]	Nitrogen Rate	Yield	Test Weight	Plant Height	Half-Bloom Date
	lb N/a	bu/a	lb/bu	inch	month/day
None	0	88.1	59.6	42	Aug 6
With seed	0	89.5	60.0	42	Aug 6
Broadcast	0	90.6	60.1	41	Aug 6
None	10	94.9	59.6	42	Aug 6
With seed	10	101.3	60.0	43	Aug 7
Broadcast	10	103.8	60.2	42	Aug 6
None	20	99.5	59.5	41	Aug 6
With seed	20	101.4	59.2	43	Aug 7
Broadcast	20	97.9	60.2	42	Aug 6
None	30	107.6	59.8	42	Aug 6
With seed	30	98.6	59.2	43	Aug 6
Broadcast	30	100.2	60.0	41	Aug 6
LSD (P<.05)					
Amisorb placement		NS	0.3	NS	NS
Nitrogen rate		1.0	NS	NS	NS
Placement x N rate		1.8	0.5	NS	NS

[1] With seed and broadcast treatments received 2 qt/a Amisorb.

Table 6. Effect of Amisorb placement and rate on 1996 dryland grain sorghum,[1] Agricultural Research Center-Hays.

Amisorb Placement Method	Amisorb Rate	Yield	Test Weight	Plant Height	Half-Bloom Date
	qt/a	bu/a	lb/bu	inch	month/day
Control	0	99.5	59.5	41	Aug 6
With seed	1	103.1	59.9	43	Aug 7
With seed	2	101.4	59.2	43	Aug 7
With seed	3	94.7	59.2	41	Aug 5
Broadcast	1	95.5	59.3	42	Aug 5
Broadcast	2	97.9	60.2	42	Aug 6
Broadcast	3	98.1	60.0	41	Aug 6
LSD (P<.05)					
Amisorb placement method		1.0	0.3	NS	NS
Amisorb rate		1.4	NS	1	NS
Placement x rate		2.0	0.5	NS	NS

[1] Entire study received 20 lb N/a applied with the seed at planting.

SOIL FERTILITY RESEARCH
KANSAS RIVER VALLEY EXPERIMENT FIELD

EFFECT OF APPLICATION METHOD, TIME, AND RATE OF SUPPLEMENTAL NITROGEN ON IRRIGATED SOYBEANS

L.D. Maddux and P.L. Barnes

Summary

A study was initiated in 1996 to evaluate nitrogen (N) application method, time, and rate on irrigated soybeans. Soybean yield for the 0 N control plot was 71.8 bu/a. Fertigation at the R1 and R3 growth stages resulted in yields of 73.7 and 73.8 bu/a, but this slight yield increase was not statistically significant. No significant differences were observed with fertigation at R5, UAN cultivated in at R1, or NH_4^+ sidedressed at R1. This study will be continued in 1997.

Introduction

Irrigated soybean yields in Kansas commonly exceed 60 bu/a. Nitrogen demand during grain fill is quite high at these yield levels. Some producers have been applying about 30 lbs/a supplemental N to soybean fields through irrigation systems at the R3 stage of growth based on research conducted using broadcast N fertilizer. This study was designed to determine the optimum rate, method, and time of N application to provide maximum, economic, soybean yields.

Procedures

A sprinkler irrigated site on a Eudora silt loam soil at the Kansas River Valley Experiment Field was used. Nitrogen rates included 0, 30, and 60 lbs N/a. Application methods were: (1) UAN dribbled at the last cultivation at R1 (beginning bloom), (2) anhydrous ammonia (NH_4) knifed on 30-inch centers at R1, and UAN fertigated at (3) R1, (4) R3 (beginning pod), and (5) R5 (beginning seed). The treatments were arranged in a randomized complete block design with four replications. A minimum of 0.5 inch of water was applied to all plots with each fertigation treatment. Leaf samples were taken at approximately R6 (pod fill). Grain yields were determined by machine harvesting, and seed weights were determined.

Results

Only yield results from this first year of the study are presented here. No significant differences in soybean yields resulted from N application method and time or N rate (Table 1). However, a slight trend to increased yield was observed with fertigation treatments at the R1 and R3 growth stages. This research will be continued next year.

Table 1. Effect of N application rate, method, and time on irrigated soybean yields, Topeka, KS 1996.

N Application Method & Time	N Rate	Yield
	------------------lbs/a--------------	------------------bu/a---------------
None	0	71.8
UAN, Cultivate, R1	30	72.3
UAN, Cultivate, R1	60	68.4
NH_4, Sidedress, R1	30	71.7
NH_4, Sidedress, R1	60	71.2
UAN, Fertigation, R1	30	73.9
UAN, Fertigation, R1	60	73.5
UAN, Fertigation, R3	30	72.4
UAN, Fertigation, R3	60	75.1
UAN, Fertigation, R5	30	74.0
UAN, Fertigation, R5	60	69.3
LSD(.05)		NS
N Application Method & Time:		
UAN, Cultivate, R1		70.5
NH_4, Sidedress, R1		71.5
UAN, Fertigation, R1		73.7
UAN, Fertigation, R3		73.8
UAN, Fertigation, R5		71.6
LSD(.05)		NS
N RATE:		
	30	72.9
	60	71.5
LSD(.O5)		NS

EFFECT OF PREPLANT AND SPLIT NITROGEN APPLICATIONS ON AMMONIUM NUTRITION OF CORN

L.D. Maddux and P.L. Barnes

Summary

Research has suggested that corn responds most to ammonium nutrition early in the growing season (prior to V6). This study evaluated the effect of nitrification inhibitors (NI), nitrogen (N) rate, and preplant and split applications of urea ammonium nitrate (UAN) on the N nutrition and yield of corn and on the soil NH_4^+:NO_3^- ratios at the V6 growth stage from 1993 through 1996. No yield was obtained in 1994. The NIs, N-Serve and DCD, were effective in maintaining N in the ammonium form until V6. NIs had no significant effect on corn yield except in 1996, when N-Serve resulted in a 9 bu/a yield increase. Cool, wet, early growing seasons in 1993 and 1995 resulted in low yields. Yields in excess of 200 bu/a were obtained in 1996.

Introduction

Corn can utilize N as either ammonium (NH_4^+) or nitrate (NO_3^-). Ammonium-N is readily converted to NO_3^- by soil organisms, so that NO_3^- is usually the primary form available for plant uptake. Previous field studies have suggested that corn responds most to NH_4^+ nutrition prior to the six-leaf (V6) growth stage. Maintaining N in the NH_4^+ form decreases the chances of N loss from denitrification or leaching. Therefore, N use efficiency as well as corn yield should be enhanced by the use of preplant NH_4^+ based fertilizers with a nitrification inhibitor (NI) and/or split N application. This study was designed to evaluate the effect of NI, N rate, and preplant and split applications of urea ammonium nitrate (UAN) on the N nutrition and yield of corn and on the soil NH_4^+:NO_3^- ratios at the V6 growth stage.

Procedures

Field plots were established on a Eudora silt loam soil at the Kansas River Valley Experiment Field near Rossville in 1993. Preplant UAN was knifed 6 inches deep on 24-inch centers at 30, 50, 80, 130, 150, and 180 lbs N/a in late April or early May. These preplant UAN treatments were applied with no NI, with N-Serve at 0.5 lbs ai/a, or DCD at 3 lbs/a (DCD treatments were not used in 1996). A sidedress treatment of 100 lb N/a was applied to the 30, 50, and 80 lbs N/a preplant treatments at V6. A no N control also was included.

Pioneer Brand 3377 hybrid corn was planted in late April or early May at 26,200 seeds/a with an insecticide applied in the furrow or as a T-band. Recommended herbicides were applied preplant, incorporated for weed control. No irrigation was applied in 1993, because the growing season was extremely wet, but plots were irrigated as needed in 1995 and 1996. In 1994, the corn was destroyed by a severe windstorm just prior to tasseling.

Soil samples were taken prior to V6 application from the preplant N application band, dried, ground, and analyzed for NH_4^+ and NO_3-. Five whole plants were harvested at V6, tasseling, and physiological maturity (PM). Plants were weighed for dry matter determination and analyzed for N content. Grain was harvested mechanically and corrected to 15.5% moisture for yield determination.

Results

The soil and plant data for 1996 have not been analyzed, so only yield data are presented here. The NIs were effective in maintaining elevated soil NH_4^+ concentrations until V6 (data not shown). All N treatments increased grain yield over that of the control in all 3 years (Table 2). No consistent differences in N treatment were observed in 1993 or 1996. In 1995, the preplant N treatments tended to yield higher than the split N treatments. For some unexplainable reason, the 50 + 100 lbs N/a treatment with or without NI had the lowest yield in 1993. Yields were low in 1993 and 1995. No inhibitor effect was observed in 1993 and 1995, but in 1996, a 9 bu/a yield increase was obtained with N-Serve. The lack of a yield response to N rate and application time in 1996 indicates that this yield increase most likely was due to an NH_4^+ nutrition effect. The lack of response to the sidedress treatment suggests that leaching of N was not a problem.

Table 2. Effect of N rate, application time, and nitrification inhibitor on grain yield, Rossville, KS.

N Rate		Nitrification	Grain Yield		
Preplant	V6	Inhibitor	1993	1995	1996
-------------lbs/a----------------			---------------------- bu/a---------------------		
180	0	None	132	131	191
180	0	N-Serve	133	140	202
180	0	DCD	130	126	
150	0	None	142	140	199
150	0	N-Serve	140	143	204
150	0	DCD	132	137	
130	0	None	136	147	186
130	0	N-Serve	136	132	196
130	0	DCD	137	135	
80	100	None	142	132	193
80	100	N-Serve	131	132	200
80	100	DCD	133	125	
50	100	None	126	140	197
50	100	N-Serve	128	131	202
50	100	DCD	129	134	
30	100	None	136	127	190
30	100	N-Serve	138	130	202
30	100	DCD	141	132	
0	0	None	54	63	143
LSD(.05)			13	12	15
NITROGEN MEANS:					
180	0		132	132	196
150	0		138	140	202
130	0		137	138	191
80	100		136	131	196
50	100		128	134	200
30	100		138	129	196
LSD(.05)			7	8	NS
NITRIFICATION INHIBITOR MEANS:					
		None	136	135	192
		N-Serve	135	135	201
		DCD	134	132	
LSD(.05)			NS	NS	7

IMPACT OF COVER CROPS ON RESIDUE AND NITROGEN CONTRIBUTION TO SUBSEQUENT CROPS

M.M. Mikha, P.L. Barnes, L.D. Maddux, and C.W. Rice

Summary

The use of winter cover crops and no-till management practices can increase the amount of residue returned to the soil. Mineralization of N from crop residues can significantly contribute to a crop's N requirement. This study was conducted to monitor N mineralization under two cover crops, hairy vetch and oat, and their effects on soil N content and corn yield. We monitored field N mineralization after soybean. Total N contents were 167 lbs/a and 145 lbs/a for hairy vetch and oat, respectively. During the growing season, N released from the two cover crops significantly increased corn grain yield compared with that of corn grown with no cover crop.

Introduction

Cover crops are important in areas where crops are grown on highly erodible soil and/or where small amounts of crop residue are left on the surface. Increasing residue amounts will increase soil organic matter which can lead to increases in soil organic carbon and nitrogen (N) as well as improve soil structure, aeration, and infiltration. Crop residue can protect the soil and reduce the aggregate breakdown by rainfall. Nitrogen is important for plant growth and development; N mineralization from crop residue can contribute to a crop's N requirement. Nitrogen contribution from crop residue could reduce future fertilizer additions and groundwater contamination.

Procedures

This field experiment was conducted in Doniphan County in northeast Kansas on a farmer’s field with Monona silty clay loam soil. Cover crops (oat and hairy vetch) were planted in October, 1994 and killed with herbicide before the summer crops, corn and soybean, were planted in June 1995. Mineralization under cover crop was monitored throughout the growing season by erecting shelters. An area of 3 ft^2 was covered with an enclosed wooden box at about 5 in. above the soil surface on soybean plots to prevent direct rain hit and direct sun radiation. The wooden box was painted white to reflect sunlight and prevent heat buildup. Nitrogen mineralization was estimated by collecting samples at 0-6, 6-12, and 12-18 in. depths every other week inside and outside shelters. Corn received 100 lb N/a as urea ammonium nitrate.

Results

Mineralization of N from the hairy vetch treatment was significantly higher (P#0.05) compared with oat and no-cover treatments, which resulted in an increased N contribution to subsequent crops. Nitrogen mineralization from hairy vetch (Figure 1) was approximately 69 lbs/a, compared with 53 lbs/a and 39 lbs/a for oat and no cover, respectively. Although residue mineralization continued after tasseling, soil inorganic N decreased with depth. The higher N contribution from hairy vetch could have been due to its high N content compared with oat and no cover. Corn grain yields were significantly different (P#0.05) for hairy vetch compared to no cover (Figure 3), but no significant difference in corn yield occurred between the two cover crops. The higher water content in the hairy vetch treatment (Figure 2) could have been due to greater residue production. This soil water could be made available to the plant during dry periods in the growing season.

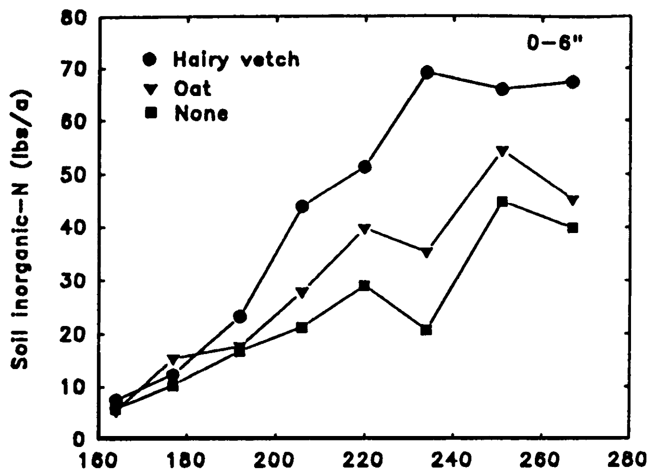


Figure 1. Soil inorganic-N in shelter area throughout the 1995 growing season.

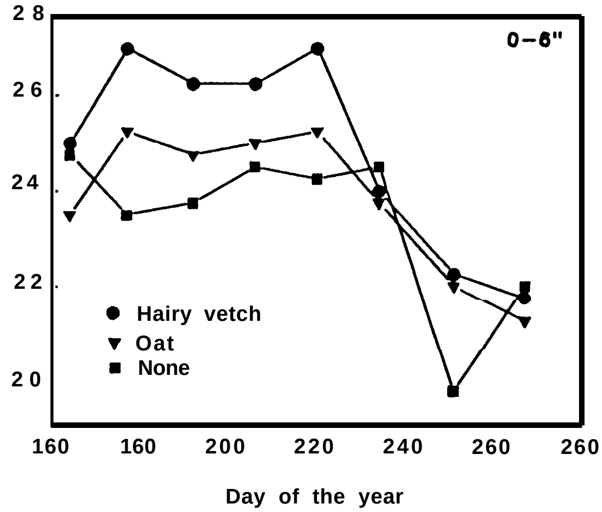


Figure 2. Percent soil moisture in sheltered area throughout the 1995 growing season.

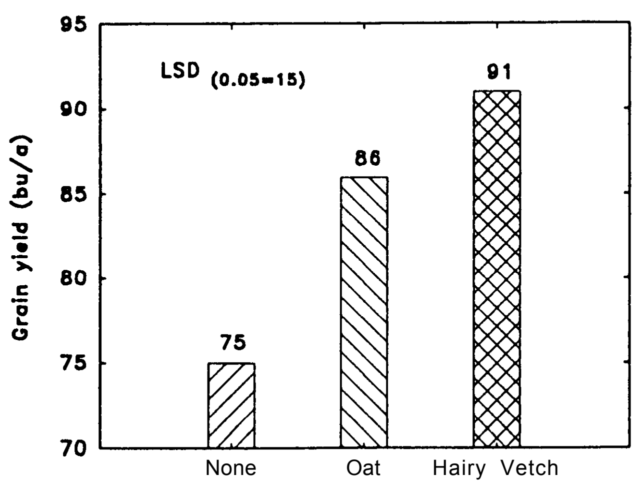


Figure 3. Corn grain yield for 1995 growing season.

SOIL FERTILITY RESEARCH
SOUTHEAST AGRICULTURAL RESEARCH CENTER

EFFECT OF SOIL pH ON CROP YIELDS

K.W. Kelley

Summary

In 1996, urea and AgrotaiN urea were compared as topdress fertilizer N sources for winter wheat at various soil pH levels ranging from 5.5 to 7.5 at the 0 to 3-in soil depth. Wheat grain yields significantly increased as soil acidity decreased; however, no significant difference in grain yield occurred between the two urea N sources. Grain yields of grain sorghum, soybean, and wheat also increased as soil acidity decreased during the 4-yr crop rotation.

Introduction

In southeast Kansas, nearly all topsoils are acidic (pH less than 7.0) in nature. Agricultural limestone is applied to correct soil acidity and to improve nutrient availability. However, applying too much lime results in alkaline soil conditions (pH greater than 7.0), which also reduces nutrient availability and increases persistence of some herbicides.

Surface-applied urea fertilizers also are more subject to possible ammonia volatilization, especially when soil pH is above 7.0. AgrotaiN urea is a new fertilizer N source that is supposed to reduce urea N volatilization for up to 14 days following application. This research seeks to evaluate urea and AgrotaiN urea as topdress fertilizer N sources for wheat at different soil pH levels and to evaluate the effects of soil pH on grain yield for other field crops typically grown in southeastern Kansas.

Procedures

Beginning in 1989, five soil pH levels (5.5, 6.0, 6.5, 7.0, and 7.5) were established on a native grass site at the Parsons Unit in a 4-yr crop rotation consisting of wheat - [wheat - double-crop soybean] - grain sorghum - soybean. In 1996, two N sources (urea and AgrotaiN urea) and two topdress N rates (30 and 60 lb N/a) were evaluated within each of the five soil pH levels for effects on wheat yield.

Results

In 1996, topsoil conditions remained dry for nearly a month after topdress N was applied in mid-February; however, grain yield response to applied topdress N was significant (Table 1). Urea and AgrotaiN urea produced similar yields at the different pH levels. Highest grain yields occurred when soil pH approached 7.0.

Grain yield responses for the various soil pH treatments during the 4-yr rotation are shown in Table 2, except for double-crop soybean, which had not been harvested at this reporting. All grain yields increased as soil acidity decreased, except for wheat in 1995. In that year, wheat yield declined at the higher pH range. This study will continue for several more rotations to evaluate soil pH effects on grain yield and nutrient availability.

Table 1. Effect of various soil pH levels on grain yield response to topdressed fertilizer N applications on winter wheat, Southeast Agricultural Research Center, Parsons, KS, 1996.

		Wheat Yield					
N Source	N Rate	pH 5.5	pH 6.0	pH 6.5	pH 7.0	pH 7.5	Avg.
	lb/a	bu/a					
Urea	30	35.1	36.7	41.7	40.0	43.8	39.5
Urea	60	41.3	40.6	44.0	50.8	51.1	45.7
AgrotaiN urea	30	35.9	37.0	41.4	42.1	47.1	40.7
AgrotaiN urea	60	40.6	39.2	42.7	48.3	49.3	44.0
Control	--	28.6	31.6	32.5	38.7	38.3	33.9
Avg.		36.3	37.0	40.5	44.0	45.9	

LSD (0.05):
Comparing lime means = 2.8 bu/a
Comparing fertilizer N for same pH level = 3.3 bu/a
Comparing fertilizer N for different pH level = 4.0 bu/a

Fertilizer N applied on Feb. 20, 1996.

Table 2. Effects of soil pH on grain sorghum, soybean, and wheat yields, Parsons Unit, Southeast Agricultural Research Center.

Soil pH			Grain Yield			
0-3"	3-6"	6-12"	1993 Grain Sorghum	1994 Soybean	1995 Wheat	1996 Wheat
			bu/a			
5.4	5.3	5.2	59.4	25.0	18.8	27.4
5.7	5.5	5.2	65.6	25.9	22.4	32.5
6.5	5.9	5.2	70.3	35.6	26.0	33.5
7.0	6.3	5.2	82.6	36.2	29.0	37.2
7.5	6.7	5.2	84.2	38.3	25.5	38.7
LSD (0.05):			4.5	3.7	2.6	3.3

USE OF A LEGUME-GRAIN SORGHUM CROPPING SYSTEM

J.L. Moyer and D.W. Sweeney

Summary

Grain sorghum was grown for 2 years with 100 lb/a or no nitrogen (N) after no clover (continuous sorghum) or red clover that was hayed (2.8 tons/a) or mulched. In Yr 1, sorghum grain production was greater after clover than after continuous sorghum. Nitrogen (100 lb/a) increased yields uniformly by about 40%. Sorghum heads/a were increased by N fertilization, but plants/a were not affected by treatments. In Yr 2, sorghum grain yield was greater after hayed clover when sorghum received no N than with 100 lb N/a or after continuous sorghum that received no N. Sorghum heads/a were greater after hayed clover when sorghum received no N than with 100 lb N/a and with no N after mulched clover.

Introduction

Grain sorghum is a productive feed-grain crop, which is heat and drought tolerant, but requires the input of N and does not maintain soil physical condition. Legume crop rotations with grain sorghum can reduce the need for added N and help maintain the physical condition of the soil or provide top growth that could be used as a livestock supplement. Red clover is suitable as a green manure crop because of its yield potential and substantial N content.

The optimum use of the legume-grain sorghum rotation in a crop-livestock system requires that several trade-offs be assessed. The legume top growth can benefit the livestock by supplementing low-quality roughage. The objectives of this research are to determine the effects of 1) fall-seeded red clover on grain sorghum yield and quality and on selected soil properties; 2) clover removal vs. incorporation of top growth on subsequent crop and soil properties; 3) 0 or 100 lb/a of N, with or without haying, on grain sorghum characteristics; and 4) the systems on nutrient content of grain sorghum stover.

Procedures

Red clover was seeded on designated plots on March 31, 1994. Hayed plots were cut on June 16, 1995, and all plots were offset-disced on June 22. In 1995 and 1996, urea was applied at the rate of 100 lb N/a to appropriate plots, then all plots were tandem-disced two times and planted with Pioneer 8500 in June. Phosphate and potash (21 and 33 lb/a, respectively) were applied to all plots with the planter, and a preemergent application of 2 lb a.i./a of alachlor was used for weed control.

Plant samples and soil data were collected at the 9-leaf stage, the boot stage, and the soft-dough stage. At harvest, whole plants, grain, and stover samples were collected. At each sampling, dry matter production, nutrient concentrations, and forage quality were determined.

Results

Hayed plots produced 2.83 tons/a (12% moisture) of red clover forage in spring, 1995. Subsequent 1995 (Yr 1) grain sorghum plant stands, head count, and grain yield are listed in Table 3. Sorghum plant populations were similar in all treatments. Head counts were significantly ($P<.05$) higher after 100 lb/a of N had been applied than where no N was added, but were similar among the previous cropping treatments.

Sorghum grain yield was increased ($P<.05$) by 40% after the application of 100 lb/a of N. Yield was 5% higher after the production of red clover than after continuous grain sorghum. No interaction occurred between clover management and N rate treatments (Table 3). Grain test weight and thousand kernel weight were similar for the treatments (data not shown).

In the second year of grain sorghum after red clover (Yr 2), plants/a and grain test weight were not affected by clover management or N rate (data not shown).

Sorghum heads/a in Yr 2 were greater ($P<.05$) with no N after hayed clover than with no N after mulched clover (Table 4). Heads/a were greater after mulched clover when sorghum received no N than when it received 100 lb N/a.

Sorghum grain yield was greater ($P<.05$) with no N after hayed clover than with 100 lb N/a after hayed clover (Table 4). Continuous sorghum with no N produced lower grain yield than sorghum with no N grown after hayed clover and sorghum with 100 lb N/a grown after mulched clover. Grain test weight was similar for the treatments (data not shown).

Table 3. Grain sorghum plant and head populations and grain yield in Yr 1 following red clover (1995) as affected by clover management and N application, Southeast Agricultural Research Center.

Treatment	Population		Grain
	Plants	Heads	Yield
	no/a (10^3)		bu/a
Clover Management			
None	45.2	45.9	34.0
Hayed	46.6	47.2	47.9
Mulched	43.3	49.0	51.9
$LSD_{.05}$	NS	NS	9.6
Nitrogen Rate			
None	44.9	44.8	37.3
100 lb/a	45.1	49.9	51.9
$LSD_{.05}$	NS	2.8	7.8
Clover treatment X nitrogen rate interaction	NS	NS	NS

Table 4. Grain sorghum head population and grain yield in Yr 2 following red clover (1996) as affected by clover management and N application, Southeast Agricultural Research Center.

Clover Management	Nitrogen Rate	Head Population	Grain Yield
	lb/a	no/a (10^3)	bu/a
None	0	36.2	58.4
	100	38.3	71.7
Hayed	0	38.8	80.7
	100	35.6	61.4
Mulched	0	34.5	67.1
	100	37.6	73.6
$LSD_{.05}$	NS	3.2	13.6

GRAIN SORGHUM RESPONSE TO LEGUME RESIDUAL AND FERTILIZER NUTRIENTS

D.W. Sweeney, J.L. Moyer, D.A. Whitney, and D.J. Jardine

Summary

Type of legume residual did not affect the yield of subsequent first or second grain sorghum crops; yield of the third (1996) grain sorghum crop was more following alfalfa residual than birdsfoot trefoil when no nitrogen (N) was applied, but was not different when fertilized with 125 lb N/a. In 1996, greater sorghum yield increases with phosphorus (P) and potassium (K) were obtained when N also was supplied. Stalk rot severity was greater with P when no K was applied. Adding K or chloride (Cl) reduced stalk rot severity, but adding both as KCl did not result in a further reduction in visual presence of *Fusarium* stalk rot.

Introduction

With the attention recently given to sustainable agriculture, interest has been renewed in the use of legumes in cropping systems. Because sustainability of our agricultural resources needs to coincide with profitability, achieving and maintaining adequate soil fertility levels are essential. The residual from legumes such as alfalfa and birdsfoot trefoil can benefit subsequent row crops by supplying N. However, little information is available on the importance of soil P and K in the residual effects of alfalfa and birdsfoot trefoil on a subsequent grain sorghum crop.

Procedures

The experiment was established on a Parsons silt loam in spring 1994. Since 1983, different soil test levels have been maintained in whole plots by fertilizer applications to develop a range of soil P and K levels. The experimental design was a split-split-plot. The whole plots comprised a factorial arrangement of P and K rates, in addition to selected Cl comparison treatments. Phosphorus rates were 0, 40, and 80 lb P_2O_5/a, and K rates were 0, 75, and 150 lb K_2O/a. Subplots were alfalfa and birdsfoot trefoil residuals. Chloride comparison treatments involved a 2x2 factorial combination of K and Cl by using KCl, K_2SO_4, $CaCl_2$, or no K or Cl. Sub-subplots were 0 and 125 lb N/a applied as urea. Three-year-old alfalfa and birdsfoot trefoil were killed by offset discing on March 22, 1994. Grain sorghum was planted at 62,000 seeds/a in June in 1994, 1995, and 1996. Stalk rot scores (bottom 10 nodes) were taken at harvest maturity in 1995 and 1996.

Results

Although not significant in previous years (data not shown), grain sorghum yield in 1996 was affected by an interaction between N rate and previous legume residual (Fig. 1). Without N, yield was 6 bu/a more where alfalfa had been grown during 1991-1993 than following birdsfoot trefoil. However, when 125 lb N/a were added, the difference in yield following either legume was less than 2 bu/a. Although mineralization in this atypical, high organic matter soil may partially mask legume residual effects, birdsfoot trefoil residual appears to be contributing less N to this third-year grain sorghum crop after legume incorporation.

Grain sorghum yield also was affected by interactions of N with P and with K fertilization. Without added N, yield increased about 12 bu/a with 40 lb P_2O_5/a but did not increase further with 80 lb P_2O_5/a (Fig. 2). With N, the yield increase with 40 lb P_2O_5/a was 25 bu/a, with little additional yield with 80 lb P_2O_5/a. Without N, sorghum yield was about 6 bu/a more with 75 lb K_2O/a than with no K but declined to about 92 bu/a with 80 lb K_2O/a (Fig. 3). In contrast, yield increased about 10 bu/a with 75 lb K_2O/a and 125 lb N/a and tended to further increase to nearly 107 bu/a with 150 lb K_2O/a and 125 lb N/a.

Although lodging was minor (data not shown), the number of internodal spaces with visual evidence of *Fusarium* stalk rot symptoms was affected by interactions of K with N and with P fertilization. Without N, stalk rot severity neared seven nodes/plant with no K, but was reduced with K fertilization (Fig. 4). With N but no K fertilization, stalk rot severity was less than without N. However, with K fertilization, little difference occurred in stalk rot severity regardless of N rate. Without P, stalk rot was evident in about five nodes/plant and did not decrease until K fertilization was increased to 150 lb K_2O/a (Fig. 5). In contrast, when P was applied with no K, more than six nodes/plant showed visual signs of *Fusarium* stalk rot. Adding K at either rate reduced the visual signs of stalk rot to less than five nodes/plant.

Because the K fertilizer used in the previous statistical analysis was KCl, analyses of additional treatments provided data regarding K and Cl effects on yield and stalk rot. Potassium as KCl or K_2SO_4 increased yields by nearly 11 bu/a and reduced stalk rot severity (data not shown). Stalk rot severity scores were affected by an interaction between K and Cl (Fig. 6). Without K or Cl, more than six nodes/plant showed visual signs of stalk rot. Adding K without Cl or adding Cl without K reduced stalk rot severity to about five nodes/plant with visual symptoms. However, adding K with Cl as KCl did not result in any further lowering of the number of nodes showing visual stalk rot.

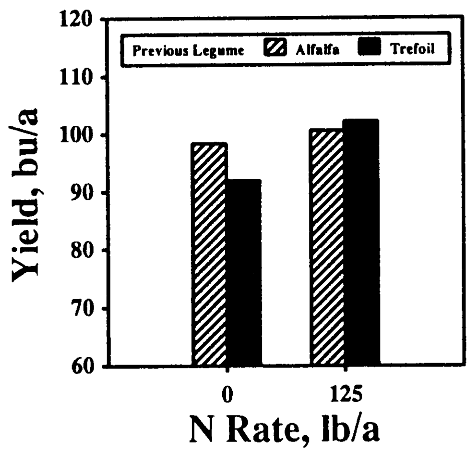


Fig. 1. Effects of N rate and legume residual on grain sorghum yield, Southeast Agricultural Research Center, 1996.

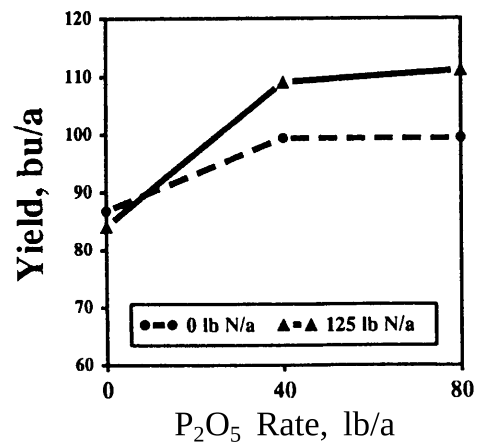


Fig. 2. Effects of N and P fertilization rates on grain sorghum yield, Southeast Agricultural Research Center, 1996.

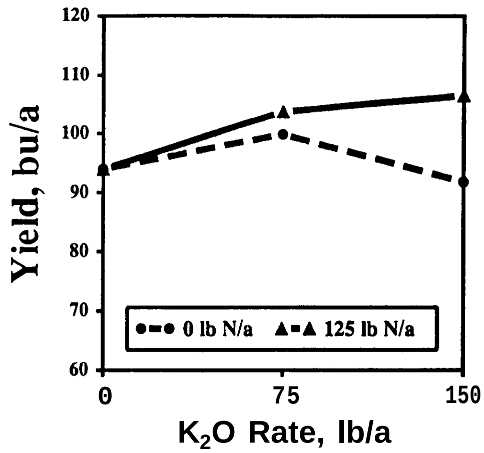


Fig. 3. Effects of N and K fertilization rates on grain sorghum yield, Southeast Agricultural Research Center, 1996.

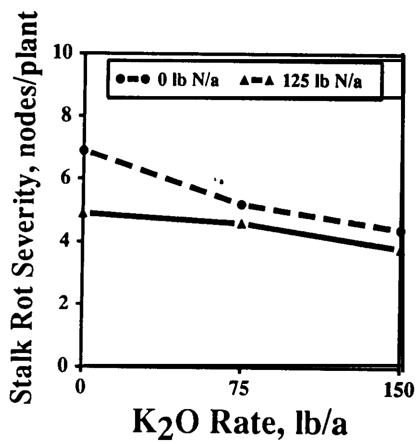


Fig. 4. Effects of N and K fertilization rates on stalk rot severity in the bottom 10 nodes of grain sorghum plants, Southeast Agricultural Research Center, 1996.

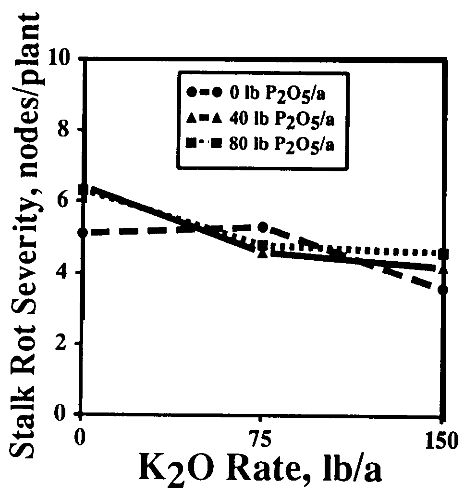


Fig. 5. Effects of P and K fertilization rates on stalk rot severity in the bottom 10 nodes of grain sorghum plants, Southeast Agricultural Research Center, 1996.

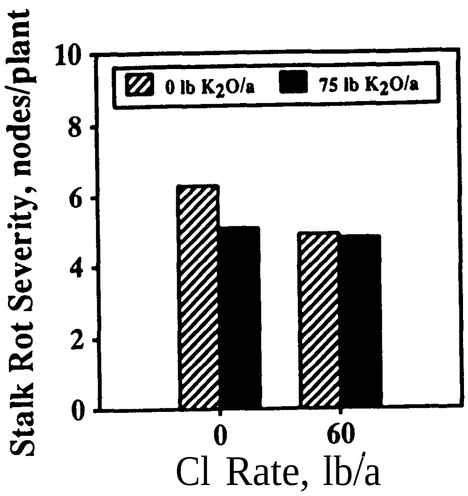
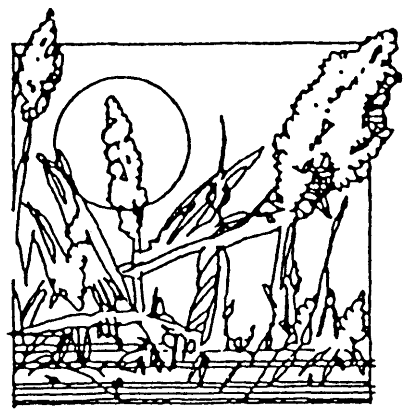


Fig. 6. Effects of K and Cl fertilization on stalk rot severity in the bottom 10 nodes of grain sorghum plants, Southeast Agricultural Research Center, 1996.



SOIL FERTILITY RESEARCH
EAST CENTRAL EXPERIMENT FIELD

PHOSPHORUS LOSSES IN RUNOFF WATER AS AFFECTED BY TILLAGE AND PHOSPHORUS FERTILIZATION

K.A. Janssen, G.M. Pierzynski, and P.L. Barnes

Summary

Phosphorus (P) in runoff from cropland can contribute to nutrient enrichment and eutrophication of surface water bodies. Research was continued during 1996 to determine which tillage systems and which methods of applying P fertilizer will result in the least P losses in runoff water for grain sorghum production under somewhat poorly drained soil conditions in east-central Kansas. The tillage systems evaluated were a chisel-disc-field cultivate system, a ridge-till system, and a no-till system. Fertilizer treatments were a P check, 50 lb/a P_2O_5 surface broadcast, and 50 lb/a P_2O_5 deep-banded. Runoff from natural rainfall was collected during three pre- and post-grain sorghum fertilization and planting periods, 1994-1996. Volume of runoff in 1994 was greatest from the chisel-disc system. In 1995, most runoff occurred with no-till. In 1996, runoff was highest with the ridge-till system. Averaged across all runoff events over 3 years, the volume of runoff was similar for each of the tillage systems, indicating no significant reduction with conservation tillage for this somewhat poorly drained soil. Sediment losses and total P losses in the runoff water followed the pattern chisel-disc > ridge-till > no-till. Soluble P losses were highest with the conservation tillage systems, largely because of surface application of P fertilizer. Losses of soluble P were reduced greatly when the P fertilizer was subsurface-banded. Comparisons of total and soluble P losses with bioavailable P losses showed that substantial algae-useable P in the runoff from this location was in the soluble P form. This could be due to limited sediment losses from minimum slope and low soil erosion potential. No differences in grain yield occurred in 1994 with tillage or P treatments. In 1995, with late planting of grain sorghum, dry weather during grain fill, and an early freeze, no-till and deep-banded P fertilizer combinations produced the highest yield. As of this writing, the 1996 grain sorghum crop has not yet been harvested.

Introduction

Agricultural runoff from cropland can contribute to the nutrient enrichment in lakes, streams, and rivers. High levels of phosphorus (P) in runoff water accelerates eutrophication of surface water bodies, producing water that has undesirable odor and taste for drinking and recreation. Excess P in runoff is a problem in the Hillsdale lake watershed in east-central Kansas. Farmers in the watershed are being urged to reduce nonpoint sources of P entering surface water (Big Bull Creek Water Quality Incentive Project). Losses of P from conventional-tilled land are believed to be mainly of P attached to soil with smaller amounts dissolved in the runoff water. Consequently, soil erosion control practices and use of conservation tillage systems are being encouraged. However, several recent studies have indicated that soluble P concentrations and losses increase with conservation tillage systems because of generally shallower fertilizer incorporation and release of P from unincorporated crop residues. This, coupled with the potential for greater than normal runoff with conservation tillage systems, because of an abundance of slowly permeable soils in the watershed, might mitigate some or all of the sediment P reduction benefits associated with conservation tillage. Consequently, we hypothesized that for somewhat poorly drained soils, best P practices may require both soil erosion control measures and subsurface placement of P fertilizer. The deeper placement would put the fertilizer P below the critical surface-water soil interface and mixing zone (approximately the top 1 inch of soil). Other research has indicated that injecting fertilizer P prevented losses of dissolved and sediment available P. Deeper P placement also might benefit crop yield because of better positional location for root uptake during dry surface soil conditions.

The objective of this study was to evaluate the effects of different tillage and P fertilization practices on P losses in runoff water for an imperfectly drained soil.

Procedures

The study was conducted at the east-central Kansas Experiment Field, Ottawa, on a 1.0 to 1.5 % slope, somewhat poorly drained, Woodson silt loam soil (fine, montmorillonitic, thermic, Abruptic Argiaquolls). This site represents prime farmland in this region of Kansas. The study was a randomized, complete block, split-plot design with tillage systems as whole plots and fertilizer treatments as subplots. All treatments were replicated three times. The tillage systems evaluated were chisel-disc-field cultivate (chisel in the fall, disc in the early spring and field cultivation immediately prior to planting); ridge-till (with ridges formed in the fall); and no-till. These tillage systems were established 5 years prior to the start of this study. Superimposed over these tillage systems were three P fertilizer treatments, a P check with no P fertilizer applied, 50 lb/a P_2O_5 surface broadcast, and 50 lb/a P_2O_5 deep-banded (coulter-knifed) at approximately 4-inch depth on 15-inch centers. This rate of P application was for two crops, grain sorghum and the following year's soybean crop. Every-other-year grain sorghum/soybean rotations are common in the watershed. Bray P-1 soil test P at the start of this study was in the medium to high range. Liquid 7-21-7 fertilizer was the source of P for all P fertilizer applications. Surface broadcast P in the chisel-disc-field cultivate system was incorporated with the field cultivation before planting. All runoff data were collected in the sorghum year of the crop rotation on the previous year's soybean stubble. Runoffs from five events in 1994, five events in 1995, and six events in 1996, spanning the period before and after P fertilizer application and grain sorghum planting, were collected. This period is considered most susceptible to erosion and P losses. Runoff water from natural rainfall was collected by delimiting 50 square foot areas (5 ft x 10 ft) with metal frames driven approximately 3 inches deep into the ground in each 10 x 50 ft plot. The runoff from within these frames was directed to a sump and then pumped though a series of dividers (five spitters) to reduce the volume and to obtain a composite sample. The volume of runoff from the splitter outlet in which the sample container had not run over was collected and measured. This volume and the splitter calibration factor for that outlet (which was determined by running a known volume of water through the spitter) were used to determine the total amount of runoff volume. Sediment concentration and losses, total P (perchloric acid digestion of unfiltered runoff samples), and soluble P (filtrate from samples through 45 um filters) concentrations and losses in the runoff water were measured in all years. Beginning in 1995, we also analyzed runoff water for bioavailable P (FeO-strip extractable P). This is a relatively new analytical procedure that has been correlated with algae-useable P. Rainfall amounts and dates on which runoff were collected in 1994 were: 0.70 (5-6-94), 2.05 (6-5-94), 1.30 (7-1-94), 1.60 (7-18-94), and 1.10 inches (8-1-94); in 1995: 0.80 (7-4-95), 1.94 (7-20-95), 1.68 (7-31-95), 0.72 (8-3-95), and 1.10 inches (8-15-95); and in 1996 1.75 (5-26-96), 2.45 (6-06-96), 2.02 (6-16-96), 1.85 (7-04-96), 1.28 (7-08-96), and 2.04 inches (7-22-96). According to long-term rainfall information, rainfall amounts were 20% below average during the 1994 sampling period, 20% above average during the 1995 sampling period, and 38% above average during the 1996 sampling period. The P fertilizer treatments were applied on 21 June 1994, 11 July 1995, and 21 June 1996. Pioneer 8310 grain sorghum was planted in

1994 and 1995, and Pioneer 8500 grain sorghum in 1996.

Results

For brevity of reporting, all data, except for soluble P data for 1995, will be presented as totals of sampling years or as averages over period of years.

Runoff Volume and Soil Loss

The amount of surface water that ran off varied with rainfall events, tillage systems, and years. Generally, most runoff occurred with the largest and most intense rainfall events. However, moisture and infiltration differences between tillage systems preceding the rainfall events also influenced runoff amounts. Runoff (Figure 1), when totaled across all 1994 samplings and averaged across all fertilizer treatments, was highest with the chisel-disc and ridge-till systems and lowest with no-till. In 1995, runoff was greatest with no-till and ridge-till and lowest with chisel-disc. This was because tillage in the chisel-disc system dried and loosened the soil prior to rainfall events, which increased infiltration and reduced runoff. In 1996, with above-average rainfall, the ridge-till system had the most runoff. These yearly differences in runoff suggest that rainfall timing, intensities, and amounts, as well as differences in infiltration within the tillage systems preceding the rainfall events, interact to affect runoff. When averaged across all sampling years (16 runoff events), the amount of runoff was 18% of the total rainfall received for the chisel-disc system, 21% for the ridge-till system, and 18% for the no-till system, suggesting no significant decrease in runoff volume with conservation tillage compared to chisel-disc for this imperfectly drained soil. This differs from runoff reductions of up to 50% and more reported with conservation tillage systems in other studies.

Soil losses in the runoff water (Figure 2) generally paralleled runoff amounts, but intensity and timing of individual rainfall events also influenced losses. Overall, soil losses in the runoff water were greatest in 1996, when rainfall and runoff amounts were highest. Sediment losses generally followed the pattern chisel-disc > ridge-till > no-till, suggesting that full-width soil loosing and residue incorporation result in greater soil losses than partial (shaving of the ridge at planting in the ridge-till system) or very limited soil and residue disturbance (coulter at planting in no-till). Averaged across all runoff events and years, soil losses for these pre- and post-plant periods were 0.76 ton/a for the chisel-disc system, 0.48 ton/a for the ridge-till system, and 0.25 ton/a for the no-till system. These are roughly 40 and 70% reductions in soil loss , respectively, for the ridge-till and no-till tillage systems, compared to the chisel-disc system. Although these amounts are for only a part of the crop year, all are below the T (tolerance) level of 4 ton/a for this soil.

Phosphorus Losses

Phosphorus losses were influenced by rainfall events, tillage system, fertilizer practices and years. In 1995, a statistically significant interaction (0.05 level) between tillage systems and P fertilization practices affected soluble and bioavailable P losses. Consequently, main effects of tillage and fertilizer practices for soluble and bioavailable P losses are presented jointly. Total P losses when summed across all runoff events for 1994 (Figure 3) were highest with the ridge-till and chisel-disc systems and lowest for no-till. These differences generally paralleled soil losses. In 1995, losses of total P were reduced and were higher with no-till and ridge-till compared to chisel-disc. This was because of less runoff volume in the chisel-disc system, resulting in lower soil and total P losses. Total P losses in 1996 were highest with chisel-disc, intermediate for ridge-till, and lowest for no-till. This corresponds again with the amount of soil loss. The effects of the P fertilizer practices on losses of total P were not statistically significant for any year (data not shown). However, some evidence indicated that surface applied P may have been causing some increase in total P losses.

Losses of soluble P were not affected by the tillage and P fertilizer treatments in 1994. In 1995, losses of soluble P varied across tillage systems and interacted with P fertilizer treatments (Table 1). The first event after P application in 1994 resulted in only 0.01 inch of runoff, whereas the first event after P application in 1995 produced 0.40 inches of runoff. Also, in 1994, 0.03 inches of rain fell between P application and the first runoff. In 1995, no measurable rainfall occurred between P application and the first runoff. In 1996, two showers (0.07 and 0.24 inches) occurred between P application and the first event which produced 0.31 inch of runoff. In 1996, as in 1995, both tillage and P fertilizer treatments caused significant differences in soluble and bioavailable P losses, but no significant interaction between tillage systems and fertilizer treatments affected P losses in 1996. Soluble P losses averaged across all years and across all runoff events are shown in Figure 4. In the chisel-disc system, where broadcast P was incorporated by field cultivation before planting, increased losses of soluble P were negligible compared to those with no P fertilizer application. In the ridge-till system, where the broadcast P fertilizer was applied on the soil surface and was covered partially by the shaving of the ridge at planting, losses of soluble P increased moderately compared to no P fertilizer application. In the no-till system, where nearly all the broadcast P was left exposed on the soil surface, soluble P losses increased nearly sevenfold compared to no P fertilizer applied. Knifed P, on the other hand, had negligible effects on increased soluble P losses compared to no P application in all tillage systems. The 1995 soluble P data (Table 1) also show that the losses of soluble P in runoff for no-till and ridge-till were highest for broadcast P in the first event after P application and diminished with successive runoff events.

Because losses of soluble P and total P in runoff do not exclusively indicate algae-useable P, bioavailable P tests for algae-useable P in runoff water have been developed. Comparisons of the FeO-strip bioavailable P losses (Figure 5) with total P and soluble P losses (Figures 3 and 4) show a strong relationship with soluble P losses. This suggests that for this soil type and landscape, substantial bioavailable P losses were associated with soluble P losses.

Grain Yield

Grain yield in 1994 was not affected by tillage or the P fertilizer treatments. In 1995, with grain sorghum planting delayed by a wet spring, dry weather during grain fill, and an early freeze, no-till yield averaged 4 bu/a better than yields of the other tillage systems, and deep-banded P (knifed P) increased yield by 6 bu/a compared to broadcast P (data not shown). As of this writing, the 1996 sorghum crop has not yet been harvested.

Conclusions

These data suggest that on minimum slope, imperfectly drained soils, conservation tillage systems, especially no-till, can reduce soil and sediment forms of P losses but can have quite variable effects on soluble and bioavailable (algae-useable) P losses depending on how the P fertilizer is applied. If P fertilizer is broadcast and left on the surface of the soil, then the chance for losses of soluble P is increased. If the P fertilizer is subsurface applied, then soluble P losses are minimal compared to those with no P fertilizer application. Our work also suggests that switching from full-width tillage systems like chisel-disc-field cultivate to conservation tillage systems must be accompanied by practices that place P fertilizers below the soil surface, or algae-useable P (bioavailable P) in runoff actually may increase.

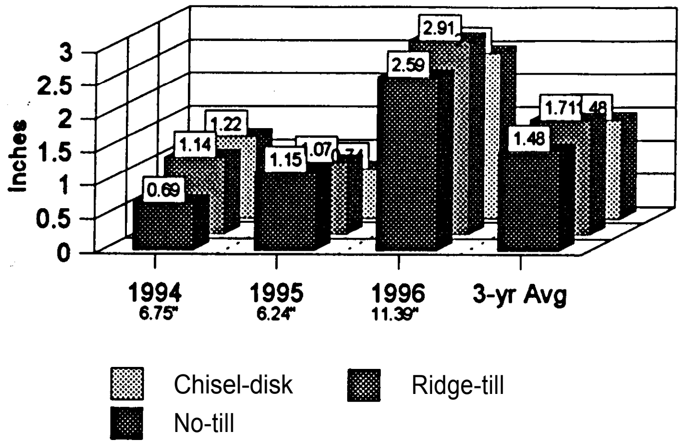


Figure 1. Amount of runoff as influenced by tillage and rainfall in 3 years, Ottawa, KS.

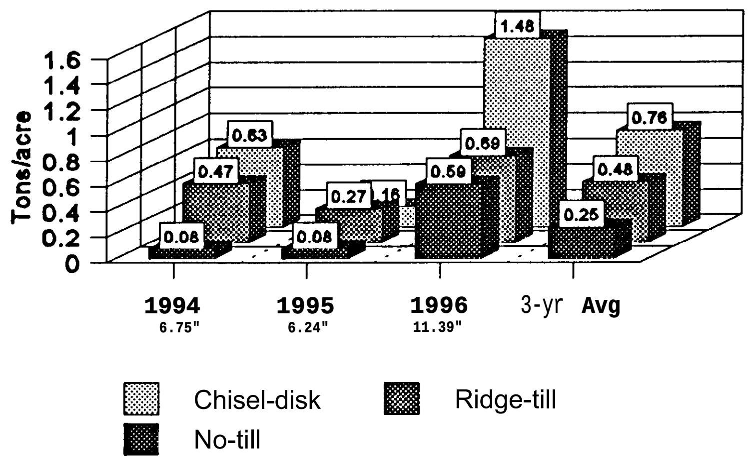


Figure 2. Soil losses as influenced by tillage and rainfall in 3 years, Ottawa, KS.

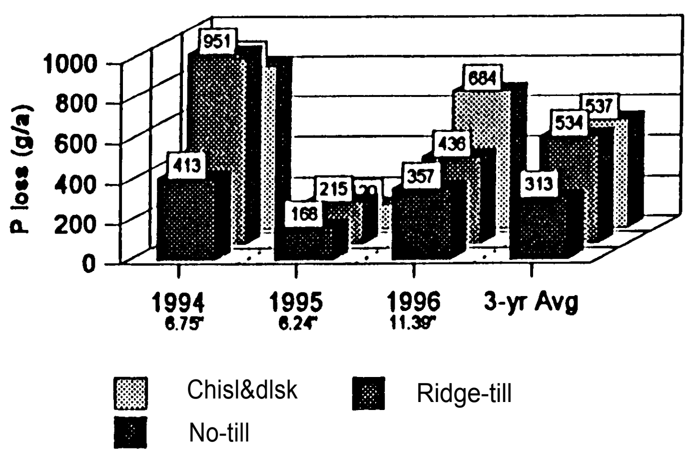


Figure 3. Total P losses as influenced by tillage and rainfall in 3 years, Ottawa, KS.

Table 1. Soluble P losses in surface water runoff as influenced by tillage and P rate/placement, Ottawa, KS.

		Date of Runoff Water Collection and Rainfall Amount					
		7-4-95	7-20-95	7-31-95	8-3-95	8-15-95	
Tillage System	Fertilizer Tmt.	0.80"	1.94"	1.68"	0.72"	1.10"	'95 Total
		g / a					
Chisel-disc, fld. cult.	P Check	0.0	2.9	2.2	1.4	0.4	6.8
Chisel-disc, fld. cult.	50 lb/a P_2O_5 BC	0.0	3.8	4.5	2.5	0.3	11.0
Chisel-disc, fld. cult.	50 lb/a P_2O_5 KN	0.0	1.7	2.3	0.7	0.3	5.1
Ridge-till	P Check	0.4	8.6	4.0	2.3	0.5	15.8
Ridge-till	50 lb/a P_2O_5 BC	0.7	45.7	10.6	8.7	1.7	67.4
Ridge-till	50 lb/a P_2O_5 KN	0.4	7.5	5.4	2.3	0.7	16.3
No-till	P Check	0.4	9.4	2.7	1.3	0.2	14.0
No-till	50 lb/a P_2O_5 BC	1.0	129.5	20.6	57.6	2.1	210.7
No-till	50 lb/a P_2O_5 KN	0.5	10.7	4.6	3.1	0.4	19.2
LSD (0.05)		0.8	33.0	5.1	7.7	1.2	33.9

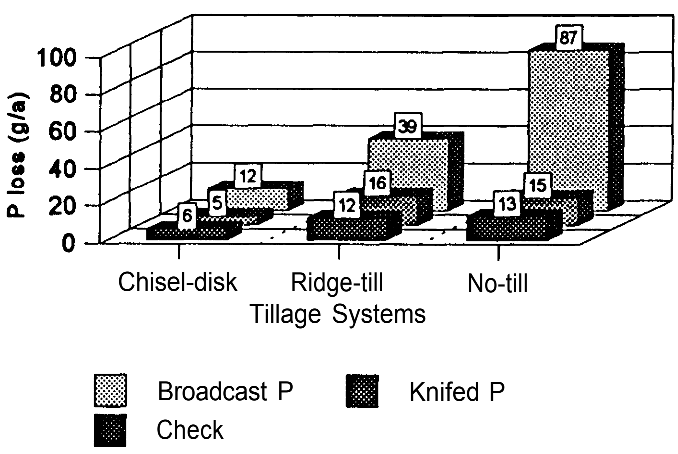


Figure 4. Soluble P losses as influenced by tillage and P rate/placement (3-year average), Ottawa, KS.

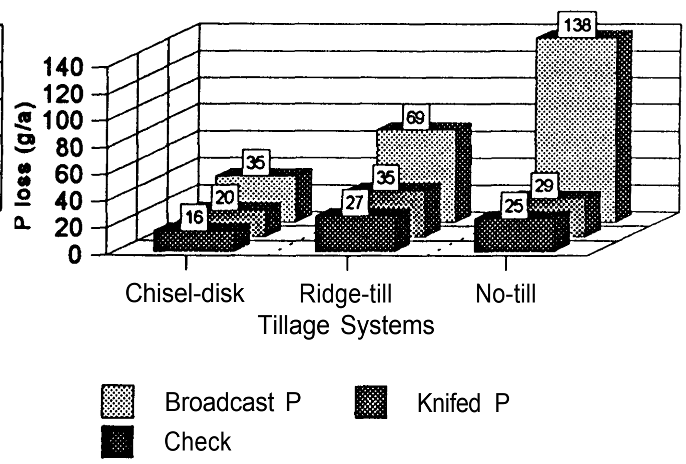


Figure 5. FeO-strip bioavailable P losses as influenced by tillage and P rate/placement (2-year average), Ottawa, KS.

SOIL FERTILITY RESEARCH
NORTH CENTRAL EXPERIMENT FIELDS

AMISORB EVALUATION FOR CORN AND GRAIN SORGHUM PRODUCTION

W.B. Gordon

Summary

Amisorb applied at 2 qt/a with starter fertilizer (30 lb N and 30 lb P_2O_5) applied 2 inches to the side and 2 inches below the seed at planting increased early season growth; nutrient uptake; and yield of irrigated, ridge-tilled corn. Amisorb did not affect growth, nutrient uptake, or yield of dryland grain sorghum.

Introduction

Amisorb (polyaspartate) is a new product offered by Amilar International. Company literature states that polyaspartate works to artificially increase the area occupied by plant roots which results in greater availability of mineral nutrients to the plants. These field experiments were designed to evaluate the potential of Amisorb to increase nutrient uptake and yield of corn and grain sorghum.

Procedures

The irrigated corn experiment was established on a Crete silt loam soil at the Irrigation Experiment Field, Scandia. The grain sorghum experiment was conducted at the North Central Kansas Experiment Field, Belleville. The corn experiment was ridged-tilled. The grain sorghum experiment was conducted under dryland, no-tilled conditions. Treatments in both experiments consisted of a no starter check, 30 lb of N and 30 lb P_2O_5, 30 lb N and 30 lb/a P_2O_5 plus 1 qt of Amisorb, and 30 lb N and 30 lb P_2O_5 plus 2qt of Amisorb. This is the rate recommend by the manufacturer. Starter fertilizer was applied 2 inches to the side and 2 inches below the seed at planting. Liquid ammonium polyphosphate (10-34-0) and urea-ammonium nitrate solution (28% UAN) were used as the starter fertilizer sources. Nitrogen as anhydrous ammonia was knifed immediately after planting to bring all corn plots to a total of 180 lb/a and grain sorghum plots to a total of 120 lb/a. Analysis by the KSU Soil Testing Lab showed that initial soil pH (April 1996) was 6.5, organic matter was 2.4%, Bray-1 P was 45 ppm, and exchangeable K was 400 ppm in the top 6 inches of soil. The corn hybrid Pioneer 3225 was planted on 22 April, and the grain sorghum hybrid Pioneer 8500 was planted on 6 June.

Results

Growing condition in 1996 were good, and yields of both corn and grain sorghum were above average. Starter fertilizer increased corn grain yield by 22 bu/a over that of the no-starter check (Table 1). Addition of Amisorb at the 1 qt/a rate did not increase yields or nutrient uptake over the starter-alone treatment. Addition of 2 qt/a Amisorb to the starter fertilizer mix gave increased dry matter production and nutrient uptake at the 6-leaf stage and resulted in a 13 bu/a yield increase over the starter alone- treatment.

Starter fertilizer increased growth and nutrient uptake at the 6-leaf stage and yields of grain sorghum compared to the no-starter check (Table 2). The addition of Amisorb to the starter fertilizer mix at either the 1 or 2 qt/a rate did not improve dry matter production, nutrient uptake, or yield of grain sorghum over the starter-alone treatment.

Table 1. Starter fertilizer and Amisorb® effects on 6-leaf stage whole plant dry matter, nutrient uptake, and grain yield of irrigated, ridged-tilled corn, Scandia, KS, 1996.

Treatment	Yield	Whole Plant Dry Weight	6-Leaf Stage N Uptake	P Uptake
	bu/a	--------------------lb/a----------------------		
No starter	191	229	5.2	0.5
30 lb N, 30 lb P_2O_5/a	213	366	10.0	1.3
30 lb N, 30 lb P_2O_5 + 1qt Amisorb/a	213	358	10.0	1.3
30 lb N, 30 lb P_2O_5 + 2 qt Amisorb/a	226	388	10.6	1.6
LSD (0.05)	12	21	0.5	0.2

Table 2. Starter fertilizer and Amisorb effects on 6-leaf whole plant dry matter, nutrient uptake and yield of no-tillage, dryland, grain sorghum, Belleville, KS, 1996.

Treatment	Yield	Whole Plant Dry Weight	6-Leaf Stage N uptake	P Uptake
	bu/a	--------------------lb/a---------------------		
No starter	136	356	7.4	0.8
30 lb N, 30 lb P_2O_5/a	156	508	14.9	1.4
30 lb N, 30 lb P_2O_5 + 1qt Amisorb/a	156	486	14.4	1.3
30 lb N, 30 lb P_2O_5 + 2qt Amisorb/a	155	502	14.6	1.3
LSD (0.05)	11	24	0.6	0.2

STARTER FERTILIZER INTERACTIONS WITH CORN AND GRAIN SORGHUM HYBRIDS

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

Summary

Two studies evaluated starter fertilizer application on corn and grain sorghum hybrids grown in a dryland, no-tillage production system on a soil high in available phosphorus (P). Treatments consisted of 12 corn or 12 grain sorghum hybrids grown with or without starter fertilizer. Starter fertilizer (30 lb N and 30 lb/acre P_2O_5) was applied 2 inches to the side and 2 inches below the seed at planting. In both the corn and grain sorghum tests, starter fertilizer improved growth of all hybrids at the 6-leaf stage of growth. Whole plant N and P uptakes at the 6-leaf stage also were improved by the use of starter fertilizer. Starter fertilizer improved grain yield of some corn and grain hybrids yields but had no effect of the yield of other hybrids.

Introduction

Maintenance of ground cover from crop residue to control soil erosion has become an important factor in crop production in Kansas. No-tillage systems have been shown to be effective in maintaining crop residues and reducing soil erosion losses. Early-season plant growth and yield can be poorer in no-tillage systems than in conventional systems. The large amount of surface residue maintained with no-tillage systems can reduce seed-zone temperature. Lower than optimum soil temperature can reduce the availability of nutrients. However, starter fertilizers can be applied to place nutrients within the rooting zone of young seedlings for better availability. Corn and grain sorghum hybrids may differ in rooting characteristics and availability to extract and use nutrients. These studies evaluate the differential responses of corn and grain sorghum hybrids to starter fertilizer.

Procedures

These field studies were conducted at the North Central Kansas Experiment Field near Belleville on a Crete silt loam soil. Both the corn and grain sorghum tests were initiated in 1995. Analysis by the KSU Soil Testing Lab showed that in the corn experimental area, the initial soil pH was 6.1, organic matter content 2.4%, Bray-1 P 43 ppm, and exchangeable K 380 ppm in the surface 6 inches of soil. Analysis in the grain sorghum area showed that pH was 6.5, organic matter 2.5%, Bray-1 P 45 ppm, and exchangeable K 420 ppm. Both corn and grain sorghum test sites had been in no-tillage production systems for 3 years prior to the establishment of these studies. The experimental design for both studies was a randomized complete block with a split-plot arrangement. Whole plots were corn and grain sorghum hybrids. The split-plots consisted of starter or no starter fertilizer. Starter fertilizer (30 lb N and 30 lb P_2O_5/a) was applied 2 inches to the side and 2 inches below the seed at planting. Liquid ammonium polyphosphate (10-34-0) and urea-ammonium nitrate solution (28% UAN) were used as starter fertilizer sources. Nitrogen as anhydrous ammonia was knifed immediately after planting to bring all corn plots to a total of 180 lb/a and grain sorghum plots to a total of 120 lb/a. In 1996, corn was planted on 23 April, and grain sorghum was planted on 22 May.

Results

<u>Corn Experiment</u>

Starter fertilizer improved the early growth and nutrient uptake of all corn hybrids tested (Table 3). When averaged over hybrids, dry matter at the 6-leaf stage averaged 181 lbs/a without starter and 340 lb/a with starter.

Dryland corn in central Kansas is normally planted as early in April as possible, so that pollination occurs in June when temperatures are more moderate and moisture conditions are more favorable than in July, when conditions are normally hot and dry. Any practice that promotes earliness often increases yields. Starter fertilizer significantly decreased the number of days from emergence to mid-silk in Pioneer 3489, Pioneer 3346, Pioneer 3394, Cargill 7777, Dekalb 591, Northrup King 6330, and Northrup King 7333, but did not affect maturity in Pioneer 3563, Cargill 6327, Dekalb 626, Dekalb 646, and ICI 8599 (Table 4).

Starter fertilizer increased grain yield of some hybrids but had no effect on the yields of other hybrids (Table 4). The average yield increase from starter fertilizer for the 7 hybrids that responded was 18 bu/a.

Grain Sorghum Study

Starter fertilizer improved the early growth and nutrient uptake of all hybrids tested (Table 5). When averaged over hybrids, dry matter at the 6-leaf stage was 138 lb/a greater with starter than without starter. Starter fertilizer can be quite helpful in improving early-season growth in cool soils. In northern Kansas, there is a risk of an early frost occurring before the crop is mature. Starter fertilizer can hasten maturity and avoid late-season, low temperature damage. Starter fertilizer significantly reduced the number of days from emergence to mid-bloom in eight of the 12 hybrids tested (Table 6).

Starter fertilizer increased grain yield of some hybrids but had no effect on the yields of other hybrids (Table 6). The average yield increase from starter fertilizer for the eight hybrids that responded was 12 bu/a.

Table 3. Mean corn hybrid and starter fertilizer effects on whole-plant dry weight and N and P uptake at the 6-leaf stage of growth, Belleville, Kansas, 1996.

Hybrid	Dry Weight	N Uptake	P Uptake
	------------------------------lb/a--------------------------------		
Pioneer 3563	249	7.6	0.81
Pioneer 3489	258	8.0	0.98
Pioneer 3346	253	8.1	0.88
Pioneer 3394	285	8.7	0.91
Cargill 6327	275	8.4	0.89
Cargill 7777	290	9.1	0.84
Dekalb 591	241	7.7	0.79
Dekalb 626	270	8.4	0.92
Dekalb 646	236	7.6	0.79
Northrup King 7333	295	8.6	0.96
Northrup King 6330	248	7.8	0.78
ICI 8599	229	7.0	0.77
LSD (0.05)	19	0.5	0.06
Starter			
With	181	10.6	1.18
Without	340	5.6	0.55
LSD(0.05)	26	0.9	0.09

Table 4. Starter fertilizer effects on grain yield and number of days from emergence to mid silk of corn hybrids, Belleville, KS.

Hybrid	Starter	Yield 1996	Yield 1995-1996	Number of Days to Mid-silk, 1996
		bu/a		
Pioneer 3563	With	136	116	71
	Without	135	115	71
Pioneer 3489	With	147	142	76
	Without	120	119	70
Pioneer 3346	With	170	155	77
	Without	148	132	72
Pioneer 3394	With	179	160	78
	Without	165	142	74
Cargill 6327	With	176	137	76
	Without	175	137	75
Cargill 7777	With	200	177	79
	Without	178	166	73
Dekalb 591	With	163	156	75
	Without	144	135	71
Dekalb 626	With	167	136	76
	Without	167	135	77
Dekalb 646	With	150	137	79
	Without	149	136	79
Northrup King 7333	With	174	141	73
	Without	156	121	78
Northrup King 6330	With	168	156	72
	Without	153	137	75
ICI 8599	With	132	120	75
	Without	132	120	75
Hybrid X Starter LSD(0.05)		6	8	2

Table 5. Mean grain sorghum hybrid and starter fertilizer effects on whole-plant dry weight and N and P uptake at the 6-leaf stage of growth, Belleville, KS, 1996.

Hybrid and Treatment	Dry Weight	N Uptake	P Uptake
	----------------------------------	lb/a	----------------------------------
Pioneer 8699	286	9.2	0.98
Pioneer 8505	289	9.0	1.02
Pioneer 8310	251	8.4	0.96
Dekalb 48	356	11.2	1.29
Dekalb 40Y	354	11.8	1.46
Dekalb 39Y	268	9.1	1.06
Dekalb 51	260	8.5	1.04
Dekalb 55	294	9.1	1.13
Pioneer 8522Y	346	10.9	1.28
Northrup King KS 383Y	295	9.9	1.06
Northrup King KS 524	279	9.4	1.04
Northrup King KS 735	263	8.7	1.03
LSD(0.05)	21	NS*	NS
Starter			
With	364	7.1	0.84
Without	226	12.1	1.39
LSD(0.05)	26	0.8	0.50

*Not significant at the 0.05 level of probability.

Table 6. Starter fertilizer effects on grain yield and number of days from emergence to mid-bloom of grain sorghum hybrids, Belleville, KS.

Hybrid	Starter	Yield 1996	Yield 1995-1996	Number of Days to Mid-bloom, 1996
		---bu/a---		
Pioneer 8699	With	133	110	55
	Without	133	109	56
Pioneer 8505	With	174	138	55
	Without	157	119	59
Pioneer 8310	With	166	122	64
	Without	150	105	67
Dekalb 48	With	170	124	61
	Without	158	109	66
Dekalb 40Y	With	155	121	62
	Without	141	101	68
Dekalb 39Y	With	121	97	60
	Without	121	145	61
Dekalb 51	With	164	127	61
	Without	149	105	66
Dekalb 55	With	179	121	64
	Without	167	105	69
Pioneer 8522Y	With	164	122	62
	Without	153	108	68
Northrup King KS 383Y	With	141	113	60
	Without	140	112	61
Northrup King KS 524	With	150	120	59
	Without	141	107	64
Northrup King KS 735	With	154	116	63
	Without	153	115	64
Hybrid X Starter LSD (0.05)		8	9	2

CORN HYBRID RESPONSE TO STARTER FERTILIZER COMBINATIONS IN A LIMITED IRRIGATION, RIDGE-TILL, PRODUCTION SYSTEM

W.B. Gordon and G. M. Pierzynski

Summary

In previous research conducted at the North Central Kansas Experiment Field, we found some corn hybrids grown under reduced tillage conditions respond to starter fertilizer containing N and P, and others do not. Little information is available concerning variability in starter responsiveness among corn hybrids for starters containing a complete complement of nutrients. This study evaluated the responses of four corn hybrids (Pioneer 3563, Pioneer 3346, Dekalb 591, and Dekalb 646) to starter fertilizer containing nitrogen (N), phosphorus (P), potassium (K), sulfur (S), and zinc (Zn). The experiment was conducted on a Carr sandy loam soil in the Republican River Valley near Scandia. Two hybrids (Pioneer 3563 and Dekalb 646) did not respond to starter fertilizer, regardless of composition. Starter fertilizer containing N and P increased early season dry weight and yield of Pioneer 3346 and Dekalb 591. The addition of 10 lb/a S to the starter fertilizer mix resulted in additional increases in early season dry weight and grain yield for Pioneer 3346 and Dekalb 591. The addition of K and Zn to the starter fertilizer did not result in additional benefit.

Introduction

Early season growth is often poorer in conservation tillage systems than in conventionally tilled systems. Cool soil temperature at planting time can reduce nutrient uptake of corn. Placing fertilizer in close proximity to the seed at planting time can alleviate detrimental effects of cool soil temperatures on plant growth and development. In previous research done at the North Central Kansas Experiment Field, we found some corn hybrids respond well to application of starter fertilizer, whereas others do not. Those experiments were conducted using starters containing only N and P. This study evaluates the response of four corn hybrids to starter fertilizers containing combinations of N, P, K, S, and Zn.

Procedures

This field study was conducted on a farmers field in the Republican River Valley near Scandia on a Carr sandy loam soil. Analysis by the KSU Soil Testing Lab showed initial soil pH was 7.2, organic matter 1%, Bray-1 P 21 ppm, and exchangeable K 280 ppm in the surface 6 inches of soil. The site had been ridge-till for 4 years prior to establishment of this study. Hybrids used in the experiment were Pioneer 3563, Pioneer 3346, Dekalb 591, and Dekalb 646. Liquid fertilizer treatments were: 30 lb N, 30 lb P_2O_5/a; 30 lb N, 30 lb P_2O_5, 20 lb K_2O/a; 30 lb N, 30 lb P_2O_5, 10 lb S/a; 30 lb N, 30 lb P_2O_5, 1 lb Zn/a; and 30 lb N, 30 lb P_2O_5, 20 lb K_2O, 10 lb S, 1 lb Zn/a. A no-starter check plot was included. Starter fertilizer was applied 2 inches to the side and 2 inches below the seed at planting. Corn was planted on 23 April 1996.

Results

Starter fertilizer containing N and P improved early season dry matter production of all hybrids (Table 7). Additional response was achieved with addition of S to the starter fertilizer mix. Addition of K and Zn did not result in additional dry matter production at the 6-leaf stage. Two hybrids (Pioneer 3563 and Dekalb 646) did not show yield response to starter fertilizer (Table 8), consistent with previous research. Starter fertilizer containing N and P increased grain yield of Pioneer 3346 and Dekalb 591. Addition of S to the starter mix resulted in additional yield increase over N and P alone for these two hybrids. Addition of K and Zn did not increase yields.

Table 7. Starter fertilizer combinations effect on 6-leaf stage dry matter accumulation of corn hybrids, Scandia, KS, 1996.

Hybrid and Starter Combination	6-Leaf Stage Dry Weight
	lb/a
Pioneer 3563	355
Pioneer 3346	408
Dekalb 591	393
Dekalb 646	421
LSD(0.05)	26
No Starter	152
30 lb N, 30 lb P_2O_5/a	409
30 lb N, 30 lb P_2O_5, 20 lb K_2O/a	406
30 lb N, 30 lb P_2O_5, 10 lb S/a	500
30 lb N, 30 lb P_2O_5, 1 lb Zn/a	402
30 lb N, 30 lb P_2O_5, 20 lb K_2O, 10lb S, 1 lb Zn/a	501
LSD(0.05)	32

Table 8. Starter fertilizer combinations effects on grain yield of corn hybrids, Scandia, KS, 1996.

Hybrid	Starter Combination	Yield
		bu/a
Pioneer 3563	No Starter	221
	30 lb N, 30 lb P_2O_5	223
	30 lb N, 30 lb P_2O_5, 20 lb K_2O/a	222
	30 lb N, 30 lb P_2O_5, 10 lb S/a	220
	30 lb N, 30 lb P_2O_5, 1 lb Zn/a	220
	30 lb N, 30lb P_2O_5, 20 lb K_2O, 10 lb S, 1 In Zn/a	221
Pioneer 3346	No Starter	153
	30 lb N, 30 lb P_2O_5/a	207
	30 lb N, 30 lb P_2O_5, 20 lb K_2O/a	207
	30 lb N, 30 lb P_2O_5, 10 lb S/a	225
	30 lb N, 30 lb P_2O_5, 1 lb Zn/a	209
	30 lb N, 30 lb P_2O_5, 20 lb K_2O, 10 lb S, 1 lb Zn/a	228
Dekalb 591	No Starter	165
	30 lb N, 30 lb P_2O_5/a	215
	30 lb N, 30 lb P_2O_5, 20 lb K_2O/a	213
	30 lb N, 30 lb P_2O_5, 10 lb S/a	229
	30 lb N, 30 lb P_2O_5, 1 lb Zn/a	215
	30 lb N 30 lb P_2O_5, 20 lb K_2O, 10 lb S, 1 lb Zn/a	229
Dekalb 646	No Starter	201
	30 lb N, 30 lb P_2O_5/a	204
	30 lb N, 30 lb P_2O_5, 20 lb K_2O/a	203
	30 lb N, 30 lb P_2O_5, 10 lb S/a	205
	30 lb N, 30 lb P_2O_5, 1 lb Zn/a	207
	30 lb N, 30 lb P_2O_5, 20 lb K_2O, 10 lb S, 1 lb Zn/a	202
Hybrid x Starter LSD(0.05)		9

SOIL FERTILITY RESEARCH
SOUTH CENTRAL EXPERIMENT FIELD

GRAIN YIELD IN CONTINUOUS WHEAT AND ALTERNATIVE CROP ROTATIONS IN SOUTH CENTRAL KANSAS AS AFFECTED BY NITROGEN RATE

W.F. Heer

Summary

Evaluation of nitrogen (N) rates on continuous winter wheat and in two crop rotations involving "alternative" crops for the area have been established at the South Central Field. The continuous winter wheat study was established in 1979. The first of the alternative rotations was established in 1986. This rotation involved corn followed by winter wheat followed by grain sorghum. This rotation was discontinued with the sorghum harvest of 1995. The second rotation (established in 1990) has soybeans replacing corn. Both rotations use no-till seeding into the previous crop's residue. The continuous wheat was revised to utilize both conventional and no-till production practices.

Long-Term Study of Nitrogen Rates in Continuous Wheat
Researchers: W.F. Heer and J.L. Havlin

Introduction

A long-term study of N rates was established on the South Central Kansas Experiment Field in the fall of 1979 and revised after the harvest of 1987 to include a tillage factor. The purpose of this study is to evaluate the yield response of continuous winter wheat to six rates of N and two tillage systems.

Procedures

The study was planted to oats in the spring of 1994. The use of an oat crop was necessary because of an infestation of cheat in 1993. The fertility rates were maintained, and the oats were harvested in July. Grain yields for the oats peaked at the 75 lb N rate, indicating that N was not the yield limiting factor. After the 1994 oat harvest, the conventional tillage subplots were plowed and disked as necessary to control weed growth until wheat was planted in October 1994. Rates of 25, 50, 75, 100, and 125 lb. N/a were applied using 34-0-0 as the N source with a Barber spreader prior to the last tillage on the conventional subplots and prior to seeding on the no-till subplots. A no-N check was included. The plots also received 40 lbs P_2O_5/a broadcast as 0-46-0. The plots then were cross seeded to Karl winter wheat at a rate of 60 lbs/a for conventional and 90 lbs/a for no-till.

Results

The results for 1995 were affected more by climatic conditions than any other factor (disease or weed pressures). The cool wet winter with lush growth was followed by a warm period. This then was followed by cold wet weather during seed setting and grain filling. The data (summarized by N rate in Table 1) reflect these conditions. The yield increases that occurred with increasing N rate did not materialize this year. The yields were up and down, with the lower N rates giving the highest yields. This is most likely the result of the stage of growth in those subplots being more advanced when the weather turned cold and wet. The no-till plots had greater yield reductions than the conventional treatments.

Rotation 1: Corn-Winter Wheat-Grain Sorghum Rotation with Six Nitrogen Rates
Researchers: W.F. Heer, J.L. Havlin, and D.L. Fjell

Research was initiated in 1986 at the South Central Experiment Field to (1) evaluate the production potential of no-tillage, dryland, short-season corn in a corn-winter wheat-grain sorghum rotation and (2) quantify the fertilizer N response for each crop in the rotation. Nitrogen rates of 0, 25, 50, 75, 100, 125 lb/a were used to allow for comparisons between this rotation and the continuous wheat study.

This rotation incorporated a short-season corn planted early into the normal wheat-sorghum-fallow rotations (the corn is planted into the sorghum stubble in the spring following sorghum harvest). The short-season corn matures early, allowing the soil profile water to be recharged (by normal late summer and early fall rains) prior to planting of wheat following corn.

Results

Corn

Corn grain yields increased with increasing N in all years of the study (Table 2). Lack of significant yield increases with higher N rates in 1987 reflect the presence of high residual N in the soil at the start of the study and the ideal growing season precipitation. As the residual soil N was removed by the cropping sequence, the higher N rates produced significantly greater corn yields than the control or the 25 and eventually (1993) the 50 lb/a N rates (Table 2). The moist warm conditions in 1988 were not ideal for corn, and thus, yields were suppressed when compared to 1987 and 1989 (Table 2). Corn yields in 1989 (Table 2) also reflect more timely precipitation and cooler growing-season temperatures compared to previous years. Insufficient precipitation during the fall and winter of 1989-90 resulted in a lack of a soil moisture recharge. This lack of soil moisture coupled with the hot dry conditions in May through July of 1990 were less than ideal for grain formation in corn. Therefore, the corn crop was harvested for silage, and the yields are reported in tons/a on a dry matter basis. Lack of moisture and high temperatures also resulted in the corn being harvested for silage yields in 1991.

More favorable moisture conditions returned in 1992 and 1993. However, temperatures were lower than average in the early spring. This led to delayed development in the corn, which is reflected in the 1992 yields. The yields reported for 1993 show the effects of both the cooler temperatures and lack of herbicide efficacy. In 1994, a late April freeze (April 28) and an extended cold period delayed corn growth and severely reduced stands. Therefore, the yield data for 1994 are not included in this report. The corn yields in the rotation have consistently been slightly lower than those of the same variety in the corn variety test at the South Central Field. In 1995, the rotation was terminated, and the land area converted to a cover crop by nitrogen study. The corn plots received a uniform application of nitrogen (except for the 0N treatments). They then were planted to corn. The corn did not survive the late April freeze, so the plots were planted to grain sorghum.

Grain Sorghum

The 1987 growing season was such that grain sorghum reflected the differences in N from the zero to the 50 lb rate and the three highest rates compared to the zero and 25 lb rates. A favorable growing season for grain sorghum (moist and warm) in 1988 produced an excellent crop with no significant yield differences among N rates (Table 3). Conditions in 1989, though favorable for corn production, caused somewhat reduced yields in the grain sorghum. Significant differences in yield occurred among N rates.

The effects of the dry conditions can be seen in the yields for sorghum in 1990, which were similar to those from the KSU variety test for grain sorghum. These dry conditions carried over into the 1991 growing season and resulted in sorghum yields that were too insignificant to be included in the results.

More favorable conditions returned in 1992 and 1993. Sorghum growth was delayed in 1992 by the cool temperatures in late spring and early summer temperatures. Flowering was delayed until mid August, and yields reported were much better than expected. The 1992 and 1993 yields also reflect the depletion of soil N in the 0 N plots. The early growing season for sorghum in

1994 was favorable to plant growth. However, the hot dry August and September were not. The sorghum plants in the higher N treatments appeared to have insufficient soil water to meet their grain filling needs. Thus, yields were reduced in comparison to previous years. As with the corn plots, the sorghum plots received a uniform application of N (except for the 0N treatments) and were seeded to grain sorghum in preparation for the new research project. The data reflect that uniform application.

Wheat

Wheat yield increases with increasing N rates were observed in 1988 and 1990 (Table 4). The extremely dry conditions from planting through early May of 1989 caused the complete loss of the wheat crop in the rotation for that year. In 1988, 1990, 1991, 1992, and 1993, when timely precipitation occurred in both germination and spring regrowth periods, wheat yields following corn were comparable to those of wheat following wheat. Though not as apparent as with sorghum, the effect of reduction in soil N in the 0 N plots also can be seen in the yields. Wheat yields in 1994 show the benefits of the cool wet April and early June. Had it not been for these conditions occurring at the right time of the plants' development, yields would have been considerably less. Weather conditions were quite different for the 1995 wheat crop in the rotation. These conditions caused noticeable variability and reductions in yields when compared to 1994. However, the yields in the rotation were higher than those of continuous wheat. Also, the test weights for the wheat in the rotation averaged 60 lb/bu, whereas the average for the continuous wheat was only 53 lb/bu. This points out the necessity to use some type of rotation in the farming operation to produce high quality crops.

Other Observations

Nitrogen application significantly increased grain N contents in all crops. Grain phosphate levels did not seem to be affected by increased N rate.

Loss of the wheat crop after corn can occur in years when fall and winter moisture is limited. This loss has not occurred where continuous winter wheat is produced under the same N rates used in the rotation. Corn will have the potential to produce grain in favorable years (cool and moist) and silage in nonfavorable (hot and dry) years. In extremely dry summers, extremely low grain sorghum yields can occur.

The major weed control problem in the rotation is with the grasses. This was expected, and work is being done to determine the best herbicides and time of application to control grasses. Some new herbicides are being marketed that should aid in their control.

Rotation 2: Soybean-Winter Wheat-Grain Sorghum Rotation with Six Nitrogen Rates

Researchers: W.F. Heer and J.L. Havlin

Research was initiated in 1990 at the South Central Experiment Field to (1) evaluate the production potential of no-tillage, dryland, short-season soybeans in a soybean-winter wheat-grain sorghum rotation and (2) quantify the fertilizer N response for each crop in the rotation. Nitrogen rates of 0, 25, 50, 75, 100, 125 lb/a were used.

This rotation incorporated a short-season (group I) soybean for the fallow portion of the normal wheat-sorghum-fallow rotations. The soybeans should mature early enough to allow the soil profile water to be re-charged prior to planting of wheat following the soybean crop.

Results

Soybeans

The soybeans have been planted in late May each year. The plots that are planted into grain sorghum stubble are fertilized with 40 units of P_2O_5 placed in the furrow at planting. The variety Hardin was selected based on yield data from the Harvey County Experiment Field. Soybeans were first planted in 1991. This proved to be a less than ideal year for the production of dryland soybeans in the south central region of Kansas. The lack of timely precipitation resulted in very low yields (Table 5). The soybean season for 1992 proved to be the exact opposite of 1991. It was moist and cool with timely precipitation. Thus, yields were extremely good for this area of Kansas. The 1993 growing season started out to be a repeat of 1992. However, things changed in mid July, and July, August, and September were extremely dry. As expected, the early beans had already set their pods and were able to produce respectable yields as reported in Table 5. Seed N increased slightly. These increases were significant only at the higher N rates. Weather conditions in 1994 provided timely rains for the production of soybeans. The above-normal precipitation in April provided excellent soil moisture at planting (early May). The cool wet July (above-normal precipitation) and warm temperatures in August allowed for excellent yields from the group I soybeans. As with the other crops, 1995 was not a kind year to the soybean. Cool wet conditions delayed planting. Early plant growth also was slowed by the cold weather conditions. This resulted in plants that were shorter than in previous years and behind in the normal stage of growth when the weather turned hot and dry in late July and early August. These conditions are reflected in the low seed yields for the 1995 crop, about one-half those of previous years. Seed N and P_2O_5 percents were not affected by previous crop N applications.

Grain Sorghum

The grain sorghum is planted at the same time for both the corn-wheat-grain sorghum and soybean-wheat-grain sorghum rotations. The grain sorghum in the soybean rotation did make it through the adverse season in 1991, when it also failed in the corn rotation. However, in the soybean rotation, the plots seeded to sorghum were following 2 years of wheat, because rotation had not cycled sufficient times to show the effects of the two previous crops in the rotation on the third. In 1992 and 1993, when sorghum followed wheat that had followed soybeans, the grain yields for sorghum were similar to those for sorghum in the corn rotation (Table 6). Seed N also increased with increasing N-rate. Early season development of grain sorghum was excellent in 1994. This again was due to the moisture and temperatures in June and July. However, the hot dry conditions in August and September are reflected in reduced yields for 1994 compared to 1993. These conditions also lead to no significant differences in grain yield by N rate for the 1994 grain sorghum. The grain sorghum crop seems to have been the least affected by the weather conditions of 1995. Even though it got off to a slow start because of the cool conditions and late planting, the hot dry July and August allowed it to proceed and be mature before the early freeze in mid-September. Yields at the 0-N rate were lower than last year, but yields for the other N rates were comparable to those of previous years. Percent N in the grain again increased with increasing N rate.

Wheat

Wheat yields also reflect the differences in N rate. However, when the wheat yields from the soybean rotation are compared with those from the corn rotation, the latter seem to show the effects of residual N from soybean production in the previous year. This is especially true for the 0 to 75 lb N rates in 1993 and the 0 to 125 lb rates in 1994 (Table 7). Yields in 1995 reflect the added N from the previous soybean crop with yield by N-rate increases similar to those of 1994. As the rotation continues to cycle, the differences at each N rate may stabilize after four to five cycles, with a potential to reduce fertilizer N applications by 25 to 50 lbs/a where wheat follows soybeans.

Table 1. Long-term effects of nitrogen rate, 1993-wheat, 1994-oats, 1995-wheat, Hutchinson, KS.

N	1993	1994	1995 Wheat		
Rate	Wheat	Oat	Test Wt.	Height	Yield
lb/a	bu/a	bu/a	lb/bu	in.	bu/a
0	14.9	29.2	57	32	21
25	17.0	53.3	55	35	20
50	15.7	60.6	54	37	20
75	21.0	72.4	54	37	23
100	18.5	71.2	51	38	19
125	15.1	69.6	50	37	17
$LSD^{*}_{(P=0.01)}$	5.2	12.4	1.0	3.0	0.15
$CV_{(\%)}$	22.3	13.0	3	5	8.03
CONV	28.5	58.0	53	38	2.18
N-T	5.57	61.0	54	34	2.29

* Unless two yields differ by at least the amount of the least significant difference (LSD), little confidence can be placed in one's being greater than the other.

Table 2. Effects of nitrogen on corn in a corn-wheat-sorghum rotation, Hutchinson, KS.

N	Yield							
Rate	1987	1988	1989	1990	1991	1992	1993	1994[1]
lb/a	- - - - - - - bu/a - - - - - -			- - - - t/a - - - -		- - - - - - - - bu/a - - - - - - -		
0	62	37	60	2.3	1.5	19	13	--
25	63	45	65	2.4	1.9	34	15	--
50	66	49	78	2.5	2.0	56	29	--
75	65	48	94	2.3	2.2	53	53	--
100	68	50	96	2.2	1.8	52	56	--
125	71	54	100	2.5	1.9	65	55	--
$LSD_{(0.01)}$	NS	7	12	NS	0.4	18	29	--
$CV_{(\%)}$	13	14	14	4	19	29	44	--

* Unless two yields in the same column differ by at least the least significant difference (LSD), little confidence can be placed in one being greater than the other.
1. 1994 yields are not reported because the first planting was damaged by the late April freeze.

Table 3. Effects of nitrogen on sorghum in a corn-wheat-sorghum rotation, Hutchinson, KS.

N	Yield								
Rate	1987	1988	1989	1990	1991	1992	1993	1994	1995
lb/a	bu/a								
0	50	82	66	29	--	66	76	82	70
25	57	82	61	36	--	87	91	97	98
50	69	80	69	35	--	98	106	89	98
75	73	83	71	39	--	101	106	88	101
100	75	81	72	35	--	99	106	77	96
125	76	80	74	36	--	102	96	83	96
$LSD_{(0.01)}$	10	NS	6	5	--	16	16	9	9
$CV_{(\%)}$	14	7	8	14	--	13	9	10	10

* Unless two yields in the same column differ by at least the least significant difference (LSD), little confidence can be placed in one being greater than the other.

Table 4. Effects of nitrogen on wheat in a corn-wheat-sorghum rotation, Hutchinson, KS.

N Rate	Yield						
	1988	1990	1991	1992	1993	1994	1995
lb/a	bu/a						
0	9	21	44	34	18	13	17
25	13	31	71	47	24	27	26
50	17	43	76	49	34	40	24
75	19	53	61	47	37	48	36
100	17	54	62	47	47	48	41
125	19	55	62	44	49	42	37
$LSD_{(0.01)}$	5	4	7	5	9	4	4
$CV_{(\%)}$	27	8	10	8	15	10	18

* Unless two yields in the same column differ by at least the least significant difference (LSD), little confidence can be placed in one being greater than the other.

Table 5. Effects of nitrogen on soybeans in a soybean-wheat-sorghum rotation, Hutchinson, KS.

N Rate	Yield 1991	1992	1993	1994	1995
lb/a	------------------		bu/a	-------------------	
0	5.8	53	31	26	12
25	5.4	50	32	26	10
50	5.3	52	31	24	11
75	5.3	51	30	27	11
100	5.8	51	28	26	12
125	5.7	53	29	28	11
$LSD_{(0.01)}$	NS	NS	4	3	NS
CV $_{(\%)}$	11	7	7	9	17

* Unless two yields in the same column differ by at least the least significant difference (LSD), little confidence can be placed in one being greater than the other.

Table 6. Effects of nitrogen on sorghum in a soybean-wheat- sorghum rotation, Hutchinson, KS.

N Rate	Yield 1991	1992	1993	1994	1995
lb/a	-------------------		bu/a	-------------------	
0	34	52	67	72	54
25	35	72	82	68	68
50	38	80	96	72	75
75	44	91	97	73	73
100	51	91	88	72	76
125	45	94	95	75	69
$LSD_{(0.01)}$	15	11	14	NS	7
CV $_{(\%)}$	21	7	9	12	11

* Unless two yields in the same column differ by at least the least significant difference (LSD), little confidence can be placed in one being greater than the other.

Table 7. Effects of nitrogen on wheat in a soybean-wheat-sorghum rotation, Hutchinson, KS.

N Rate	Yield				
	1991	1992	1993	1994	1995
lb/a	----------------		bu/a	----------------	---
0	51	31	24	23	19
25	55	36	34	37	26
50	55	37	41	47	34
75	52	37	46	49	37
100	51	35	45	50	39
125	54	36	46	52	37
$LSD_{(0.01)}$	NS	4	6	2	0.8
CV $_{(\%)}$	7	6	9	5	7

* Unless two yields in the same column differ by at least the least significant difference (LSD), little confidence can be placed in one being greater than the other.

ALFALFA YIELDS AS AFFECTED BY SEEDING-TIME APPLICATIONS OF NITROGEN UNDER NO-TILLAGE MANAGEMENT.

W. F. Heer, K.L. Roozeboom, and J.P. Shroyer

Summary

A tillage study with alfalfa seeded in wheat stubble was planted in the fall of 1990. Differences in dry matter production by tillage were observed in the first year of this study. However, these differences did not continue into the second and third years, indicating that tillage prior to seeding may affect dry matter yield in the year of establishment, but thereafter no yield differences should be realized from planting alfalfa into wheat stubble. A similar study was established in oat stubble in the fall of 1992. As with the wheat stubble study, this study was designed to evaluate stand establishment and yield under four tillage systems (conventional, disc, no-till burn, and no-till) prior to planting. Fall establishment of alfalfa was good in all tillage treatments. However, in the spring, the stand in the no-till plots appeared to be thinning out (a condition that had occurred in a previous planting). To evaluate this condition, a fourth study was established using only no-till practices with five alfalfa varieties and four rates of nitrogen (N) fertilizer at seeding time. Addition of N did not significantly affect dry matter yield. Desiccation of plants in the establishment year did not seem to occur.

Introduction

Considerable concern had been expressed regarding the effects of preplant tillage on establishment of alfalfa. To answer some of the questions, research using four preplant tillage factors was established at the South Central Experiment Field. The first of the studies was in wheat stubble, and the remaining three have been in oat stubble. Alfalfa was seeded in the fall of 1990 in an area where wheat had been harvested in the previous year. The following fall, a similar study was planted into a block of ground that was in oats the previous year. This study was abandoned because of stand losses in the no-till plots. It was replanted in a new area in 1992. The alfalfa in the no-till plots again showed signs of seedling loss. One possible cause for this was the lack of available soil nitrogen (N) because of decomposition of the oat straw. Thus, a fourth study to determine the effects of seeding time N on no-till establishment of alfalfa was started.

Procedures

A no-till study where alfalfa was seeded directly into oat stubble and then had N applied was started in the fall of 1994. The varieties used in the study were Kanza, Riley, Cody, KS 1002, and KS 1001. Nitrogen fertilizer rates of 50, 75, and 125 lb/a were applied at seeding time, and a no-N check was included.

Results

The alfalfa in the no-till plots (that seeded into standing oat stubble in the fall of 1992) showed signs of plant thinning and desiccation. However, sufficient stands persisted, and the data are presented in Table 8. Differences in yield by tillage present in the first cutting did not continue into the second and third cutting for 1993. The first cutting differences were sufficiently large to cause total yields by tillage for 1993 to be significantly different; the no-till burn treatment had the greatest yield. The wet April of 1994 resulted in no significant differences in yield by tillage for the first cutting that year. However, as the summer became hot and dry, yields were reduced and differences by tillage were apparent. By the end of the season, the no-till and offset disk treatments had the highest yields. Yield reductions in the fourth cutting in the no-till treatment after the extended dry period are quite possibly the effects of the earlier reported problem with stands in the no-till plots. In 1995, only three cuttings were taken from these plots because of a cold wet spring and the hot dry July and August. Differences in dry matter yield were realized only in the first cutting (Table 8). The offset disk treatment had a lower total yield than the other treatments. This is the same trend that was seen in the earlier study with alfalfa seeded into wheat stubble.

The study with varieties and N rates was cut twice for dry matter yield in 1995. The dry matter yields are summarized in Table 9. Addition of N at planting did not appear to significantly affect the dry matter yield. Yield for three of the varieties showed slight yield increases at the 125 lb/a N rate compared to the 0 lb/a N rate. The desiccation of plants in the establishment year did not seem to occur with this planting.

Table 8. Alfalfa establishment by tillage in oat stubble, Hutchinson, KS.

	Yield					
	1st[1]	2nd	3rd	1995	1994	1993
Treatment				Avg.	Avg.	Avg.
Tillage			tons/a[2]			
Offset disk	1.5	1.8	0.9	4.2	6.2	4.3
No-till	2.0	1.9	1.0	5.0	6.1	3.4
Conventional	1.9	2.0	1.0	5.0	5.5	3.4
No-till burn	1.9	2.0	1.0	4.9	5.7	4.4
L.S.D. $_{(P=0.05)}$	0.2	NS	NS	0.3	NS	0.6
C.V. $_{(\%)}$	5.9	6.9	8.3	3.6	4.9	9.2

[1] Cutting.
[2] On an oven-dry basis.

Table 9. Alfalfa seeded into oat stubble with starter nitrogen fertilizer, 1995, Hutchinson, KS.

	Dry Matter Yield											
	0 lb N/a			50 lb N/a			75 lb N/a			125 lb N/a		
Variety	1[1]	2[2]	Tot[3]	1	2	Tot	1	2	Tot	1	2	Tot
	ton/a											
Kanza	0.8	0.9	1.7	0.8	0.8	1.5	0.8	0.9	1.7	0.8	0.9	1.7
Riley	0.6	0.7	1.3	0.5	0.8	1.3	0.5	0.7	1.2	0.7	0.9	1.6
Cody	0.7	0.7	1.4	0.7	0.8	1.5	0.6	0.7	1.4	1.1	0.9	2.0
KS1002	0.7	0.8	1.4	0.6	0.8	1.5	0.7	0.8	1.5	0.9	1.0	1.9
KS1001	0.7	0.7	1.4	0.7	0.8	1.5	0.7	0.8	1.5	0.7	0.8	1.5
LSD (P=0.05)	NS	0.1	0.3	0.3	NS	NS	0.3	0.1	0.3	0.3	0.1	0.3

[1] 1 = first cutting. [2] 2 = second cutting . [3] 3 = total for 1995.

SOIL FERTILITY RESEARCH
HARVEY COUNTY EXPERIMENT FIELD

EFFECTS OF HAIRY VETCH WINTER COVER CROP SEEDING RATE AND SPRING TILLAGE GRAIN SORGHUM AND WHEAT

M.M. Claassen

Summary

Hairy vetch planted in early October following spring oats produced 2.54 tons of dry matter by termination in the following June. Seeding rates of 25 and 40 lb/a resulted in equivalent yields that contained an average of 133 lb/a of N. Method of vetch termination (no-till vs disc) had no effect on grain sorghum yields. Fertilizer N at 50 lb/a increased N concentration of sorghum flag leaves but did not affect yield. Unfertilized winter wheat no-till planted into sorghum stubble showed the residual effect of vetch with average yield increases of 6.5 bu/a across N rates and 7.9 bu/a at zero previous fertilizer N. Residual N from vetch and fertilizer significantly increased wheat whole-plant and grain N content.

Introduction

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

Procedures

Spring oats were grown on the site in 1994. Stubble mulch tillage practices, initiated with a V-blade, were used after oat harvest. Relatively high temperatures and dry soil in late summer made it necessary to postpone vetch planting. A grain drill with double disc openers on 7 in. spacing was used to seed the vetch on October 8, 1994. A substantial crop of volunteer oats was eliminated by an early November application of Fusilade + crop oil concentrate (2 oz ai/a + 1% v/v). Spring termination of hairy vetch was delayed by cool and wet conditions. Vetch forage yield was determined by harvesting a 1 meter^2 area in each plot on June 7. The entire site then was sprayed with Roundup + 2,4-D LVE + Pen-A-Trate II nonionic surfactant (0.375 + 0.71 lb ae/a + 0.5%). Nitrogen fertilizer was broadcast as ammonium nitrate on specified plots prior to tillage (disc, roller harrow) later in June after some soil drying had occurred. Pioneer 8500 grain sorghum treated with Concep II safener and Gaucho insecticide was planted at approximately 30,000 seeds/a on June 27. Temik 15G insecticide at 7 lb/a was applied in the furrow with the seed at planting. Weeds were controlled with preemergence application of Lasso + atrazine (2.0 + 0.5 lb ai/a). Grain sorghum was combine harvested on October 27.

Wheat cultivar 2163 was no-till planted into sorghum stubble at 75 lb/a on November 6, 1995. No fertilizer was applied. Nutrient status of wheat was determined from whole-plant samples of three tillers from six locations within each plot collected when plants were fully headed.

Results

Mid-October rain enabled vetch to emerge slowly later that month. Fall growth remained rather limited. However, cool wet conditions allowed hairy vetch to develop considerable spring growth. At the time when it was controlled with herbicide, vetch was about 22 in. tall and had reached late bloom stage. Hairy vetch production was not affected by seeding rate. Average hairy vetch dry matter yield was 2.54 tons/a with an average N content of 2.62% (Table 1). Consequently, the average potential amount of N to be mineralized for use by the sorghum crop was 133 lb/a. Sorghum stands averaged about 2,000 plants/a more in plots with hairy vetch than where no cover crop had grown. However, sorghum following vetch tended to reach half bloom 1 to 2 days later than sorghum after no cover crop. Also, half bloom for no-till sorghum was delayed about 3 days in comparison with sorghum in tilled plots. N concentration of sorghum flag leaves was slightly higher with 50 lb N/a than with no fertilizer. Despite late June planting and an early fall frost, sorghum yields averaged 84 bu/a. However, hairy vetch, tillage, or N rate had no significant effects on yield.

Wheat emergence was delayed by late planting and dry conditions. Little or no tillering occurred until spring. An extremely dry winter as well as cyclical periods of warm and cold temperatures caused considerable wheat stress. However, favorable spring moisture and temperatures allowed late tillering to occur and development of reasonable yields under the circumstances. The residual effect of hairy vetch produced an average wheat yield increase of 6.5 bu/a, but vetch seeding rate had no effect (Table 2). At the zero level of fertilizer N on the previous sorghum crop, vetch increased wheat yield by 7.9 bu/a. Prior tillage system for grain sorghum had no effect on yield of wheat. The residual effect of 50 lb N/a on sorghum improved wheat production by 2.8 bu/a. Whole-plant analysis showed a significant increase of 0.41% N in wheat that followed sorghum after vetch. Residual no-till and N fertilizer effects on plant N content also were significant but smaller. Similar trends in treatment effects on grain N levels also occurred. Residual effect of vetch on wheat grain represented a 1% increase in protein.

Table 1. Effects of hairy vetch cover crop, tillage, and N rate on grain sorghum, Hesston, KS, 1995.

Hairy Vetch Seeding Rate	Tillage System	N Rate	Vetch Yield[1] Forage	Vetch Yield[1] N	Grain Yield	Stand	Half Bloom	Leaf N	Lodg-ing
			ton/a	lb/a	bu/a	1000's/a	days[2]	%[3]	%
0	NT	0	----	----	81.7	21.9	60	2.85	7
0	NT	50	----	----	80.7	19.0	60	2.93	12
0	Disc	0	----	----	88.8	19.4	60	2.88	7
0	Disc	50	----	----	84.5	22.6	57	2.88	20
25	NT	0	2.72	149	85.6	23.5	62	2.81	8
25	NT	50	2.19	121	82.6	22.1	62	3.04	13
25	Disc	0	2.61	133	81.0	24.0	58	2.76	24
25	Disc	50	2.59	144	88.9	23.2	58	2.99	23
40	NT	0	2.63	125	90.3	22.9	62	2.99	7
40	NT	50	2.42	135	80.6	22.5	63	2.99	10
40	Disc	0	2.74	139	85.6	22.7	58	2.87	14
40	Disc	50	2.44	119	81.4	22.1	60	2.95	25
LSD .05			----	---	NS	4.0	2.6	0.29	12
Main Effect Means:									
Seeding Rate									
0			----	----	83.9	20.7	59	2.89	11
25			2.53	137	84.5	23.2	60	2.90	17
40			2.55	130	84.5	22.5	61	2.95	14
LSD .05			NS	NS	NS	2.0	1.3	NS	NS
Tillage System									
No Till			2.49	133	83.6	22.0	62	2.93	9
Disc			2.59	134	85.0	22.3	59	2.89	19
LSD .05			----	---	NS	NS	1.1	NS	5
N Rate									
0			2.68	137	85.5	22.4	60	2.86	11
50			2.41	130	83.1	21.9	60	2.96	17
LSD .05			----	---	NS	NS	NS	0.12	5

[1] Oven-dry weight and N content determined prior to application of specified N rates.
[2] Days from planting to 50% bloom.
[3] Flag leaf N content at late boot to early heading.

Table 2. Residual effects of hairy vetch cover crop and effects of tillage and N rate on no-till wheat after grain sorghum Hesston, KS, 1996.

Hairy Vetch Seeding Rate[1]	Tillage System[2]	N Rate[3]	Grain Yield	Bushel Wt	Plant N[4]	Grain N
		lb/a	bu/a	lb	%	%
0	NT	0	20.9	56.6	1.21	1.87
0	NT	50	25.6	56.6	1.19	1.88
0	Disc	0	21.9	56.5	1.02	1.89
0	Disc	50	22.9	56.8	1.16	1.91
25	NT	0	28.1	56.3	1.45	2.04
25	NT	50	30.2	56.0	1.80	2.19
25	Disc	0	27.2	56.1	1.32	2.01
25	Disc	50	31.1	55.8	1.47	2.07
40	NT	0	29.4	56.4	1.55	2.08
40	NT	50	30.9	56.1	1.77	2.19
40	Disc	0	27.1	55.9	1.44	1.98
40	Disc	50	30.6	56.0	1.58	2.05
LSD .05			5.5	0.7	0.22	0.12
Main Effect Means:						
Seeding Rate						
0			22.8	56.6	1.14	1.89
25			29.2	56.1	1.51	2.08
40			29.5	56.1	1.59	2.07
LSD .05			2.8	0.4	0.11	0.06
Tillage System						
No Till			27.5	56.3	1.49	2.04
Disc			26.8	56.2	1.33	1.98
LSD .05			NS	NS	0.09	0.05
N Rate						
0			25.8	56.3	1.33	1.98
50			28.6	56.2	1.49	2.05
LSD .05			2.3	NS	0.09	0.05

[1] Vetch seeded in the fall of 1994.
[2] Seedbed preparation for sorghum planting (spring of 1995).
[3] N rates applied prior to preceding grain sorghum crop only.
[4] Whole-plant nutrient concentrations of fully headed wheat.

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

NITROGEN MANAGEMENT FOR NO-TILL CORN AND GRAIN SORGHUM PRODUCTION

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Summary

Surface-applied urea-containing fertilizers have potential for volatilization and immobilization losses of nitrogen (N), particularly when residue levels are high. Results in 1996 indicate few differences in performance of N sources. When differences were noted, AgrotaiN outperformed urea. Lack of difference in performance between N sources likely was due to rainfall shortly after N application at most sites. Time of N application had minimal impact on corn or sorghum yields in 1996.

Introduction

Careful management of nitrogen (N) is critical in conservation-tillage production systems, where large amounts of old crop residue are left on the soil surface to help alleviate wind and water erosion. Conservation tillage acreage in Kansas is increasing, because we are in the conservation compliance phase of the current farm program. Previous work at Kansas State University indicated that knifed placement of N in high-residue production systems was superior to broadcast N applications. This research was begun to evaluate N rates, sources, urease inhibitor, time of N application, and the effect of type of residue in no-till corn and grain sorghum production systems.

Procedures

Four corn and three grain sorghum sites were established in 1996. Nitrogen rates (varied depending on crop and cropping sequence) and N sources (urea, urea + NBPT, and ammonium nitrate) were evaluated. NBPT is a urease inhibitor and is available commercially as AgrotaiN. All N was surface broadcast either in early to mid-March (early) or right after planting (planting). All sites were no-till.

Leaf samples were taken at V-6 and boot or tassel stages, and N content was determined. Chlorophyll meter readings were taken at V-6 and boot/tassel stages with a Minolta SPAD 502 chlorophyll meter (data not reported). Grain yields were determined. Individual grain samples were retained for moisture, test weight, and N determinations.

Results

Corn results are summarized in Tables 1-4, and grain sorghum results in Tables 5-7.

Corn yields (both dryland and irrigated) were excellent. Yields were above average. Nitrogen source comparisons indicated small differences in 1996, probably because of rainfall shortly after N application. When differences were noted, urea + NBPT (AgrotaiN) produced higher yields and higher grain protein than urea. The urease inhibitor has potential to reduce both volatilization and immobilization by slowing urea breakdown, allowing urea to get into the soil. Both volatilization and immobilization can be problems with surface- applied N in high-residue production systems.

Time of N application had minimal effect at most sites, but the planting time application sometimes produced higher yields, tissue N levels, and grain protein than the early application.

Results over the past 3 years indicate that ammonium nitrate and urea with a urease inhibitor often outperformed urea and UAN.

The chlorophyll meter continued to show promise as an in-field N assessment tool. However, the correlation between leaf N concentrations and meter readings seems to be much better late in the growing season (tassel or boot) than at the V-6 growth stage. The V-6 stage would be closer to the time for making a sidedress N decision.

Table 1. Nitrogen management on continuous no-till corn, North Agronomy Farm, Manhattan, KS, 1996.

N	N	6-Leaf	Tassel	Grain	
Rate	Source	N	N	Yield	Protein
lb/a		- - - - - % - - - - -		bu/a	%
0	--	2.16	1.35	37	5.5
50	Urea	2.91	1.60	98	5.9
100	Urea	3.21	2.08	114	6.9
150	Urea	3.20	2.50	129	8.2
50	AgrotaiN*	2.78	1.92	89	6.0
100	AgrotaiN	3.01	2.10	126	6.9
150	AgrotaiN	3.37	2.49	128	8.3
50	Am. nit.	2.81	1.55	72	6.2
100	Am. nit.	3.14	2.14	130	7.7
150	Am. nit.	3.29	2.65	122	8.8
LSD (0.05)		0.40	0.31	25	0.8
Mean Values:					
N	50	2.83	1.69	87	6.0
Rate	100	3.12	2.11	123	7.2
	150	3.29	2.54	126	8.4
LSD (0.05)		0.21	0.19	16	0.5
N	Urea	3.11	2.05	114	7.0
Source	AgrotaiN	3.05	2.17	114	7.1
	Am. nit.	3.08	2.11	108	7.6
LSD (0.05)		NS	NS	NS	0.5

* AgrotaiN is urea + NBPT

Table 2. Nitrogen management on no-till corn following soybeans, Kansas River Valley Experiment Field, Topeka, KS, 1996.

N	N	Time of	6-Leaf	Tassel	Grain	
Rate	Source	Application	N	N	Yield	Protein
lb/a			- - - - - %	- - - - -	bu/a	%
0	--	--	2.45	2.50	168	7.1
75	Urea	Early	2.51	2.83	179	7.4
150	Urea	Early	2.78	2.90	194	7.7
75	AgrotaiN	Early	2.43	2.76	182	7.3
150	AgrotaiN	Early	2.49	2.87	197	7.7
75	Am. nit.	Early	2.67	2.87	193	7.5
150	Am. nit.	Early	2.69	2.81	192	7.6
75	Urea	Planting	2.73	2.92	206	7.3
150	Urea	Planting	3.29	2.81	209	8.0
75	AgrotaiN	Planting	2.63	2.78	192	7.6
150	AgrotaiN	Planting	2.66	3.00	208	8.0
75	Am. nit.	Planting	2.90	2.94	196	7.7
150	Am. nit.	Planting	3.00	2.81	194	7.8
LSD (0.05)			0.36	0.22	23	0.4
Mean Values:						
N	75		2.64	2.85	191	7.5
Rate	150		2.82	2.87	199	7.8
LSD (0.05)			0.15	NS	NS	0.2
N	Urea		2.83	2.86	197	7.6
Source	AgrotaiN		2.55	2.85	195	7.7
	Am. nit.		2.82	2.86	194	7.6
LSD (0.05)			0.18	NS	NS	NS
Time of	Early		2.59	2.84	190	7.5
Application	Planting		2.87	2.88	201	7.7
LSD (0.05)			0.15	NS	9	0.2

Table 3. Nitrogen management on no-till corn following wheat, Sandyland Experiment Field, St. John, KS, 1996.

N	N	Time of	6-Leaf	Tassel	Grain	
Rate	Source	Application	N	N	Yield	Protein
lb/a			- - - - - % - - - - -		bu/a	%
0	–	–	2.38	2.70	167	6.9
75	Urea	Early	2.84	2.85	209	7.6
150	Urea	Early	2.72	2.60	210	8.1
75	AgrotaiN	Early	2.74	2.64	208	8.2
150	AgrotaiN	Early	2.82	2.84	224	8.3
75	Am. nit.	Early	2.50	2.83	174	7.7
150	Am. nit.	Early	3.00	2.50	228	8.5
75	Super urea	Early	2.76	2.64	214	7.9
150	Super urea	Early	3.12	2.76	202	8.2
75	Urea	Planting	2.51	2.76	199	7.2
150	Urea	Planting	3.26	2.57	225	8.4
75	AgrotaiN	Planting	2.63	2.69	195	7.8
150	AgrotaiN	Planting	3.00	2.55	223	8.4
75	Am. nit.	Planting	2.82	2.61	230	8.4
150	Am. nit.	Planting	2.82	2.85	207	8.3
75	Super urea	Planting	2.56	2.48	202	8.1
150	Super urea	Planting	3.09	2.81	229	8.3
	LSD (0.05)		NS	NS	40	0.8
Mean Values:						
N	75		2.67	2.69	204	7.8
Rate	150		2.98	2.68	218	8.3
	LSD (0.05)		NS	NS	14	0.3
N	Urea		2.83	2.69	210	7.8
Source	AgrotaiN		2.80	2.68	212	8.2
	Am. nit.		2.78	2.70	210	8.2
	Super urea		2.88	2.67	212	8.1
	LSD (0.05)		NS	NS	NS	NS
Time of	Early		2.81	2.71	209	8.1
Application	Planting		2.83	2.66	214	8.1
LSD (0.05)			NS	NS	NS	NS

Table 4. Nitrogen management on no-till corn following soybeans, Cornbelt Experiment Field, Powhattan, KS, 1996.

N	N	Time of	6-Leaf	Tassel	Grain	
Rate	Source	Application	N	N	Yield	Protein
lb/a			- - - - - %	- - - - -	bu/a	%
0	--	--	3.90	2.28	143	7.0
60	Urea	Early	3.79	2.40	153	7.3
120	Urea	Early	3.92	3.02	158	7.3
60	AgrotaiN	Early	4.07	2.71	143	7.3
120	AgrotaiN	Early	4.02	3.01	160	7.7
60	Am. nit.	Early	4.06	2.70	145	7.5
120	Am. nit.	Early	4.07	3.07	176	8.1
60	Urea	Planting	4.00	2.63	161	7.6
120	Urea	Planting	4.10	3.15	162	7.6
60	AgrotaiN	Planting	4.07	2.81	145	7.7
120	AgrotaiN	Planting	3.89	3.02	177	8.0
60	Am. nit.	Planting	4.13	2.94	138	7.3
120	Am. nit.	Planting	3.96	3.15	162	7.9
	LSD (0.05)		NS	0.37	22	0.6
Mean Values:						
N	60		4.01	2.70	147	7.4
Rate	120		3.99	3.07	165	7.8
	LSD (0.05)		NS	0.16	9	0.2
N	Urea		3.95	2.80	158	7.5
Source	AgrotaiN		4.01	2.89	156	7.7
	Am. nit.		4.06	2.96	155	7.7
	LSD (0.05)		NS	NS	NS	NS
Time of	Early		3.99	2.82	156	7.5
Application	Planting		4.02	2.95	157	7.7
	LSD (0.05)		NS	NS	NS	NS

Table 5. Nitrogen management on no-till milo following corn, North Central Experiment Field, Belleville, KS, 1996.

N Rate	N Source	Time of Application	6-Leaf N	Tassel N	Grain Yield
lb/a			- - - - - %	- - - - -	bu/a
0	--	--	2.69	2.73	108
60	Urea	Early	2.75	2.84	130
120	Urea	Early	3.59	2.74	153
60	AgrotaiN	Early	3.07	3.05	136
120	AgrotaiN	Early	3.39	2.60	155
60	Am. nit.	Early	3.04	2.89	130
120	Am. nit.	Early	3.11	2.85	154
60	Urea	Planting	2.96	2.81	136
120	Urea	Planting	3.02	2.77	155
60	AgrotaiN	Planting	3.19	2.95	138
120	AgrotaiN	Planting	3.38	2.98	159
60	Am. nit.	Planting	2.87	2.92	140
120	Am. nit.	Planting	3.14	2.96	156
	LSD (0.05)		NS	NS	9
Mean Values:					
N	60		2.98	2.81	135
Rate	120		3.27	2.91	155
	LSD (0.05)		NS	NS	4
N	Urea		3.08	2.79	143
Source	AgrotaiN		3.26	2.89	147
	Am. nit.		3.04	2.90	145
	LSD (0.05)		NS	NS	4
Time of	Early		3.16	2.82	143
Application	Planting		3.09	2.89	147
	LSD (0.05)		NS	NS	4

Table 6. Nitrogen management on continuous no-till milo, Nemaha Co., Seneca, KS, 1996.

N Rate	N Source	Time of Application	6-Leaf N	Tassel N	Grain Yield	Grain Protein
lb/a			- - - - - %	- - - - -	bu/a	%
0	--	--	3.54	2.58	89	6.8
60	Urea	Early	3.58	2.87	131	7.6
120	Urea	Early	3.54	3.11	128	8.7
60	AgrotaiN	Early	3.71	2.87	134	8.1
120	AgrotaiN	Early	3.61	3.13	129	9.1
60	Am. nit.	Early	3.26	2.88	128	7.7
120	Am. nit.	Early	3.21	3.04	140	8.9
60	Urea	Planting	3.79	2.92	127	7.7
120	Urea	Planting	3.88	3.14	136	8.5
60	AgrotaiN	Planting	3.86	2.85	130	7.9
120	AgrotaiN	Planting	3.97	3.13	135	8.1
60	Am. nit.	Planting	3.72	2.90	119	7.7
120	Am. nit.	Planting	3.94	3.40	141	9.1
	LSD (0.05)		NS	0.26	19	0.4
Mean Values:						
N	60		3.65	2.88	128	7.8
Rate	120		3.69	3.16	135	8.7
	LSD (0.05)		NS	0.10	7	0.2
N	Urea		3.70	3.01	131	8.1
Source	AgrotaiN		3.79	3.00	132	8.3
	Am. nit.		3.53	3.06	132	8.4
	LSD (0.05)		NS	NS	NS	0.2
Time of	Early		3.49	2.98	132	8.3
Application	Planting		3.86	3.06	131	8.2
	LSD (0.05)		0.22	NS	NS	NS

Table 7. Nitrogen management on no-till milo following wheat, Sandyland Experiment Field, St. John, KS, 1996.

N Rate	N Source	Time of Application	8-Leaf N	Grain Yield
lb/a			%	bu/a
0	–	–	3.37	119
75	Urea	Early	3.51	129
150	Urea	Early	3.46	132
75	AgrotaiN	Early	3.30	132
150	AgrotaiN	Early	3.27	140
75	Am. nit.	Early	3.27	144
150	Am. nit.	Early	3.39	137
75	Super urea	Early	3.32	141
150	Super urea	Early	3.55	140
75	Urea	Planting	3.56	140
150	Urea	Planting	3.78	149
75	AgrotaiN	Planting	3.68	151
150	AgrotaiN	Planting	3.73	153
75	Am. nit.	Planting	3.69	151
150	Am. nit.	Planting	3.88	138
75	Super urea	Planting	3.68	150
150	Super urea	Planting	3.80	153
LSD (0.05)			0.22	17
Mean Values:				
N	75		3.50	141
Rate	150		3.61	143
LSD (0.05)			0.08	NS
N	Urea		3.58	137
Source	AgrotaiN		3.49	144
	Am. nit.		3.56	142
	Super urea		3.58	146
LSD (0.05)			NS	8
Time of	Early		3.38	137
Applicationn	Planting		3.72	148
LSD (0.05)			0.08	6

NITROGEN - TILLAGE SORGHUM STUDY

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Summary

Since 1982, the responses of grain sorghum to tillage system, nitrogen (N) rate, N source, and N placement have been investigated. Until 1995, N sources and placements used were ammonium nitrate, broadcast and urea-ammonium nitrate solution, either broadcast or knifed, at rates of 0, 30, 60, 120 lbs N/a. In 1995, the placement variable was dropped, and N sources (ammonium nitrate, urea, and urea + NBPT (AgrotaiN)) were evaluated. All N was surface broadcast. The tillage systems used were no-till or conventional. Results in 1996 indicate that flag leaf N concentrations were higher for conventional tillage, but yields were not significantly affected by tillage. Yields were good in 1996 and were increased by N application up to 120 lb/a. Nitrogen sources performed similarly in 1996.

Introduction

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

This long-term study was altered slightly in 1995 to evaluate N sources, including ammonium nitrate, urea, and urea + NBPT, which is an experimental urease inhibitor.

Procedures

Three N sources at three rates each (30, 60, 120 lb N/a) were used. These were ammonium nitrate, urea, and urea + NBPT (AgrotaiN). All materials were surface broadcast. The two tillage methods used were conventional tillage, consisting of fall chisel and field cultivation before planting, and no tillage. The N was incorporated in the conventional tillage system. A check plot without N was included in each tillage method. The treatments were replicated three times and arranged in a split-plot design with tillage as the main plot treatment and N source by N rate as the subplot treatments. Planting (Cargill 837), flag leaf sampling, and harvesting were done on May 29, July 24, and September 26, respectively.

Results

Results are summarized in Table 8. Grain yield, flag leaf N, and grain protein were increased significantly by N application up to 120 lbs. All N sources performed similarly in 1996, possibly because of significant rainfall within 48 hours of N application. In 1995, AgrotaiN had outperformed urea, particularly in no-till. Grain yields were not influenced by tillage. As in years past, flag leaf N concentrations were significantly higher for conventional tillage compared to no-till.

Table 8. Nitrogen management and tillage effects on continuous grain sorghum, North Agronomy Farm, Manhattan, KS, 1996.

N Rate	N Source	Tillage	Leaf N	Grain Yield	Grain Protein
lb/a			%	bu/a	%
0	--	No-till	1.28	30	5.7
30	Am. nit.	No-till	1.35	62	5.6
60	Am. nit.	No-till	1.78	88	5.9
120	Am. nit.	No-till	2.19	116	9.0
30	Urea	No-till	1.56	58	5.9
60	Urea	No-till	1.89	85	5.9
120	Urea	No-till	2.46	125	7.9
30	AgrotaiN	No-till	1.51	53	6.3
60	AgrotaiN	No-till	2.29	84	6.1
120	AgrotaiN	No-till	2.57	125	8.1
0	--	Conventional	1.43	36	6.4
30	Am. nit.	Conventional	1.74	63	6.0
60	Am. nit.	Conventional	2.10	101	6.9
120	Am. nit.	Conventional	2.60	116	8.9
30	Urea	Conventional	1.76	65	5.9
60	Urea	Conventional	2.25	95	6.4
120	Urea	Conventional	2.58	113	8.5
30	AgrotaiN	Conventional	2.06	77	6.1
60	AgrotaiN	Conventional	2.35	99	6.6
120	AgrotaiN	Conventional	2.43	113	8.3
LSD (0.05)			0.44	21	0.9
Mean Values:					
N	30		1.66	63	5.9
Rate	60		2.11	92	6.3
	120		2.47	118	8.4
LSD (0.05)			0.19	9	0.4
N	Am. nit.		1.96	91	7.1
Source	Urea		2.08	90	6.8
	AgrotaiN		2.20	92	6.9
LSD (0.05)			0.19	NS	NS
Tillage	No-till		1.96	87	6.8
	Conventional		2.21	93	7.1
LSD (0.05)			0.06	NS	0.3

MANAGEMENT ALTERNATIVES FOR GRAIN SORGHUM PRODUCTION ON ACID SOILS

R.E. Lamond, A.J. Suderman, V.L. Martin, D.A. Whitney, S.R. Duncan, and M.A. Davied

Summary

Recent research addressing wheat production on acid, high aluminum (Al) soils confirmed that liming raises soil pH and reduces Al levels, thus improving wheat production. Banding phosphorus (P) with the seed also was found to be an effective management alternative to improve wheat production when liming was not possible. Banding P complexes Al out of the soil solution. Variety selection was also critical, because considerable differences exist among varieties as to how they perform on acid, high Al soils. Research was initiated in 1995 and continued in 1996 to evaluate liming and P and Amisorb for improving grain sorghum production on acid, high Al soils. A companion study evaluated many grain sorghum hybrids. Responses noted on grain sorghum mirrored those observed earlier on wheat. Banding 35 lb P_2O_5/a increased grain sorghum yields at both sites, even though the Bray-1 P soil tests were high to very high. Lime significantly increased yields in Sedgwick Co. in 1996, but had nonsignificant effects at Sandyland, probably because the lime was applied in 1996. Amisorb had no significant effects on yields or plant nutrient concentrations. Grain sorghum hybrid performance varied considerably in Sedgwick Co.

Introduction

Acid soils have become major crop production problems in southcentral and central Kansas. As soils become very acid, Al levels increase and become detrimental to crop growth. With lime quarries more than 100 miles away from much of the area, producers are interested in alternatives to liming to help manage this problem. Phosphate fertilizer is known to react with soluble soil Al and reduce Al toxicity. The objective of this research was to evaluate liming and P, hybrid selection, and Amisorb as management tools for grain sorghum production on acidic, high Al soil.

Procedures

Research was continued on a Shellabarger sandy loam near Garden Plain in 1996. The site had a pH of 4.6, KCl-extractable Al of 55 ppm, and a Bray-1 P level of 47 ppm. Lime rates (0, 5000, 10000 lb ECC/a) and P rates (0, 35 lb/a banded with seed) were evaluated. The 10,000 lb ECC/a rate of lime was the full recommended rate. The lime was applied on June 12, 1995. This was the second year at this site. Grain sorghum (Pioneer 8505) was planted on May 28. A second site (Sandyland Field) was initiated in 1996 on a 4.8 soil with 24 ppm Al and 44 ppm Bray-1 P. Lime was applied on May 16, and sorghum (Pioneer 8505) was planted on June 18. Lime rates (0, 1500, 3000 lb ECC/a); P (0 and 35 lb/a banded); and Amisorb (0, 2 qt/a) were evaluated. Grain yields were determined at harvest, and grain samples were retained for moisture and test weight analyses.

A companion study evaluated grain sorghum hybrid performance in an area immediately adjacent to the lime and P study in Sedgwick Co.

Results

Results from 1996 are summarized in Tables 9 and 10. Lime application significantly increased yields in Sedgwick Co., but not at Sandyland. Lack of a significant lime response at Sandyland was likely because the lime was applied shortly before planting. This study will be repeated next year on the same site, and a larger response to liming is anticipated. Visual growth and yield responses to banded P were dramatic at both sites. Banded P with the seed at planting increased grain yield. Banded P likely reduced concentrations of soil Al. Whenever liming is not possible, banding P with the seed at planting is an effective short-term management option on these soils. Remember that banding P will not raise soil pH, so liming ultimately will be necessary. Amisorb had no effect on grain yields or leaf nutrient concentrations at Sandyland.

Considerable differences were noted among grain sorghum hybrids grown on the acid, high Al soil in Sedgwick Co. (Table 11). Follow-up work is needed to further evaluate hybrids, but some hybrids apparently perform better on these soils.

Table 9. Lime and phosphorus on grain sorghum, Sedgwick Co., KS, 1996.

Lime Rate	P_2O_5 Rate	Grain Yield	2-Year Avg. Yield
lb ECC/a	lb/a	bu/a	bu/a
0	0	39	56
0	35 Band	45	76
5000	0	52	64
5000	35 Band	59	83
10000	0	61	73
10000	35 Band	61	86
LSD (0.05)		8	13
Mean Values:			
Lime	0	42	65
Rate	5000	55	73
	10000	61	80
LSD (0.05)		6	9
P2O5	0	51	64
Rate	35 Band	55	81
LSD (0.05)		4	7

Table 10. Lime, phosphorus, Amisorb on grain sorghum, Sandyland Experiment Field, St. John, KS, 1996.

Lime	P_2O_5*	Amisorb**	Grain	6-Leaf						
Rate	Rate		Yield	N	P	K	Ca	Mg	S	Zn
lb ECC/a	lb/a		bu/a	- - - - - - - - - - - - -	%	- - - - - - - - - - - - -				ppm
0	0	NO	102	3.95	.34	3.19	.54	.18	.23	52
0	35	NO	116	4.11	.52	3.44	.59	.18	.27	47
0	0	YES	103	3.89	.39	3.61	.55	.20	.25	50
0	35	YES	113	3.97	.53	3.09	.56	.18	.25	43
1500	0	NO	95	3.92	.36	3.49	.62	.21	.25	42
1500	35	NO	110	3.92	.46	3.24	.46	.18	.24	36
1500	0	YES	92	4.10	.37	3.34	.57	.17	.25	53
1500	35	YES	105	4.15	.54	3.27	.64	.19	.26	46
3000	0	NO	114	3.81	.35	3.49	.65	.18	.23	49
3000	35	NO	116	3.89	.46	3.66	.64	.20	.26	48
3000	0	YES	117	3.88	.37	3.65	.64	.20	.24	52
3000	35	YES	112	4.06	.57	3.32	.63	.19	.25	44
LSD(0.05)			NS	NS	.09	NS	NS	NS	NS	NS
Mean Values:										
Lime	0		108	3.98	.44	3.33	.56	.19	.25	48
Rate	1500		101	4.02	.43	3.34	.57	.19	.25	44
	3000		115	3.91	.46	3.53	.64	.19	.25	48
	LSD(0.05)		NS	NS	NS	NS	.07	NS	NS	NS
P_20_5	0		104	3.92	.36	3.46	.60	.19	.24	50
lb/a	35 Band		112	4.02	.53	3.34	.59	.19	.25	44
	LSD(0.05)		NS	NS	.04	NS	NS	NS	NS	5
Amisorb	NO		109	3.93	.43	3.42	.58	.19	.25	46
	YES		107	4.01	.46	3.38	.60	.19	.25	48
	LSD(0.05)		NS	NS	NS	NS	NS	NS	NS	NS

(Continued)

Table 10. Continued

Lime	P_2O_5*	Amisorb**	Boot Stage						
Rate	Rate		N	P	K	Ca	Mg	S	Zn
lb ECC/a	lb/a		- - - - - -	- - - -	- - - % - - -	- - - -	- - - - - -		ppm
0	0	NO	3.04	.36	1.97	.28	.17	.17	42
0	35	NO	3.17	.38	2.07	.31	.18	.18	42
0	0	YES	3.20	.38	1.97	.29	.17	.17	45
0	35	YES	2.99	.34	2.02	.30	.18	.18	40
1500	0	NO	3.22	.34	2.12	.34	.19	.19	45
1500	35	NO	3.04	.35	2.11	.35	.18	.18	57
1500	0	YES	3.27	.37	2.11	.34	.19	.19	49
1500	35	YES	2.97	.34	2.08	.35	.17	.17	51
3000	0	NO	3.26	.38	1.97	.37	.19	.19	58
3000	35	NO	3.24	.37	2.11	.37	.19	.19	58
3000	0	YES	3.14	.38	2.06	.34	.19	.19	61
3000	35	YES	3.26	.39	2.17	.36	.19	.19	47
	LSD(0.05)		NS	NS	NS	.07	NS	NS	NS
Mean Values:									
Lime	0		3.10	.36	2.01	.29	.17	.17	42
Rate	1500		3.13	.35	2.11	.34	.18	.18	51
	3000		3.22	.38	2.08	.36	.19	.19	56
	LSD(0.05)		NS	NS	NS	.03	.01	.01	8
P_20_5	0		3.19	.36	2.03	.33	.18	.18	50
lb/a	35 Band		3.11	.36	2.10	.34	.18	.18	49
	LSD(0.05)		NS	NS	NS	NS	NS	NS	NS
Amisorb	NO		3.16	.36	2.06	.34	.18	.18	51
	YES		3.14	.37	2.07	.33	.18	.18	49
	LSD(0.05)		NS	NS	NS	NS	NS	NS	NS

*P_2O_5 Applied in direct seed contact
** Amisorb applied at 2 qt/a in direct seed contact

Table 11. Grain sorghum hybrid performance on acid, high Al soil, Sedgwick Co., KS.

Hybrid	1995	1995 Avg.	1996	1996 Avg.	2-Year Avg.
	bu/a	%	bu/a	%	%
NC+ 6B67	95	125	70	112	118
NC+ 270	92	121	68	108	114
Pioneer 8500	92	121	76	121	121
Cargill 737	88	116	48	75	96
NC+ 7B90	86	113	78	124	118
NC+ 7B29	85	112	56	90	101
NC+ 7R83	84	111	89	141	126
NC+ 271	84	111	63	100	105
Pioneer 8505	84	111	65	104	107
NC+ 5C35	81	107	51	80	93
NC+ Y363	80	105	46	73	89
NC+ 6B12	80	105	59	94	100
NC+ 6B50	79	104	48	76	90
NC+ 6R55E	79	104	61	97	101
Pioneer	78	103	50	80	91
Pioneer 8601	78	103	70	111	107
NC+ 472	77	101	61	97	99
Asgrow	77	101	44	69	85
DPL 1505Y	75	99			
NC+ 573E	75	99	75	119	109
NC+ 262	75	99	38	61	80
Dekalb DK51	75	99	50	79	89
NC+ 7C49	75	99	74	118	108
Pioneer 8446	72	95	64	102	98
Dekalb	72	95	80	127	111
Asgrow A570	72	95	91	144	120
NC+ 7B44	70	92	52	82	87
NC+ 7R37E	69	91	76	121	106
NC+ 371	65	86	66	104	95
Dekalb DK-	63	83	89	141	112
NC+ 174	56	74			
Delta Pine	54	71			
T36	33	43	42	66	55
NC+ X663			61	97	
NC+ X820			94	149	
NC+ X602			57	90	
NC+ X7501			72	113	
NC+ XFG739			62	98	
NC+ 6Y831			56	89	
NC+ X7281			59	93	
Asgrow A406			51	96	
Pioneer			66	105	
Olde 214			62	99	
Olde 246Y			53	84	
Wilson 535Y			66	104	
NK KS 710			55	87	
Test Avg.	76		63		

Planted and harvested by NC+ Hybrids.

CHLORIDE FERTILIZATION ON CORN, GRAIN SORGHUM, AND SOYBEAN

R.E. Lamond, K. Rector, B.H. Marsh, and D.A. Whitney

Summary

Recent research in Kansas has shown that wheat often responds to chloride (Cl) fertilization. In some cases, Cl fertilization has slowed the progression of leaf diseases on wheat. In other cases, Cl responses occurred where soil Cl levels were low, indicating that some Kansas soils may be deficient in Cl. In light of consistent wheat response to Cl, work was continued in 1996 to evaluate Cl fertilization on dryland corn, grain sorghum, and soybeans. Results from 1996 indicate that Cl fertilization often can increase corn and grain sorghum yields and leaf tissue Cl concentrations, but had no significant effect on soybean yield.

Procedures

Chloride rates (0, 20, 40 lb/a) and sources (NH_4Cl and KCl) were evaluated on corn (North Agronomy Farm, Riley Co.) and corn and grain sorghum (Cornbelt Experiment Field, Brown Co.). In Marion Co., Cl rates of 0, 10,20, 30, and 40 lb/a as KCl were evaluated on grain sorghum and soybean. Nitrogen was balanced on all treatments. All fertilizer materials were broadcast just after planting. Leaf samples were taken at V-6 and tassel/boot stages for Cl analysis. Grain yields were determined.

Results

Yields in 1996 were excellent (Tables 12, 13, 14), and significant corn and grain sorghum yield increases were noted. Chloride fertilization significantly increased leaf tissue Cl concentrations. Chloride sources performed similarly. With the positive results obtained in 1996, this work will be continued in 1997.

Table 12. Chloride fertilization on corn, 1996.

		Riley Co.			Brown Co.		
Cl	Cl		Leaf Cl			Leaf Cl	
Rate	Source	Yield	6-leaf	Tassel	Yield	6-leaf	Tassel
lb/a		bu/a	- - - % - - -		bu/a	- - - % - - -	
0	--	127	0.18	0.23	108	0.50	0.14
20	NH_4Cl	130	0.21	0.28	118	1.39	0.19
40	NH_4Cl	136	0.47	0.39	113	1.35	0.29
20	KCl	128	0.32	0.30	123	1.42	0.22
40	KCl	137	0.54	0.38	130	1.49	0.31
LSD (0.05)		NS	0.07	0.06	11	0.44	0.12
Mean Values:							
Cl	20	129	0.27	0.28	120	1.41	0.20
Rate	40	137	0.51	0.37	122	1.42	0.30
LSD (0.05)		NS	0.04	0.03	NS	NS	0.06
Cl	NH_4Cl	133	0.34	0.34	116	1.37	0.24
Source	KCl	133	0.43	0.32	127	1.46	0.27
LSD (0.05)		NS	NS	NS	7	NS	NS

Table 13. Chloride fertilization on grain sorghum, Cornbelt Experiment Field, Powhattan, KS, 1996.

Cl Rate	Cl Source	Yield	Leaf Cl 6-leaf	Leaf Cl Boot
lb/a		bu/a	- - - % - - -	
0	--	119	0.82	0.08
20	NH_4Cl	127	1.17	0.27
40	NH_4Cl	121	1.20	0.41
20	KCl	123	0.90	0.24
40	KCl	130	1.28	0.36
LSD (0.05)		10	0.38	0.09
Mean Values:				
Cl	20	125	1.03	0.25
Rate	40	125	1.24	0.38
LSD (0.05)		NS	0.17	0.05
Cl	NH_4Cl	123	1.19	0.34
Source	KCl	127	1.09	0.30
LSD (0.05)		NS	NS	NS

Table 14. Chloride fertilization on grain sorghum and soybeans, Marion Co., KS, 1996.

Cl Rate*	Grain Sorghum Yield	Soybean Yield
lb/a	bu/a	bu/a
0	106	42
10	106	45
20	120	43
30	108	46
40	103	46
LSD (0.05)	NS	NS

* Cl applied as KCl, broadcast after planting.

SULFUR FERTILIZATION ON GRAIN SORGHUM AND SOYBEAN

K. Rector, R.E. Lamond, D.A. Whitney, and M.A. Davied

Summary

Previous work in Kansas indicated a possible need for sulfur (S) as a part of the total nutrient management plan. This work evaluated S fertilization on grain sorghum and soybean in central Kansas (Marion Co.). In 1996, S fertilization had little effect on grain sorghum or soybean yields.

Procedures

Sulfur rates (0, 10, 20, 30 lb/a) were evaluated on grain sorghum and soybean. Sulfur was broadcast after planting as sodium bisulfate. Grain yields were determined.

Results

Yields were average to excellent, but the addition of S had nonsignificant effects on yields of either crop (Table 15).

Table 15. Sulfur fertilization on grain sorghum and soybean, Marion Co., KS, 1996.

S Rate	Grain Sorghum Yield	Soybean Yield
lb/a	- - - - - - - - - - bu/a	- - - - - - - - - -
0	108	30
10	115	31
20	109	31
30	106	30
LSD (0.05)	NS	NS

LATE-SEASON NITROGEN AND AMISORB APPLICATION ON IRRIGATED SOYBEANS WITH HIGH-YIELD POTENTIAL

R.E. Lamond, T. Wesley, D.A. Whitney, V.L. Martin, and S.R. Duncan

Summary

Irrigated soybean yields in Kansas can be exceptional. Several producers are producing irrigated soybeans with yields in the 70-80 bu/a range. With these yields and the high protein levels of soybeans, nitrogen (N) demand during grain fill is quite high, and producers have been questioning a need for supplemental N. Work was continued in 1996 to evaluate N rates and sources on irrigated soybeans. Amisorb, a nutrient uptake enhancer, also was evaluated. Nitrogen and Amisorb were applied at the R-3 growth stage. Results from 1996 indicate that N application increased soybean yields at one of two sites. Application of Amisorb had no effect on soybean yields. Grain samples are being analyzed for protein. After 2 years of work, results indicate that supplemental N applied at the R-3 growth stage can consistently increase yields of irrigated soybeans with high production potential.

Procedures

Two sites (Brunker Farm, Johnson Co. and the Sandyland Experiment Field) were selected to evaluate N rates (0, 20, 40 lb/a) and Amisorb (0 or 2 qt/a). Nitrogen and Amisorb were applied at the R-3 stage of growth (first pods 1/4-1/2 inch long). The N was applied as UAN. Nitrogen and Amisorb were applied in a surface band 2 in. from the row. Grain yields were determined by hand harvest. Grain samples were retained for protein analyses.

Results

Average to excellent yields were obtained in 1996 (Table 16). Application of N significantly increased soybean yields at one of two sites. Amisorb had no effect on soybean yields. Samples also are being analyzed for protein content.

This work will be continued in 1997.

Table 16. Late-season nitrogen and Amisorb applications on soybeans, Kansas, 1996.

N		Grain Yield	
Rate	Amisorb	Johnson Co.	Stafford Co.
lb/a		- - - - - - - - - - bu/a	- - - - - - - - - -
0	No	64.8	64.9
0	Yes	66.8	69.2
20	No	75.7	68.2
20	Yes	70.3	64.2
40	No	73.5	66.2
40	Yes	70.2	68.7
LSD (0.10)		7.1	NS
Mean Values:			
N	0	65.7	67.0
Rate	20	73.0	66.2
lb/a	40	71.9	67.5
LSD (0.10)		5.4	NS
Amisorb	No	71.3	66.4
	Yes	69.1	67.3
LSD (0.10)		NS	NS

N and Amisorb (2 qt/a) applied as dribble band 2 in. from row at R-3 growth stage.

SEED PLACEMENT OF STARTER FERTILIZERS FOR CORN

G.M. Pierzynski and M. Ashraf

Summary

Interest has increased in placing starter fertilizers directly with the seed when corn is planted using equipment without starter fertilizer disc openers. We compared the effects of three liquid starter fertilizers applied at three different rates directly with the seed. Two planting dates were used to provide differences in soil moisture content at seeding. Plant populations, V6 dry matter yields, and grain yields were measured. The use of the highest rate of 10-34-0 significantly reduced plant populations compared to all other treatments for an 11 April 1996 planting when the soil moisture content (0-3 in.) was 18%. No such differences were found for a 17 May 1996 planting when the soil moisture content was 23%. For the 11 April planting, V6 dry matter yields significantly increased with 10 or 15 gal/a compared to 5 gal/a for the 4-10-10 and 7-21-7 liquids, whereas they significantly decreased with 15 gal/a compared to 5 or 10 gal/a for the 10-34-0 liquid. For the 11 April planting, grain yields were significantly lower with 15 gal/a of 10-34-0 compared to 5 or 10 gal/a. No significant treatment effects with V6 dry matter or grain yields occurred for the 17 May planting.

Introduction

This study is being conducted in cooperation with George Rehm at the University of Minnesota. Farmers in Minnesota often use seed-placed, starter fertilizers for corn because of the use of large “fold-up” planters that cannot accommodate starter fertilizer disc openers. It is believed that seed placement of fertilizers can decrease yields, if soil moisture levels are low at planting. This study was conducted in Kansas because our soil moisture levels tend to be low early in the spring and increase as we approach the high rainfall months of May and June. In Minnesota, they tend to be high coming out of winter, and producers must wait for the soil to dry before planting. The use of large planters is not common in Kansas, however, some producers do use seed-placed starter fertilizers for corn and sorghum.

Procedures

The study was conducted at the Agronomy Farm in Manhattan on an area mapped as a Kahola silt loam. Two plantings were made: 11 April 1996 and 17 May 1996. The hybrid Dekalb 591 was planted each time at a seeding rate of 28,423 seeds/a. The treatments consisted of a control without starter fertilizer and a factorial arrangement of starter fertilizer source (4-10-10, 7-21-7, or 10-34-0) and rate (5, 10, or 15 gal/a) with four replications. Solutions were metered through a John Blue positive-diplacement pump and placed directly with the seed. Soil moisture content was determined in each replicate block from 0-3 in. and 3-6 in. depths at planting. Stand counts were taken nearly every day beginning at emergence and continuing until no further increases in plant populations were found. Stand counts were repeated at approximately the V6 growth stage, and 10 randomly selected plants were collected for dry matter yield determinations. Grain was harvested on 11 September and 2 October.

Results

Soil moisture contents were 18.6% at 0-3 in. and 21.9% at 3-6 in. on 11 April and 23.0% at 0-3 in. and 23.7% at 3-6 in. on 17 May. Eleven days after the 11 April planting and with the 15 gal/a rate, the 4-10-10 and 10-34-0 sources had significantly lower populations compared to the control and the 7-21-7 source (Fig. 1). Gradually, the populations for the 4-10-10 source equaled those for the control and the 7-21-7 source, whereas the population for the 10-34-0 source continued to be significantly lower compared to the remaining sources and the control. Five days after the 17 May planting and with the 15 gal/a rate, the 7-21-7 and 10-34-0 sources had significantly lower populations compared to the 4-10-10 source and the control (Fig. 2). These differences were not evident 6 days after planting, and for the remaining time, no significant differences occurred between any treatments. The source effect was more pronounced for the 11 April planting date than for the 17 May planting, probably because of lower soil moisture levels for the earlier planting. The only significant rate effect found for either planting date was that the population for the highest rate of 10-34-0 was lower than that for 5 or 10 gal/a (Figs. 3 and 4).

A significant source by rate interaction affected V6 dry matter and grain yields for the 11 April planting. The V6 yields increased significantly as the rate of 4-10-10 or 7-21-7 increased from 5 to 10 or 15 gal/a, whereas they decreased when comparing 15 gal/a to 5 or 10 gal/a for 10-34-o (Table 17). Grain yield for the highest rate of 10-34-o was also significantly lower at 15 gal/a compared to 5 or 10 gal/a. Only 4-10-10 at 10 gal/a had a significantly higher grain yield compared to the control at this same planting date. No significant treatment effects were found for V6 dry matter or grain yields for the 17 May planting date. A severe thunderstorm in early July heavily damaged the corn planted in May, reducing yields and increasing variability.

The general recommendation for corn or sorghum is that not more than 10 lb/a of N plus K,O be placed with the seed. In this study, the 10 gal/a rate slightly exceeded this recommendation, and the 15 gal/a rate far exceeded it. Results for 10-34-o are consistent with the general recommendation.

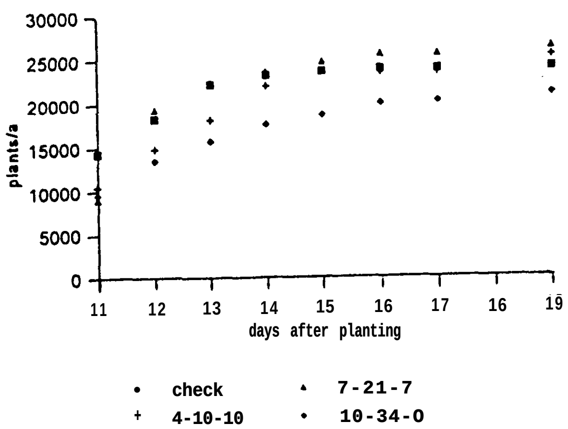

Figure 1. Effect of starter fertilizer source at 15 gal/a on corn populations, 11 April planting.

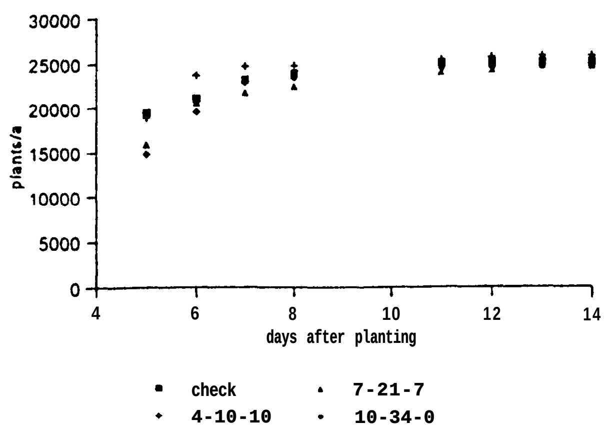

Figure 2. Effect of fertilizer source at 15 gal/a on corn populations, 17 May planting.

Table 17. V6 dry matter and grain yields of corn with starter fertilizer, Manhattan, KS, 1996.

		Planting Date			
		V6 Dry Matter		Grain	
Source	Rate	11 April	17 May	11 April	17 May
	--- gal/a ---	-------lb/a------		-------bu/a------	
Control	0	453	328	199	168
4-10-10	5	434	384	198	156
	10	560	354	204	177
	15	617	312	205	144
7-21-7	5	444	324	210	167
	10	507	346	225	162
	15	574	343	212	173
10-34-0	5	532	342	211	153
	10	521	361	214	151
	15	394	350	183	171
	LSD (0.05)	123	NS	16	NS

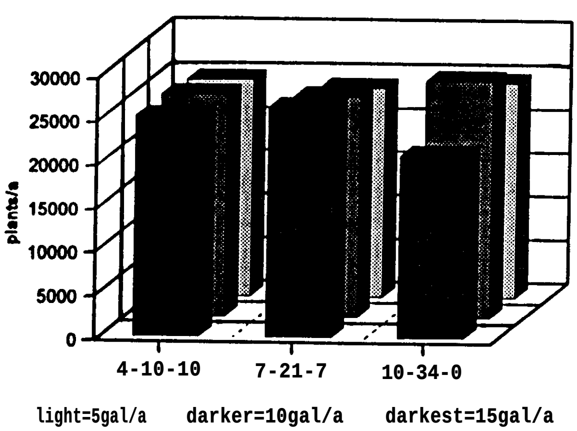

Figure 3. Fertilizer source and rate effects on final corn populations, 11 April planting.

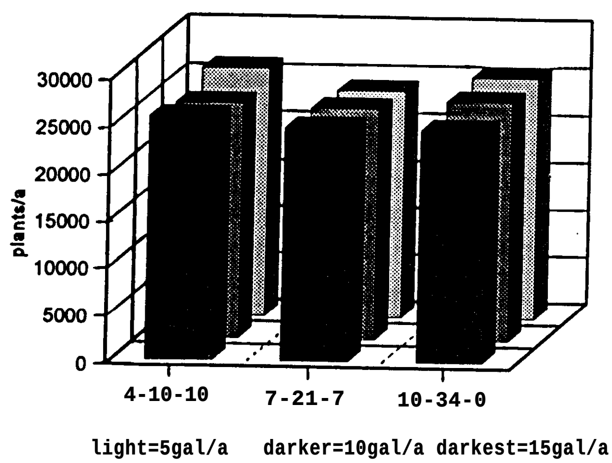

Figure 4. Fertilizer source and rate effects on final corn populations, 17 May planting.

NITROGEN SOURCE AND TILLAGE EFFECTS ON CORN YIELD AND SOIL NITROGEN AVAILABILITY

Y. Espinoza, C.W. Rice, and R.E Lamond

Summary

This long-term corn study (7 years) examines availability of N after 5 years of manure and NH_4NO_3 application. In 1995, plots were subdivided to assess the residual effect of previous N sources on N availability and corn production. Grain yields were lower in 1996 than in 1995, because wind damaged 10% of corn after the tasseling stage. Residual N fertilizer did not provide adequate N for corn in the 2 years after fertilization. In 1995, yields were similar with previous manure application (5 yrs.) and application in that year, but yields decreased approximately 20% with application in 1996. The N mineralization potential of the soil indicated that the soil with manure and no-tillage had the greatest N-supplying capacity.

Introduction

This study was begun in 1990 to assess the fate of N from different sources and rates under two tillage systems planted to corn. Losses of N from leaching and denitrification have prompted research into various management options for sustaining groundwater supplies and crop yields. Such management options include no-tillage and manure application, which were evaluated in comparison with chemical fertilizer and conventional tillage in this study. Manure may increase the soil's N-supplying capacity. To determine changes in N supply, we assessed the contribution of N from the soil for plant uptake.

Procedures

The study was located at the North Agronomy Farm in Manhattan on a Kennebec silt loam soil. This was the seventh year in which all plots have received the same treatments each year. Tillage regimes include no-tillage and conventional tillage, which consisted of fall chiseling and spring discing, N source incorporation, planting, and cultivation. The N treatments were as follows: no N, 150 lb N/a as ammonium nitrate, and 150 lb/a as cattle manure. In 1995, plots were divided to determine carryover of N from previous years.

The pool of potentially mineralizable N was determined from laboratory incubations of disturbed samples from the 0-5 cm depth.

Results

Grain yields for 1995 and 1996 for applied and residual N are summarized in Table 18. Grain yields were lower in 1996 than in 1995. These lower yields were partly attributed to wind, which broke off 10% of the corn plants after tasseling. All plots receiving N produced higher yields than the plots that had not received N application for 2 years.

Tillage system seems to be important in those treatments that received N fertilizer. Grain yields in conventional tillage were higher than no tillage for manure and NH_4NO_3 application. In the residual treatments, tillage did not affect yields (Table 18). Manure application maintained the N supply of this soil as shown by the similar grain yields between residual and continual manure application. Grain yields with residual manure in 1996 were higher than those with residual NH_4NO_3, suggesting that fertilizer did not maintain the N-supplying capacity of the soil.

The potential N mineralization of this soil (Fig. 1) indicates that residual manure with no tillage has the highest potential to supply N in this soil. These results agree with the grain yield observed during 2 consecutive years without applied N. The addition of organic amendments, such as manure, increased soil organic N. Incorporation of manure N, applied for 5 years, into the more stable organic fraction supplied subsequent crops N needs.

stable organic fraction supplied subsequent crops N needs.

Accounting for this N source can decrease N fertilizer needs and reduce contamination of groundwater.

Table 18. Effects of tillage and nitrogen source on corn grain yield, Manhattan, KS, 1995, 1996.

Tillage	N Source	Applied		Residual	
		1995	1996	1995	1996
		bu/a		bu/a	
No tillage	None	58	33		
	Manure	78	81	91	77
	NH_4NO_3	116	82	79	45
Conventional tillage	None	76	62		
	Manure	95	89	101	75
	NH_4NO_3	105	107	88	71

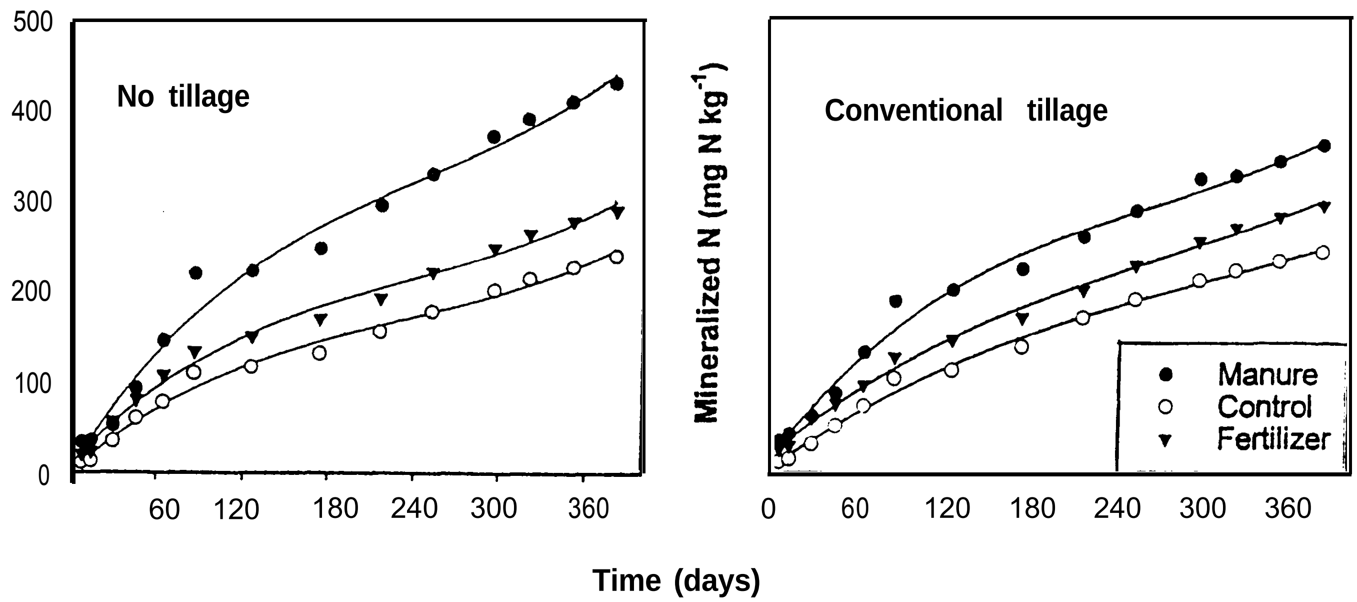

Figure 1. Cumulative N mineralized during 381 days of laboratory incubation.

NITROGEN NUTRITION PLUS AND AMISORB USE ON IRRIGATED SOYBEANS

D.A. Whitney, W.B. Gordon, and R.E. Lamond

Summary

Foliar applications of micronutrients at the V-1 and R-3 growth stages of soybean were not effective in increasing grain yields or nutrient concentration in leaf samples. Nitrogen at 20 lbs/a or Amisorb applied to the soil surface at the R-3 growth stage also was not effective in increasing yields or nutrient concentrations.

Introduction

Irrigated soybeans with high yield potential require considerable quantities of macro- and micronutrients to produce optimum yields. Recent research has shown response to nitrogen (N) applied when first pods are ¼ to ½ inch long. Other products have been promoted to enhance nutrient uptake through either supplying nutrients or stimulating greater nutrient uptake. This study was conducted to further investigate the use of late-season N for irrigated soybeans and to test two products for their effects on soybean yield and plant nutrient concentration.

Procedures

The study was conducted at the Irrigation Experiment Field near Scandia on a furrowed irrigated Crete silt loam soil. Soybeans (variety Dekalb CX377) were planted on May 18 in 30- inch rows using seedbed preparation and weed control practices of the field. Individual plots were 4 rows by 40 ft long. All treatments were applied postemergence with the CLAW EL Nutrition Plus for Beans foliar applied at the V-1 growth stage at 2 and 4 qts/a and at the R-3 growth stage at 2 qts/a in 20 gal/a of water. Late-season N (20 lbs/a) and Amisorb (2 qt/a) were applied as a surface band at the R-3 growth stage. CLAW EL Nutrition Plus for Beans is a micronutrient fertilizer of mannitol chelated trace elements with 0.2% B, 0.3% Fe, 3.2% Mn, .01% Mo, and 2.1% Zn from Brandt Consolidated, Pleasant Plains, IL. Amisorb is manufactured by Amilar International, contains 40% carpramid, and is sold as a nutrient absorption enhancer.

A composite soil sample (0 to 6 in.) was taken when the V-1 treatments were applied and analyzed for routine soil tests through the KSU Soil Testing Lab. A leaf sample was taken at the time of the R-3 treatment applications from the check and the 2 and 4 qt Nutrition Plus treatments applied at V-1. A second leaf sample was taken from all plots at the R-4 growth stage for analysis. Grain yields were taken at maturity using a plot combine to harvest the two center rows. A portion of grain was retained for moisture determination. Final yields were adjusted to 13% moisture.

Results

Excellent grain yields were obtained, but no significant response was obtained to any of the treatments (Table 20). Leaf samples at the R-3 and R-4 growth stages did not show an increase in leaf nutrient with any treatment (Tables 19 and 20). The lack of response was not totally unexpected, because the site had excellent nutrient levels according to the soil test results (Table 21).

Table 19. Effect of Nutrition Plus, nitrogen, and Amisorb on leaf nutrient concentration of irrigated soybean at the R-3 growth stage, Irrigation Experiment Field, Scandia, KS.

Treatment/Growth Stage	Nutrient Concentration, R-3 Stage									
	N	P	K	Ca	Mg	S	Fe	Cu	Mn	Zn
	- - - - - - - - - - - - % - - - - - - - - - - - -						- - - - - - ppm - - - - - -			
Check	5.24	.47	2.46	1.56	.29	.39	316	12	79	97
Nutrition Plus, 2qts/V-1	5.00	.47	2.48	1.74	.29	.41	317	13	88	101
Nutrition Plus, 4qts/V-1	5.21	.47	2.34	1.71	.31	.42	323	13	90	100
LSD (.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 20. Effect of Nutrition Plus, nitrogen, and Amisorb on irrigated soybean grain yield and leaf nutrient concentration at the R-4 growth stage, Irrigation Experiment Field, Scandia, KS.

Treatment/Growth Stage	Grain	Nutrient Concentration, R-4 Stage								
	Yield	N	P	Ca	Mg	S	Fe	Cu	Mn	Zn
		- - - - - - - - % - - - - - - - -					- - - - - - ppm - - - - - -			
Check	69	3.31	.27	.246	.13	.19	136	9	172	30
Nutrition Plus[1], 2qts/V-1	69	3.23	.27	2.44	.15	.19	138	9	186	31
Nutrition Plus, 4qts/V-1	68	3.16	.28	2.71	.16	.19	134	9	186	32
Nutrition Plus, 2qts/R-3	69	3.21	.28	2.38	.14	.19	134	9	160	28
Nutrition Plus, 4qts/V-1 & R-3	69	3.12	.26	2.60	.16	.19	139	10	200	30
Nitrogen, 20 lbs/R-3	69	3.13	.28	2.57	.15	.18	135	9	165	29
Amisorb[2], 2qt/R-3	69	3.28	.26	2.39	.13	.20	149	10	182	28
N plus Amisorb/R-3	69	3.19	.26	2.43	.15	.20	140	9	164	28
LSD (.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Nutrition Plus - mannitol chelated trace elements (0.2% B, 0.3% Fe, 3.2% Mn, .01% Mo, and 2.1% Zn)
Amisorb - 40% carpramid

Table 21. Experimental site characteristics, Scandia, KS.

Soil Tests		Cultural Practices
pH	5.9	Planting date - May 18
Lime reg., lbs/a ECC	2000	Variety - Dekalb CX377
Bray-1 P, ppm	21	Previous crop - Corn
Exch K, ppm	380	Soil series - Crete silt loam
Org. mat., %	2.3	V-1 application - June 17
DTPA Zn, ppm	1.9	R-3 application - July 18
DTPA Fe, ppm	70	Harvest date - October 12
DTPA Cu, ppm	1.2	
DTPA Mn, ppm	30	

NITROGEN AND MPACT USE ON GRAIN SORGHUM

D.A. Whitney and W.B. Gordon

Summary

Excellent grain yield and plant N concentration increases were found to nitrogen (N) fertilization at two locations. The percentage increase in yield with N was much greater at the Agronomy Research Farm than at the Irrigation Experiment Field location. The profile N soil test results showed considerable residual nitrate-N at the Irrigation Field location. MPACT was not effective in increasing grain yield or plant N concentration at either location.

Introduction

Calibration of nitrogen (N) soil tests for grain sorghum in northeast Kansas has been ongoing for the past 5 years. The project was initiated in cooperation with researchers in Nebraska, because little calibration research for grain sorghum was available in either state. The objective of this research was to further calibrate the preplant profile N test and to compare the preplant profile N test to the presidedress nitrate test. An additional objective was added in 1996 to investigate yield response of grain sorghum to MPACT (a product to be used as a supplemental mix for plant growth development with a balanced fertilizer program).

Procedures

Locations were established in 1996 at the Irrigation Experiment Field, Scandia and at the North Agronomy Farm, Manhattan. Table 22 summarizes soil tests, soil series, and some cultural practice data for the two locations. At the Irrigation Field location, soil samples by replication were taken to a depth of 48 inches prior to fertilizer application, with the first foot split into two 6-inch increments and foot increments for the deeper depths at the Irrigation Field location. Soil samples were taken at both locations to a 2-foot depth using the same sampling increments when the sorghum was at the 8- to 10-leaf stage for the presidedress nitrate test. A leaf sample and chlorophyll meter reading also were taken at the 8- to 10-leaf stage and at boot to early head emergence from each plot. Nitrogen rates were in 30 lb increments to 150 lbs/a at the Irrigation location and in 60 lb increments to 120 lbs/a at the North Agronomy Farm. At both locations, MPACT was applied alone or with 60 and 120 lbs N at 0.1 gal/a as recommended by the manufacturer. MPACT is a product of Enviro Products Corp and is a 10-5-5 with extract from a special fermentation process using dairy manure. Each study consisted of four replications with individual plots four-rows (30 inch row spacing) wide by 30 feet (Irrigation) and 20 feet (Agronomy Farm) long. Planting, hybrid selection, and weed and pest control were done by the cooperating experiment location technicians. Grain yields were taken at maturity by hand harvest of one center row at the Agronomy Farm and by machine harvest of the two center rows at the Irrigation Field. A portion of the harvested grain sample was retained after weighing for determination of moisture and grain N concentration. All yields are reported corrected to 14% moisture.

Results

A very marked grain yield increase to N fertilization was obtained at the North Agronomy Farm location (Table 23) with 120 lbs/N treatment having yields more than double those of the no-N treatment. The excellent N response was not unexpected, because this location has been in continuous no-till sorghum with no N fertilization for several years. The excellent response to N also was evident for N concentrations in leaf samples taken at the 8- to 9-leaf stage and at boot to early heading. Nitrogen fertilization also had an effect on leaf phosphorus (P) concentration, which was significantly higher at the 8- to 9- leaf stage in the no-N treatment than with the 60 lb N rate. The opposite was true at the boot stage, with significantly lower P concentrations with the no-N treatment compared to the 120 lb N/a treatment. The reason for the reversal in P concentration for the two sampling dates is unclear. However, leaf P concentrations in all leaf samples were adequate for optimum plant growth. MPACT had no effect on yield or plant N or P concentration.

At the Irrigation Field location, which was in continuous irrigated ridge-till sorghum production, a significant yield increase was obtained to N fertilization, with 120 lbs/a being only slightly better than 90 lbs/a (Table 24). The profile N soil test taken in March showed a significant amount of residual N. The current KSU recommendation for 150 bu/a irrigated sorghum with a profile N test of 85 lbs/a would be to apply 100 lbs N/a. The residual N effect also was quite evident in the N concentration and chlorophyll meter results for the 8- to 9-leaf samples, which showed no significant increase with N fertilization compared to no-N. The 3% N in the no-N treatment leaf samples would be considered an adequate level. By the boot stage, very significant increases in leaf N concentration and chlorophyll meter readings were found with increasing N rates. Results from this location suggest that the profile N test is a better predictor of residual N than the presidedress test. Again, MPACT had no effect on grain yield or any other parameter measured.

Table 22. Site characterization data for the two locations in Kansas.

Parameter	Irrigation Field	Manhattan
Soil Test Data		
pH	6.3	6.3
Bray P-1, ppm	25	32
Exch K, ppm	470	270
Org. mat., %	3.1	2.8
Profile N, lbs/24"	85	-
Profile N, lbs/48"	162	-
Presidedress $N0_3$-N, lbs/24"	21	10
Soil type	Crete sicl	Smolan sil
Planting date	May 22	June 5
Previous crop	sorghum	sorghum
Hybrid	Pioneer 8505	Cargill 837

Table 23. Effect of nitrogen rate and MPACT on grain sorghum grain yield, moisture, and N concentration and on tissue N, P, and chlorophyll at two growth stages at North Agronomy Farm, Manhattan, KS.

		Grain			8-Leaf			Boot		
N Rate	MPACT	Yield	Moist.	N	N	P	Chlor.	N	P	Chlor.
lbs/a	gal/a	bu/a	%	%	- - % - -		SPAD	- - % - -		SPAD
0	0	51	21.5	1.05	2.29	.43	39	1.37	.31	30
0	0.1	48	21.5	1.05	1.90	.40	37	1.36	.30	30
60	0	85	16.9	.98	2.19	.30	39	2.02	.30	42
60	0.1	97	16.8	.99	2.18	.34	43	2.03	.32	42
120	0	108	16.0	1.13	2.66	.37	47	2.67	.40	55
120	0.1	112	16.1	1.16	2.74	.35	47	2.73	.41	54
LSD (.05)		13	3.0	NS	.38	.07	5	0.17	.02	4

Table 24. Effect of nitrogen rate and MPACT on grain sorghum grain yield and moisture and on leaf tissue N, P, and chlorophyll at two growth stages at Irrigation Experiment Field, Scandia, KS.

		Grain		8- to 9-Leaf			Boot		
N Rate	MPACT	Yield	Moist.	N	P	Chlor.	N	P	Chlor.
lbs/a	gal/a	bu/a	%	- - % - -		SPAD	- - % - -		SPAD
0	No	117	18.4	2.96	.28	43	1.85	.28	35
0	Yes	106	18.5	3.09	.31	44	1.60	.29	35
30	No	131	18.2	3.22	.29	44	2.36	.33	41
60	No	149	18.2	3.17	.30	43	2.23	.34	42
60	Yes	149	18.5	3.16	.31	43	2.32	.32	39
90	No	163	18.4	3.38	.32	47	2.68	.36	45
120	No	170	18.5	3.19	.29	43	2.83	.37	45
120	Yes	172	18.4	3.39	.31	43	2.77	.36	44
150	No	173	18.4	3.24	.27	43	2.78	.35	44
LSD (.05)		17	NS	NS	NS	NS	0.38	.08	8

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CROP

Corn

Forage Grasses, Alfalfa

Grain Sorghum

Soybeans

Wheat

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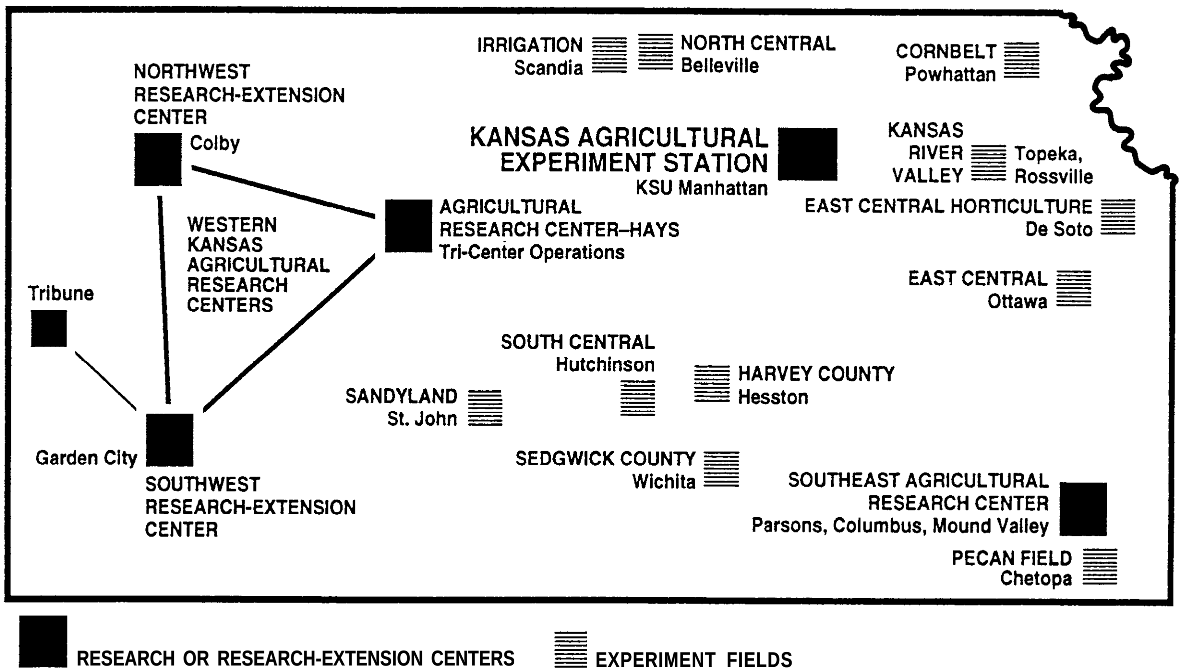

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