KANSAS FERTILIZER RESEARCH 1997

Report of Progress 800

Kansas State University
Agricultural Experiment Station and Cooperative Extension Service

INTRODUCTION

The 1997 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.

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

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Precipitation Data (Inches)

1996	Manhattan	S.W.KS RES-EXT. CTR. Tribune	S.E.KS AG.RES.CTR. Parsons	E.CEN EXP.FLD. Ottawa
August	3.22	4.67	5.10	8.43
September	3.28	3.77	8.81	3.72
October	3.20	0.00	2.56	4.07
November	2.07	0.30	4.45	3.22
December	0.03	0.08	0.34	0.47
Total 1996	32.14	21.88	35.74	43.91
Dept. Normal	-0.74	6.22	-2.77	5.64
1997				
January	0.00	0.12	0.58	0.98
February	2.48	0.97	4.38	4.17
March	0.10	0.00	2.11	1.22
April	5.24	1.41	2.59	3.77
May	2.16	1.56	5.30	10.32
June	2.07	3.37	7.32	2.71
July	2.22	5.32	5.31	3.36
August	4.17	4.41	4.39	5.58
September	2.78	1.84	5.49	3.90

1996	N.CEN EXP.FLD. Belleville	KANSAS RV. VALLEY EXP.FLD.	S.CEN. EXP.FLD. Hutchinson	AG.RES. CTR. Hays
August	3.51	5.10	3.78	5.06
September	6.47	2.30	4.74	3.10
October	0.95	2.52	1.41	0.94
November	4.85	1.79	3.00	3.70
December	0.00	0.04	0.22	0.03
Total 1996	34.30	46.52	26.03	31.83
Dept. Normal	3.26	-11.88	-1.28	10.03
1997				
January	0.05	0.23	0.00	0.00
February	1.04	1.37	2.29	0.71
March	0.40	0.16	0.34	0.01
April	3.67	2.94	2.90	2.58
May	1.21	2.32	2.60	1.56
June	2.43	1.49	6.92	4.35
July	2.56	2.61	2.17	3.45
August	2.07	4.60	4.09	6.32
September	4.57	1.83	5.47	2.03

WHEAT FERTILIZATION STUDIES
KANSAS STATE UNIVERSITY, DEPARTMENT OF AGRONOMY

EFFECTS OF CHLORIDE RATES AND SOURCES ON WINTER WHEAT IN KANSAS

R.E. Lamond, D.D. Roberson, K. Rector, M.A. Davied, 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 1997 in Marion County (two sites) and Stafford County.

Chloride rates (10, 20 lb/a) and sources (potassium chloride (KCl), magnesium chloride ($MgCl_2$), sodium chloride NaCl), and slow release sodium chloride (SR NaCl) were evaluated. A no-Cl treatment was included. Nitrogen was balanced at all locations.

Leaf tissue samples were taken at boot stage and analyzed for Cl content and digestibility (IVDMD). Grain yields were determined, and grain samples were retained for analyses. Grain yields from Stafford Co. are not reported because of problems with harvesting equipment.

Results

Grain yields were excellent in 1997. Chloride significantly increased wheat grain yields at both sites (Table 1), although not all Cl treatments increased yields.

Chloride fertilization had little impact on wheat forage digestibility (Table 2). All Cl sources performed similarly.

Chloride fertilization also significantly increased Cl concentrations in wheat leaf tissue at all sites (Table 1).

Table 1. Effects of chloride rates and sources on wheat, Kansas, 1997.

Cl	Cl	Marion Co. A		Marion Co. B	
Rate	Source	Yield	Leaf Cl	Yield	Leaf Cl
lb/a		bu/a	%	bu/a	%
0	--	66	.32	81	.50
10	KCl	69	.36	93	.52
20	KCl	75	.46	82	.60
10	$MgCl_2$	73	.33	92	.56
20	$MgCl_2$	71	.34	94	.59
10	NaCl	73	.38	87	.58
20	Nacl	76	.48	88	.61
10	SR NaCl	74	.36	88	.56
20	SR NaCl	76	.40	86	.63
	LSD (0.05)	7	.07	8	.09
Mean Values:					
Cl	10	72	.36	90	.55
Rate	20	74	.42	87	.61
	LSD (0.10)	NS	.04	NS	.05
Cl	KCL	72	.41	88	.56
Source	$MgCl_2$	72	.34	93	.57
	NaCl	75	.43	88	.59
	SR NaCl	75	.38	87	.59
	LSD (0.10)	NS	.05	NS	NS
Cultivar		Jagger		2137	
Soil test Cl (0-24 in.) lb/a:		35		43	

Table 2. Effects of chloride rates and sources on wheat forage digestibility, Kansas, 1997.

Cl Rate	Cl Source	In Vitro Dry Matter Disappearance: Marion Co. A	Marion Co. B	Stafford Co.
lb/a			%	
0	--	73.7	75.7	78.4
10	KCl	70.7	75.3	79.6
20	KCl	71.9	74.3	78.1
10	$MgCl_2$	71.1	76.2	79.8
20	$MgCl_2$	72.8	73.5	77.7
10	NaCl	71.5	75.0	78.2
20	NaCl	72.5	73.9	78.7
10	SR NaCl	71.5	76.1	80.3
20	SR NaCl	72.0	75.3	79.3
	LSD (0.10)	NS	NS	NS
Mean Values:				
Cl	10	71.2	75.2	79.5
Rate	20	72.3	73.7	78.5
	LSD (0.10)	NS	NS	NS
Cl	KCl	71.3	74.1	78.9
Source	$MgCl_2$	71.9	74.4	78.8
	NaCl	72.0	73.9	78.5
	SR NaCl	71.7	75.3	79.7
	LSD (0.10)	NS	NS	NS
Cultivar		Jagger	2137	2137

EVALUATION OF CHLORIDE FERTILIZATION/WHEAT CULTIVAR INTERACTIONS

D.D. Roberson, 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. Research in 1996 and 1997 indicated that some wheat cultivars seem to respond consistently to Cl fertilization, whereas others do not, even when soil test Cl levels are low. Yield increases were most consistent when soil Cl levels were <20 lb/a (0-24 in.) and when plant Cl concentrations were <0.10%. Chloride fertilization significantly (P<0.10) increased wheat yields of one or more cultivars at three of four sites over 2 years. Ogallala was a consistent nonresponder in both years.

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 the Great Plains.

Procedures

Studies were continued in Saline and Marion counties in 1997 to evaluate Cl fertilization/wheat cultivar interactions. Sixteen commonly grown winter wheat cultivars were seeded in early October. Chloride was applied 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 as well as grain test weights were determined. Grain yields were corrected to 13% moisture.

Results

Effects of chloride fertilization and cultivar on plant Cl are summarized in Table 3. Chloride fertilization significantly increased plant Cl concentrations at both sites for all 16 cultivars. Significant differences in plant Cl were noted between cultivars both in the abscence or presence of Cl fertilization, suggesting that different cultivars take up Cl differently. The site with the lowest soil Cl level (Marion Co.) had the lowest plant Cl concentrations; all 16 cultivars had less than 0.10% Cl without Cl fertilization. Chloride fertilization consistently increased plant Cl concentrations, regardless of soil Cl level.

Chloride fertilization significantly increased yields of 12 of 16 wheat cultivars in Marion Co. (Table 3). This site had soil Cl levels <20 lb/a (0-24 in.) and plant Cl concentrations <0.10%. Yields were unaffected by Cl fertilization in Saline Co., which had a higher soil Cl level. In Marion Co., Cl deficiency symptoms were noted on 'Cimarron' and were corrected by Cl fertilization. This cultivar showed a 23 bu/a increase in yield when Cl was applied. Both soil and plant analyses appear to be good predictors of potential Cl responses; however, a Cl nutrition/plant disease interaction also can be a factor.

Table 3. Chloride fertilization on wheat cultivars, Kansas, 1997.

	Marion Co.[1]				Saline Co.[2]			
	Yield		Tissue Cl		Yield		Tissue Cl	
Cultivar	+Cl	-Cl	+Cl	-Cl	+Cl	-Cl	+Cl	-Cl
	bu/a		%		bu/a		%	
AP 7510	82	86	.07	.50	96	96	.40	.60
Cimarron	50	73	.06	.40	79	80	.36	.49
Coronado	79	83	.07	.44	87	80	.35	.59
Custer	82	87	.06	.39	100	95	.36	.50
Jagger	88	90	.06	.48	98	89	.36	.55
Karl 92	77	87	.06	.41	87	82	.32	.48
Ogallala	82	81	.06	.31	89	90	.29	.41
Pecos	85	91	.05	.46	92	94	.33	.57
Rowdy	82	85	.07	.35	91	88	.34	.50
Tam 107	83	87	.06	.44	82	88	.33	.48
Tam 200	69	77	.06	.47	81	81	.36	.57
Tomahawk	84	83	.05	.45	87	83	.31	.53
2137	89	91	.07	.47	100	99	.33	.52
2163	87	97	.06	.52	99	93	.41	.64
2180	80	79	.07	.39	79	85	.35	.52
7853	73	71	.07	.36	82	89	.32	.45
LSD's (0.05) Between Columns	2		.01		NS		.02	

[1] Marion Soil Test Cl: 7 lb/a (0-24 in.)
[2] Saline Co. Soil Test Cl: 22 lb/a (0-24 in.)

HARD RED WINTER WHEAT RESPONSE TO CHLORIDE FERTILIZATION AND AMISORB

S.R. Duncan, R.E. Lamond, D.A. Whitney, G. McCormack, and M. Pfeifer

Summary

Previous studies with winter wheat have shown positive responses to chloride (Cl) fertilization. The responses have tended to be variety specific and not always consistent within responsive varieties. With refinement of a profile Cl soil test, recommendations from the Kansas State University Research and Extension Soil Testing Laboratory are made with greater confidence than in the past. An application of 20-40 lb Cl/a, regardless of Cl source, to soils testing below 15 ppm Cl in the 0-24 in. profile usually will result in significant increases in wheat grain yield. Winter wheat yields in the first year of this study did not increase as the result of Cl applications, even though soil test levels of Cl were well below the 15 ppm floor. Grain yields of winter wheat did not increase with topdress applications of Amisorb.

Introduction

A significant acreage of the wheat grown in central Kansas is being treated with fertilizers containing Cl. University studies have shown that a positive response to 20-40 lb Cl/a, regardless of Cl source. More intense studies have shown specific varieties respond differently to the Cl applications. For example, 2163, a wheat variety planted on approximately 1.4 million acres in central Kansas in the fall of 1996, is very responsive to Cl. Conversely, Karl 92, a variety also planted on approximately 1.4 million acres, rarely shows a response to Cl, even with low Cl soil tests. 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, resulting in greater nutrient availability to the plants. The purpose of these studies was to evaluate the effects of Amisorb and Cl on winter wheat yields.

Procedures

Plots were established in the fall of 1996 on three sites in central Kansas: two sites in Kingman County and one in Ellsworth County. Soil test Cl levels and wheat varieties on the sites are shown in Table 4. Treatments of 0 and 20 lb Cl/a, as muriate of potash, alone or combined with 0, 1, and 2 qt/a Amisorb were broadcast applied in late February, 1997. All plots received the same basic fertility program as the rest of the field. Grain was harvested in June.

Results

Grain yields from the different treatments are reported in Table 4. The Maloney plot was grazed by cattle late in the season after the treatments were applied, which may explain the lower yields and may have affected results. No yield response to any rate of Cl, Amisorb, or combinations of the two was evident in any of the plots. The variety (2163) on the Janssen plot and included in the blend of three on the Maloney plot normally is responsive to Cl applications, especially when soil Cl test levels are so low. Jagger, the variety on the Messinger plot, is not thought to respond strongly to Cl fertilization and did not in 1997. The extremely long fill period and lack of foliar diseases experienced in the spring of 1997 could very well have masked any kind of yield response from the treatments.

These studies will be continued in the 1997-98 growing season.

Table 4. Wheat responses to chloride fertilization and Amisorb treatment at three sites in South Central Kansas, 1997.

Fertility Treatment		Plot, County		
Chloride†	Amisorb	Janssen, Ellsworth	Maloney, Kingman	Messinger, Kingman
lb/a	qt/a	- - - - - - - - - - - - -	bu/a	- - - - - - - - - - - - -
0.00	0.00	70	32	46
0.00	1	66	33	48
0.00	2	70	32	47
20	0.00	72	32	44
20	1	73	30	42
20	2	65	32	44
LSD (0.05)		17	5	7
Wheat variety		2163	Blend	Jagger
Chloride test, lb/a		7	4	4

† Supplied as muriate of potash 0-0-60 (Kcl).

EVALUATION OF AMISORB ON WHEAT

R.E. Lamond, M.A. Davied, D.D. Roberson, V.L. Martin, and T. Maxwell

Summary

Amisorb is a polymer of aspartic acid that has a high cation exchange capacity. Research has shown that this polymer may affect growth and production of several crops through improved nutrient uptake. This research evaluated Amisorb on wheat. Results from this work indicate that use of Amisorb had nonsignificant effects on leaf tissue nutrient concentrations, grain yields, and grain protein concentrations.

Introduction

Previous field research in Kansas and other states indicates that use of Amisorb has increased grain yields in some cases. The apparent mode of action is enhanced nutrient uptake. The objective of this research was to evaluate the use of Amisorb on wheat at several locations in central Kansas.

Procedures

A factorial arrangement with four replications including N rates (0, 40, 80 lb N/a) and Amisorb (none, 1 qt/a and 2 lb/a granular) was used at three sites. At a fourth site the Amisorb treatments were evaluated on an area receiving a blanket N application. The 1 and 2 qt/a Amisorb treatments were applied as a liquid. The N and liquid granular Amisorb were topdressed in February at all sites. Table 5 summarizes soil test information from the four sites. Leaf samples were taken at boot stage for nutrient analyses. Grain yields were determined (corrected to 13% moisture), and samples retained for protein analysis.

Results

Results from this work are summarized in Tables 6, 7, and 8. Although yields at most sites were good, the use of Amisorb had no significant effects on wheat grain yields or protein concentrations or leaf tissue nutrient concentrations. Nitrogen application increased leaf N and grain protein concentrations but had nonsignificant effects on grain yields, likely because of high residual soil N levels at all sites.

Amisorb was evaluated by other Kansas researchers in 1997, and their work is summarized elsewhere in this report.

Table 5. Soil test information at Kansas research sites, 1997.[1]

Site	pH	Bray-1 P	K	N	Organic Matter
		- - - - ppm	- - - -	lb/a	%
Saline Co. A	8.0	10	748	106	2.7
Saline Co. B	7.9	40	330	114	3.9
Sandyland Irrigated	6.1	49	281	66	1.4
Sandyland Dryland	6.6	24	78	22	1.0

[1] pH, P, K, and O.M. values are for 0-6 in. samples, N values are for 0-24 in.

Table 6. Effects of nitrogen and Amisorb on wheat, Saline County, Kansas, 1997.

		Saline Co. A					Saline Co. B				
N		Grain	Leaf Tissue *			Grain	Grain	Leaf Tissue			Grain
Rate	Amisorb	Yield	N	P	K	Protein	Yield	N	P	K	Protein
lb/a		bu/a	- - - - % - - - -				bu/a	- - - - % - - - -			
0	None	52	1.93	.20	2.03	10.7	61	2.14	.27	2.30	11.3
0	1 Qt/a	54	2.14	.20	2.03	10.5	58	2.10	.26	2.21	11.7
0	2 Qt/a	51	2.02	.20	2.00	10.4	64	2.18	.28	2.33	11.3
0	2 lb Gran	61	2.04	.19	2.13	11.2	57	2.26	.27	2.37	11.5
40	None	58	2.13	.20	2.16	11.5	60	2.28	.26	2.44	11.9
40	1 Qt/a	55	2.12	.20	2.17	11.4	65	2.36	.26	2.43	11.6
40	2 Qt/a	55	2.10	.19	2.13	11.5	59	2.31	.25	2.57	11.6
40	2 lb Gran	57	2.14	.20	2.21	11.5	58	2.20	.26	2.37	11.8
80	None	65	2.25	.20	2.35	12.3	61	2.65	.26	2.54	11.9
80	1 Qt/a	58	2.19	.20	2.22	12.4	58	2.61	.26	2.61	13.1
80	2 Qt/a	60	2.32	.21	2.33	12.4	58	2.62	.27	2.58	12.9
80	2 lb Gran	53	2.24	.20	2.27	12.1	64	2.53	.26	2.45	12.5
LSD (0.10)		NS	0.16	NS	0.15	0.7	NS	0.28	NS	0.19	1.1
Mean Values:											
N	0	54	2.03	.20	2.04	10.7	60	2.17	.27	2.30	11.5
Rate	40	56	2.21	.20	2.17	11.5	61	2.28	.26	2.45	11.8
	80	59	2.25	.20	2.30	12.3	60	2.61	.26	2.55	12.6
LSD (0.10)		NS	0.08	NS	0.07	0.3	NS	0.14	NS	0.09	0.5
	None	56	2.10	.20	2.18	11.5	61	2.36	.26	2.42	11.7
Amisorb	1 Qt/a	56	2.15	.20	2.14	11.4	60	2.36	.26	2.42	12.2
	2 Qt/a	55	2.15	.20	2.15	11.4	60	2.37	.27	2.49	12.0
	2 lb Gran	57	2.14	.20	2.20	11.6	60	2.31	.26	2.39	12.0
LSD (0.10)		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

* Tissue samples taken at boot stage.

Table 7. Effects of nitrogen and Amisorb on irrigated wheat, Sandyland Exp. Field, Kansas, 1997.

		Sandyland Field, Irrigated				
N		Grain	Leaf Tissue *			Grain
Rate	Amisorb	Yield	N	P	K	Protein
lb/a		bu\a	- - - - - - - - - - - - - - - -	%	- - - - - - - - - - - - - - - -	
0	None	58	2.00	.32	2.54	12.3
0	1 Qt/a	52	2.27	.33	3.02	13.2
0	2 Qt/a	56	2.06	.32	2.65	13.5
0	2 lb Gran	59	1.95	.31	2.57	13.4
40	None	52	2.10	.32	2.60	13.3
40	1 Qt/a	52	2.14	.30	2.70	14.0
40	2 Qt/a	53	2.05	.32	2.57	13.7
40	2 lb Gran	54	2.26	.33	2.90	14.1
80	None	52	2.24	.32	2.83	14.5
80	1 Qt/a	50	2.47	.32	2.99	14.4
80	2 Qt/a	50	2.37	.32	3.02	14.3
80	2 lb Gran	54	2.33	.32	2.79	14.1
LSD (0.10)		NS	0.38	NS	NS	1.4
Mean Values:						
N	0	57	2.07	.32	2.70	13.1
Rate	40	53	2.14	.32	2.71	13.8
	80	52	2.35	.32	2.88	14.3
LSD (0.10)		NS	0.19	NS	NS	0.7
	None	54	2.11	.32	2.68	13.4
Amisorb	1 Qt/a	51	2.30	.32	2.87	13.9
	2 Qt/a	53	2.16	.32	2.74	13.8
	2 lb Gran	56	2.18	.32	2.75	13.8
LSD (0.10)		NS	NS	NS	NS	NS

* Tissue samples taken at boot stage.

Table 8. Effects of Amisorb on wheat, Sandyland Exp. Field, Kansas, 1997.

	Sandyland Field, Dryland				
	Grain	Leaf Tissue *			Grain
Amisorb	Yield	N	P	K	Protein
	bu/a	- - - - - - - - - - - - - - % - - - - - - - - - - - - - -			
None	32	1.24	.19	1.61	11.1
1 Qt/a	34	1.30	.20	1.63	11.4
2 Qt/a	33	1.28	.19	1.58	10.8
2 lb Gran	35	1.26	.19	1.62	11.2
LSD (0.10)	NS	NS	NS	NS	NS

* Tissue samples taken at boot stage.

HARD RED WINTER WHEAT RESPONSE TO SULFUR FERTILIZATION AND AMISORB

S.R. Duncan, R.E. Lamond, D.A. Whitney, V.L. Martin, G. McCormack, and L. Kater

Summary

Past studies on winter wheat in Kansas have shown mixed responses to sulfur (S) fertilization. Most Kansas soils have organic matter (OM) contents greater than 1%, so S usually is not recommended as part of the fertility program. Results from this work also were mixed, but winter wheat generally did not respond to S, even on soils with 1% or less OM. Amisorb topdress applications also did not appear to result in wheat grain yield response. The weather conditions experienced in the 1996-97 growing season probably had a greater influence on grain yields than any part of the wheat fertility programs, including S and Amisorb.

Introduction

A significant amount of the wheat acreage in Kansas is grown on soils with organic matter (OM) levels of 1% or less. Soil temperatures during a major portion of the wheat growing season are below 50EF. Consequently, available sulfur (S) in the soil solution is low. Results of recent research on bromegrass, a cool-season perennial, have shown consistently significant forage yield increases with the addition of S to the fertility program. In 1996, S applications on soils with low OM and testing low to moderate for SO_4-S did not result in increased wheat grain yields. 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, resulting in greater nutrient availability to the plants. The current sites were established to continue and expand an S fertilization project that started in 1996.

Procedures

Plots were established on four sites in central and south central Kansas: Ottawa, Kingman, and Pratt counties and on the Sandyland Experiment Field in Stafford County. Organic matter content, soil test, and wheat variety information are shown in Table 9. Treatments of 0, 5, 10, and 20 lb S/a, as ammonium thiosulfate (ATS), alone or combined with 0, 1, and 2 qt Amisorb/a were broadcast in late February and early March, 1997. Nitrogen (N) in plots not treated with ATS was balanced to the same levels using liquid urea ammonium nitrate (UAN). All plots were fertilized with the same program used by the farmer or the Experiment Field. Grain was harvested in June.

Results

Grain yields are reported in Table 9. The Ottawa County plots were lost to a custom harvester. The Maloney plots were grazed by cattle after the plots were established, which may explain the lower yields and may have affected results. Only one significant yield response was noted at one location, and as previously mentioned, results from the Maloney site were suspect. No S or Amisorb rate resulted in yield responses at the other sites. The extremely long fill period and lack of foliar diseases experienced in the spring of 1997 could very well have masked any kind of yield response from the treatments.

This study will be continued in the 1997-98 growing season.

Table 9. Wheat response to sulfur fertilization and Amisorb treatment at three sites in South Central Kansas, 1997.

Fertility Treatment		Plot, County		
Sulfur†	Amisorb®	Sandyland, Stafford	Maloney, Kingman	Fitzsimmons, Pratt
lb/a	qt/a	- - - - - - - - - - - - - bu/a - - - - - - - - - - - - -		
0	0	42	32	77
0	1	42	36	73
0	2	37	36	72
5	0	42	35	66
5	1	42	38	78
5	2	42	38	67
10	0	44	30	71
10	1	44	36	71
10	2	41	41	83
20	0	43	38	67
20	1	41	33	78
20	2	46	36	66
LSD (0.05)		9	10	17
Wheat variety		2137	Blend	Tomahawk
Sulfur test, lb/a		1.2	1.4	1.2
Organic matter, %		1.0	0.8	1.4

† Supplied as ammonium thiosulfate 12-0-0-26 (ATS).

EVALUATION OF A BIOLOGICAL INOCULANT ON WHEAT

R.E. Lamond, M.A. Davied, and D.D. Roberson

Summary

Research in China evaluating biological inoculants on wheat indicates potential for these products to improve N efficiency. In 1997 Feiyuan, a biological inoculant, was evaluated at two sites in eastern Kansas. Although yields were good to excellent, the inoculant had no impact on wheat tissue N concentrations, grain yields, or grain protein.

Introduction

Considerable research has been conducted in China and Europe evaluating the use of biological inoculants on cereal crops. These materials apparently have the potential to improve nitrogen (N) utilization efficiency, even in nonlegume crops like wheat. Little work has been done in the United States evaluating these inoculants. This work was initiated to evaluate Feiyuan on wheat.

Procedures

A factorial arrangement of N rates (0, 40, 80 lb N/a) and Feiyuan treatments (none, wet seed, dry seed, foliar) was used to evaluate this inoculant on wheat. Field studies were established at the North Agronomy Farm (silty clay loam) and the Ashland Agronomy Farm (sandy loam). Four replications were used. The North Farm site had 3% organic matter and high residual N (110 lb/a), whereas the Ashland site had 1.1% organic matter with low residual N (12 lb/a). Feiyuan was applied either as a wet seed treatment (1:25 ratio by weight with water, seed soaked 12 hours before planting); a dry seed treatment (3 lb/a mixed with seed), or a foliar treatment (3 lb/a applied in 20 gal/a water at jointing). Nitrogen as ammonium nitrate was topdressed in February. Jagger was used at the North Farm and 2163 was used at Ashland. Stand counts were taken at greenup, and leaf N samples were taken at boot stage for N analysis. Grain yields were determined by harvesting a 20 ft length of the center three rows of each plot. Yields were corrected to 13%. Grain samples were retained for test weight and protein analysis.

Results

Results of this research are summarized in Tables 10 and 11. Effects of the inoculant on leaf N concentrations, grain test weight, and protein were minimal. The wet seed treatment resulted in lower stand counts and, subsequently, lower yields at both sites. This occurred because the seed swelled during the soaking process, resulting in a lower seeding rate relative to other treatments.

Nitrogen rate effects were much more dramatic, particularly at the Ashland site, which had low residual N levels. Nitrogen applications up to 80 lb/a significantly increased leaf N, grain yields, and grain protein. At the North Farm, 80 lb N/a increased leaf N and grain protein compared to the no N treatment, but N effects on yield were nonsignificant. This site had high residual soil N.

Based on these results, effects of this inoculant on wheat are minimal.

Table 10. Effects of Feiyuan and nitrogen on wheat yields and protein, northeastern Kansas, 1997.

		Ashland Farm		North Agronomy Farm	
N Rate	Feiyuan	Plants per 12"	Leaf N	Plants per 12"	Leaf N
lb/a			%		%
0	None	9.5	1.32	8.6	1.91
0	Wet seed 1:25	5.0	1.40	6.3	2.06
0	Dry seed 3 lb/a	8.5	1.33	7.4	2.06
0	Foliar 3 lb/a	9.8	1.25	8.6	1.93
40	None	9.1	1.42	8.4	1.99
40	Wet seed 1:25	3.9	1.53	4.4	2.06
40	Dry seed 3 lb/a	8.8	1.48	7.9	2.19
40	Foliar 3 lb/a	9.6	1.36	8.8	2.08
80	None	12.3	1.64	9.5	2.06
80	Wet seed 1:25	4.1	1.73	6.1	2.14
80	Dry seed 3 lb/a	10.2	1.55	7.3	2.19
80	Foliar 3 lb/a	10.2	1.68	7.8	2.11
LSD (0.05)		2.1	0.23	1.8	NS
Mean Values:					
N	0	8.2	1.32	7.7	1.99
Rate	40	7.9	1.45	7.4	2.08
	80	9.2	1.65	7.7	2.12
LSD (0.05)		NS	0.12	NS	0.11
	None	10.3	1.46	8.8	1.99
Feiyuan	Wet seed 1:25	4.3	1.55	5.6	2.09
	Dry seed 3 lb/a	9.2	1.45	7.6	2.15
	Foliar 3lb/a	9.5	1.43	8.4	2.04
LSD (0.05)		1.5	NS	1.0	NS

Table 11. Effects of Feiyuan and nitrogen on wheat stand counts and leaf N, northeastern Kansas, 1997.

		Ashland Farm			North Agronomy Farm		
N Rate	Feiyuan	Yield	Test Wt.	Protein	Yield	Test Wt.	Protein
lb/a		bu/a	lb/a	%	bu/a	lb/bu	%
0	None	28	61	10.1	74	64	12.0
0	Wet seed 1:25	22	58	10.5	62	63	11.9
0	Dry seed 3 lb/a	27	61	11.0	75	64	11.8
0	Foliar 3 lb/a	31	61	10.1	69	64	12.1
40	None	45	61	10.8	72	63	12.1
40	Wet seed 1:25	42	61	10.6	62	63	12.5
40	Dry seed 3 lb/a	49	61	10.6	70	63	12.2
40	Foliar 3 lb/a	49	61	10.1	75	64	12.5
80	None	56	61	11.7	79	64	12.2
80	Wet seed 1:25	50	60	12.0	66	63	12.7
80	Dry seed 3 lb/a	50	61	12.2	72	64	13.2
80	Foliar 3 lb/a	55	61	12.7	75	64	12.5
LSD (0.05)		12	NS	1.3	9	NS	1.2
Mean Values:							
N	0	27	60	10.4	70	64	12.0
Rate	40	46	61	10.5	70	63	12.3
	80	53	61	12.2	73	64	12.7
LSD (0.05)		6	NS	0.6	NS	NS	0.6
	None	43	61	10.9	75	64	12.1
Feiyuan	Wet seed 1:25	35	60	11.0	63	63	12.4
	Dry seed 3 lb/a	42	61	11.3	72	64	12.4
	Foliar 3lb/a	45	61	10.9	73	64	12.4
LSD (0.05)		7	NS	NS	5	NS	NS

GRASS FERTILIZATION STUDIES
KANSAS STATE UNIVERSITY - DEPARTMENT OF AGRONOMY

NITROGEN RATES AND SOURCES FOR BROMEGRASS

R.E. Lamond, D.D. Roberson, and M.A. Davied

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 AgrotaiN® (urea with a urease inhibitor) or ammonium nitrate. AgrotaiN is now commercially available.

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 through 1997 to evaluate effects on bromegrass of N sources topdressed in March.

Procedures

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

Results

Forage yields in 1997 were average (Table 1). Excellent responses to N were noted up to the 90 lb N/a rate. In 1997, AgrotaiN produced higher forage yields than urea or UAN. AgrotaiN also produced significantly higher forage protein concentrations than all other N sources. Comparing 4-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. Effects of nitrogen rates and sources on bromegrass, Riley Co., Kansas.

N	N	Forage		1994-1997 Avg.	
Rate	Source	Yield	Protein	Yield	Protein
lb/a		lb/a	%	lb/a	%
0	--	2330	8.7	3490	8.6
45	Urea	4360	8.8	5590	9.4
90	Urea	5620	10.3	6690	11.6
45	AgrotaiN	4960	10.0	6100	10.2
90	AgrotaiN	5930	11.3	7480	12.0
45	Am. Nitrate	4800	9.2	6080	9.6
90	Am. Nitrate	5990	10.8	7170	11.8
45	UAN	3850	8.6	5070	9.0
90	UAN	4790	9.1	6280	10.1
LSD (0.05)		806	0.7	--	--
Mean Values:					
N	45	4490	9.1	5710	9.5
Rate	90	5580	10.4	6910	11.4
LSD (0.05)		420	0.4	--	--
N	Urea	4990	9.6	6160	10.5
Source	AgrotaiN	5450	10.6	6790	11.1
	Am. Nitrate	5390	10.0	6630	10.7
	UAN	4320	8.8	5670	9.5
LSD (0.05)		600	0.5	--	--

BROMEGRASS FERTILIZATION STUDIES

R.E. Lamond, G.L. Keeler, J. Holthaus, H.C. George, M.A. Davied, D.D. Roberson, G.L. Kilgore, 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) from the soil. Results from these studies confirm that bromegrass responds to P fertilization, particularly when P soil test levels are low. Good efficiency of applied N will not be achieved until P needs are met.

Introduction

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

Procedures

Studies were continued in 1997 in Douglas County (two sites), Miami County (four sites), and Jackson County (three sites) to evaluate N, P, and S. All sites were low to medium in available P. All fertilizer was applied in February, and grass was harvested in early June at all sites. Forage samples were retained for analyses.

Results

The 1997 results are summarized in Tables 2 and 3. Yields were average in Douglas and Jackson counties, yet good responses to N were noted. The 80 lb N/a rate produced yields not significantly different than 120 lb N/a at four of five sites in these counties, probably because the yields were only average. Yields in Miami County were excellent and were increased by N application up to 120 lb/a at three of the four sites. Phosphorus fertilization increased brome forage yields at five of the nine sites. The four nonresponsive sites had soil test P levels of 14 ppm or greater, whereas the five responsive sites all had less than 10 ppm. The addition of S tended to produce higher yields, though not all of the yield increases were statistically significant.

These studies will be continued in 1998.

Table 2. Fertility management on bromegrass in Douglas and Jackson counties, Kansas, 1997.

			Forage Yield				
N	P	S	Douglas Co. A	Douglas Co B	Jackson Co. A	Jackson Co. B	Jackson Co. C
	lbs/a				- - - - - - - - - - - lbs/a - - - - - - - - - - -		
0	0	0	2300	1210	2850	2160	1480
40	0	0	4180	3610	4180	4750	2980
80	0	0	4470	3790	5870	5140	4174
120	0	0	4350	3500	6120	5750	3900
40	30	0	4380	3830	4490	4880	3500
80	30	0	4990	4490	6170	5090	4240
120	30	0	5100	4770	6100	5540	4270
80	30	20	5470	4560	6170	5310	4540
	LSD (0.10)		520	600	770	430	790
Mean Values:							
N	40		4280	3710	4370	4840	3240
Rate	80		4730	4140	5980	5120	4210
	120		4720	4130	6110	5640	4240
	LSD (0.10)		320	NS	530	320	610
P_2O_5	0		4330	3630	5360	5210	3750
Rate	30		4820	4360	5610	5180	4040
	LSD (0.10)		260	350	NS	NS	NS
	Soil Test P (lb/a)		6	4	12	15	18

Table 3. Fertility management on bromegrass in Miami County, Kansas, 1997.

N	P	S	Forage Yield			
			Miami Co. A	Miami Co B	Miami Co. C	Miami Co. D
	lbs/a		- - - - - - - - - - -	lbs/a	- - - - - - - - - - -	
0	0	0	4330	3270	3950	3880
40	0	0	7810	7200	7970	7380
80	0	0	8140	8360	9150	8260
120	0	0	8460	11,340	11,760	11,080
40	30	0	8250	7380	8640	8500
80	30	0	8940	9080	11,200	10,570
120	30	0	9390	11,280	12,240	11,500
80	30	20	8860	9810	10,710	11,030
	LSD (0.10)		1120	760	1290	1040
Mean Values:						
N	40		8030	7290	8300	7940
Rate	80		8540	8720	10,170	9420
	120		8920	11,310	12,000	11,290
	LSD (0.10)		NS	590	970	710
P_2O_5	0		8130	8960	9620	8910
Rate	30		8860	9250	10,690	10,190
	LSD (0.10)		710	NS	790	580
	Soil Test P (lb/a)		9	14	7	6

EVALUATION OF NITROGEN RATES AND AMISORB ON BROMEGRASS

R.E. Lamond, M.A. Davied, and D.D. Roberson

Summary

Amisorb is marketed as a nutrient absorption enhancer and has been shown to positively affect growth and production of a number of crop plant species. Little work has been done on cool-season forage grasses; thus, this work was initiated to evaluate. Amisorb on bromegrass. Even though brome forage yields were below average in 1997 at this site, nitrogen (N) application up to 90 lb/a increased yields and forage protein. The addition of Amisorb at either 1 or 2 qt/a had no effect on yields, but the 2 qt/a rate did significantly increase forage protein. More field research is needed to establish guidelines for potential use of Amisorb.

Introduction

Amisorb is a heavy polymer of aspartic acid with a very high cation exchange capacity. The polymer has been shown to positively affect the growth and production of some crops. These responses are believed to be the results of improved nutrient uptake. Most work evaluating Amisorb has been done on row crops or cereals, with little available information on cool-season grass forages. This study evaluated N and Amisorb applications on bromegrass.

Procedures

Nitrogen rates (0, 45, 90 lb/a) and Amisorb (0, 1, 2 qt/a) were evaluated on established bromegrass at the North Agronomy Farm, Riley County. The N was applied as urea-ammonium nitrate (UAN) solution. When Amisorb was applied, it was mixed with UAN prior to application. All treatments were topdressed in late February. A no-N, no-Amisorb check treatment was included. Grass was harvested in late May. Forage yields were determined, and forage was analyzed for protein content.

Results

Brome forage yields at this site were below average (Table 4). Even with the fairly low yields, N application up to 90 lb/a increased forage production and protein concentrations. Amisorb application had no effect on bromegrass forage yields. However, the 2 qt/a rate produced significantly higher forage protein than either the no Amisorb or the 1 qt/a treatments.

Table 4. Evaluation of nitrogen rates and Amisorb on bromegrass, Riley Co. Kansas, 1997.

N Rate	Amisorb	Forage Yield	Forage Protein
lb/a	qt/a	lb/a	%
0	0	2330	8.7
45	0	3850	8.7
90	0	4790	9.1
45	1	3770	8.8
90	1	4760	9.0
45	2	3640	8.9
90	2	4640	9.6
LSD (0.10)		390	0.4
Mean Values:			
N Rate 45		3750	8.8
N Rate 90		4720	9.3
LSD (0.10)		230	0.3
Amisorb 0		4300	8.9
Amisorb 1		4260	8.9
Amisorb 2		4140	9.3
LSD (0.10)		NS	0.3

BROMEGRASS YIELDS AND QUALITY AS AFFECTED BY VARIOUS RATES OF PHOSPHORUS AND HARVEST DATES

D.E. Kehler and S.R. Duncan

Summary

Research has shown that bromegrass responds to phosphorus (P) fertilization, especially when soil test P levels are low. Nitrogen (N) will not be used efficiently until P needs are satisfied. Our first-year results indicate that dry matter yields and crude protein concentrations increased with N fertilization. Dry matter yield increases were greater with the addition of P to the fertilizer treatment. Forage P concentration also responded positively to P fertilization. Though delaying harvest from early June to early July resulted in significantly more dry matter harvested, forage crude protein and P concentration were reduced significantly. This work will be continued in 1998.

Introduction

A significant amount of the smooth bromegrass acreage grown for hay in south central Kansas is produced on soils with low soil test phosphorus (P) levels. In many fields, this low level of soil P has resulted in an invasion of prairie threeawn. Many producers apply only nitrogen (N) to their bromegrass because of a lack of soil testing or cost of P fertilization. Application of N alone on these low P soils can result in poor stands of bromegrass. Harvest often is delayed past optimum time in anticipation of increased yields, but delaying harvest adversely affects hay quality and hurts bromegrass stands. This 5-year study was established to show the cumulative effects of various P rates and harvest dates on dry matter yields, hay quality, and potential rejuvenation of a bromegrass hay meadow that was in poor condition.

Procedures

This study was established on a site in Butler County in February 1996. Initial soil tests taken at a depth of 4 in., showed a pH of 6.4, available P of 7.5 ppm and available potassium of 255 ppm. The field has a history of low yields and a very heavy invasion of prairie threeawn. Extremely dry conditions in the winter of 1996 delayed fertilization of plots until March. Triple superphosphate and urea were used as the nutrient sources. Phosphorus was topdressed at 30 lb P_2O_5/a alone and in combination with 80 lb/a N as urea at 0, 15, 30, and 45 lbs/a P_2O_5. These treatments have remained constant throughout the study. Severe droughty conditions resulted in no forage harvest in 1996. A second set of soil tests was done in December 1996, and fertilizer was applied in February 1997. A third set of soil tests was done in September 1997. A 14 ft by 34 in. area was harvested from half of each 10 ft by 20 ft plot with a 34 in. sickle-bar mower on June 2 or July 2, 1997. The same halves will be harvested in the same sequence approximately 30 days apart in each year of this study. The hay was cut at a 4 in. stubble height, and after the July 2 harvest, all previously uncut border areas were cut and removed from the site. Bromegrass was in bloom on the June 2 cutting date and at hard dough on the July 2 harvest. A subsample from each plot was weighed and then dried in a dehydrator to determine percent dry matter. The yield results shown are approximately 96% dry matter.

Results

Soil test results are shown in Table 5. An increase in available P from P_2O_5 applications was not observed until the test in September 1997 (Table 5) and then only on the plots that had received two applications of 30 or 45 lbs/a P_2O_5.

Even though brome production was low (unharvestable) in 1996, prairie threeawn in plots that received any amount of P was reduced 75-80% by December 1996 (not shown). By May of 1997, prairie threeawn was virtually eliminated from plots that received P in 1996 and 1997. Plots that had no application of P in either year remain infested with prairie threeawn. Infestation levels were determined by visual evaluation. Table 6 summarizes the results of the 1997 harvests. As expected on this low P testing soil, increasing rates of P resulted in increased N utilization. The dramatic increase created by the addition of only 15 lbs/a of P_2O_5 to the fertility program shows that application of N alone when low soil test P levels exist is not cost effective. The additional 650 lbs/a dry matter (worth approximately $22.75) produced by applying 30 vs 15 lbs/a P_2O_5 (an additional $4-5/a) also is cost effective. Although a significant (36%) increase in forage occurred for the July 2 harvest compared to the June 2 harvest, 23% and 15% decreases in crude protein and P concentrations, respectively, existed for all treatments. The forage P levels of all samples (less than 0.02%) were low for livestock utilization. The high protein concentration of the forage from the 80-0-0 treatments may have been due to delayed maturity resulting from low P levels in the soil.

This study will be continued through the year 2000 to follow the cumulative effects of these management practices.

Table 6. Soil test results* from and fertilizer P_2O_5 applied to a bromegrass hay meadow, Butler Co., Kansas, 1996-1997.

P_2O_5 Applied, lbs/a		Available P, ppm	
March 1996	February 1997	December 1996	September 1997
0	0	4	5
15	15	3	6
30	30	3	12
45	45	7	22

* Initial soil test results were: pH = 6.4; available P = 7.5 ppm; available K = 255 ppm.

Table 6. Influences of fertilizer treatment and cutting date on dry matter yield and protein and phosphorus concentrations of smooth bromegrass growing on a low phosphate site, Butler Co., Kansas, 1997.

Fertilizer N - P - K	Cutting Date	Dry Matter Yield	Crude Protein	Phosphorus
lb/a		lb/a	- - - - - - - - - - - - %	- - - - - - - - - - - -
0-0-0	June 2	261	5.6	0.080
	July 2	1308	6.2	0.087
80-0-0	June 2	1009	10.5	0.093
	July 2	2389	8.5	0.080
0-30-0	June 2	644	6.3	0.137
	July 2	1373	5.4	0.133
80-15-0	June 2	2619	9.5	0.113
	July 2	3633	6.9	0.100
80-30-0	June 2	3154	9.4	0.120
	July 2	4414	5.9	0.083
80-45-0	June 2	3349	9.4	0.143
	July 2	4052	6.1	0.100
LSD (P=0.05)		355	1.4	0.019
Treatment means:				
0-0-0		784	5.9	0.083
80-0-0		1699	9.5	0.087
0-30-0		1009	5.8	0.135
80-15-0		3126	8.2	0.107
80-30-0		3784	7.6	0.102
80-45-0		3701	7.8	0.122
LSD (P=0.05)		235	1.2	0.017
Harvest means:				
	June 2	1839	8.4	0.114
	July 2	2862	6.5	0.097
LSD (P=0.05)		137	0.7	0.010

NITROGEN RATES AND SOURCES FOR BROMEGRASS IN ANDERSON COUNTY

G. L. Kilgore and J. Zimmerman

Summary

Nitrogen (N) sources and rates for bromegrass have been the subjects of research for years. However, we continue to get questions from producers and fertilizer dealers as to N sources and rates. Topdressing N later than mid February in southeast Kansas potentially can result in N volatization from any urea-containing fertilizer because of warm temperatures. This study, with applications in March, showed that forage yields with rates of 90 and 120 lbs. N/a from ammonium nitrate were significantly higher than forage yields with urea. Protein content increased as N rates increased, and protein content was slightly higher when ammonium nitrate was applied, regardless of the rate.

Introduction

Urea-containing fertilizers (urea and UAN) have the potential for volatization loss of N when material is topdressed on cool-season grass later than the recommended time of November to mid February. Volatization isn't a concern when soil and air temperatures are cool. This study was initiated to measure the performance of ammonium nitrate and urea as N sources applied to bromegrass.

Procedures

Nitrogen rates (0, 30, 60, 90, 120 lb N/a) and sources (ammonium nitrate and urea) were evaluated on bromegrass on a farm in Anderson County, Kansas. Twenty pounds of P_2O_5 was applied to all treatments. Application was made on March 6, and grass was cut with a sickle bar plot mower on June 13. Forage yields were determined, and forage was analyzed for protein content.

Results

Forage yields for 1997 were good (Table 7). Response to N was good above the 60 lb rate. Yields continued to increase as N rate increased to the 120 lb rate. At the 90 and 120 lb N rates, ammonium nitrate produced significantly higher yields than urea. At the lower rates, forage yields were not significantly different between the two N sources. Protein content increased as N rates increased, and protein content was slightly higher with ammonium nitrate as the N source.

Table 7. Nitrogen rates and sources for bromegrass, Anderson Co., KS., 1997

N	N	Forage	
Rate	Source	Yield	Protein
lbs/a		t/a	%
0		1.21	6.8
30	Urea	1.49	7.9
60	Urea	2.15	8.4
90	Urea	2.79	8.9
120	Urea	3.25	9.4
30	Am Nitrate	1.28	8.4
60	Am. Nitrate	2.18	8.8
90	Am. Nitrate	3.15	9.4
120	Am. Nitrate	4.27	10.4
LSD .05		0.61	0.6

SOIL FERTILITY RESEARCH
SOUTHWEST RESEARCH - EXTENSION CENTER

NITROGEN MANAGEMENT OF DRYLAND WINTER WHEAT

A.J. Schlegel, J.L. Havlin, and K.C. Dhuyvetter

Summary

Research was initiated in 1993 to determine the nitrogen (N) fertilizer requirement for dryland winter wheat grown under reduced tillage systems in western Kansas. Application of N fertilizer increased grain yields up to 20 bu/a at sites when residual soil N was less than 10 ppm. Grain yields were maximized by N rates of 40 to 80 lb/a. Yields tended to be about 2 to 5 bu/a greater when N was injected rather than broadcast.

Introduction

The N fertilizer recommendations for winter wheat in western KS were developed under clean tillage systems. In these systems, most of the residue is incorporated into the soil, leaving a seedbed with minimal residue cover. Current reduced-tillage systems emphasize conserving surface residue to reduce erosion potential and enhance soil water storage. However, crop residue on the soil surface can impact the efficiency of N fertilizer utilization by plants. This research was initiated to determine whether adoption of reduced-tillage systems has changed the N fertilizer requirements for dryland winter wheat in western Kansas.

Procedures

Six sites that varied in residual soil N were selected each year, in conjunction with farmer cooperators. All sites were on silt loam soil that contained adequate amounts of other nutrients. Fluid N (28% N as urea-ammonium nitrate solution) was spoke injected in the fall and spring and broadcast during the winter and spring at five rates (20, 40, 60, 80, and 100 lb N/acre) along with a zero N control. Four of the sites were lost to spring freeze damage in 1996, and one site was lost and another damaged by hail in 1997. The center of each plot was combine harvested, and grain yields were adjusted to 12.5% moisture.

Results

Application of N fertilizer increased grain yields at the two sites in 1996 by 13 to 15 bu/a (Table 1). The N rate required to maximize yield was 80 lb/a. The highest yields were obtained when the N was injected in the fall. Both sites had less than 6 ppm residual soil N (NO_3+NH_4 in 0-24" depth) and more than 20% residue cover at planting.

Nitrogen fertilization increased grain yields at all sites in 1997. Yield increases ranged from 6 to 22 bu/a. All sites had less than 10 ppm residual soil N at planting, but surface residue cover was very low at several sites. Hail reduced grain yield at the site with the least yield increase. The rate of N required to maximize yield ranged from 40 to 80 lb/a. Grain yields were 3 to 4 bu/a greater with injected N rather than broadcast when averaged across all sites. The best time of injection varied across sites. Grain yields with fall injection were greater at one site, less at another, and not significantly different at three sites. No differences occurred between winter and spring broadcast applications.

Table 1. Effects of time and method of N application and N rate on grain yield of dryland winter wheat at two locations, SWREC, 1996.

		Grain Yield	
Time/Method of Application	N Rate	Dixon	Hager
	lb/a	bu/a	
Fall	20	38	36
Inject	40	42	40
	60	48	42
	80	50	47
	100	51	47
Winter	20	39	34
Broadcast	40	45	35
	60	43	40
	80	42	43
	100	42	45
Spring	20	40	34
Inject	40	48	37
	60	44	38
	80	43	41
	100	42	41
Spring	20	36	32
Broadcast	40	38	32
	60	40	36
	80	48	38
	100	44	35
Control		31	29
Soil NH_4+NO_3 (ppm in 0-2 ft)		3.9	5.9
Soil NO_3 (0-6")		3.9	7.2
(6-24")		1.6	3.3
Soil OM % (0-6")		2.2	1.6
Residue Cover (% at planting)		23	30
ANOVA (P>F)			
N rate		0.001	0.001
Linear		0.001	0.001
Quadratic		0.001	0.003
Time of application		0.047	0.001
Bdct vs Inject		0.014	0.001
F/W vs Spring		0.203	0.001
Spring bdct vs Inject		0.191	0.001
N rate x Appl.		0.055	0.080
MAIN EFFECT MEANS			
Time/Method of application			
Fall inject		46	42
Winter bdct		42	39
Spring inject		43	38
Spring bdct		41	35
$LSD_{.05}$		3	2
N rate			
0 lb/acre		31	29
20		38	34
40		43	36
60		44	39
80		46	42
100		45	42
$LSD_{.05}$		3	2

Note: Time/method means and ANOVA and interactions are calculated without 0 N included. N means and ANOVA include 0 N rate.

Table 2. Effects of time and method of N application and N rate on grain yield of dryland winter wheat at five locations, SWREC, 1997.

Time/Method of Application	N Rate	NolanH	Lawson	Dixon[a]	Hager	NolanCL
		Grain Yield				
	lb/a	bu/a				
Fall	20	31	24	23	24	51
Inject	40	38	30	25	31	53
	60	39	39	27	34	57
	80	47	44	20	36	53
	100	46	44	23	39	54
Winter	20	26	21	25	22	47
Broadcast	40	31	25	21	23	50
	60	35	31	29	27	57
	80	35	34	28	29	59
	100	40	37	25	33	53
Spring	20	33	29	26	24	52
Inject	40	37	37	24	31	55
	60	40	36	27	34	54
	80	43	36	28	37	58
	100	40	42	28	38	63
Spring	20	25	26	23	18	49
Broadcast	40	29	29	29	21	55
	60	34	30	24	27	53
	80	39	32	21	30	51
	100	42	39	27	33	55
Soil NH_4+NO_3 (fall) (ppm in 0-2 ft)		6.8	8.3	9.1	9.4	9.6
Soil NO_3 ppm (0-6")		10.7	12.0	12.9	20.5	13.6
(6-24")		3.6	1.9	2.9	4.1	5.8
Soil OM % (0-6")		1.7	1.8	1.5	1.8	1.9
Residue Cover %		4	20	7	2	21
ANOVA (P>F)						
N rate		0.001	0.001	0.001	0.001	0.001
Linear		0.001	0.001	0.001	0.001	0.001
Quadratic		0.001	0.979	0.002	0.001	0.011
Time of Application		0.001	0.001	0.081	0.001	0.055
Bdct vs Inj		0.001	0.001	0.777	0.001	0.039
Bdct winter vs spring		0.872	0.095	0.602	0.500	0.844
Inject Fall vs spring		0.015	0.532	0.012	0.913	0.064
N rate x Appl.		0.001	0.004	0.011	0.896	0.125
MAIN EFFECT MEANS						
Time/Method of applic.						
Fall inject		40	36	23	33	54
Winter bdct		33	29	25	27	53
Spring inject		38	36	26	33	56
Spring bdct		33	31	25	26	53
$LSD_{.05}$		1	2	2	3	3
N rate						
0 lb/acre		21	23	20	14	46
20		29	25	24	22	50
40		33	30	25	27	53
60		37	34	27	30	55
80		41	36	24	33	55
100		42	40	26	36	56
$LSD_{.05}$		2	4	3	3	3

Note: Time/method means and ANOVA and interactions are calculated without 0 N included. N means and ANOVA includes 0 N rate.
[a]Damaged by hail.

BEST MANAGEMENT PRACTICES FOR RETURNING CRP LAND TO WHEAT PRODUCTION

A.J. Schlegel and C.R. Thompson

Summary

The majority of the CRP acres in Kansas are in the western area. Most contracts under the initial CRP are about to expire. If these acres are not re-enrolled in the new program, most of the CRP land is expected to be returned to crop production. This study was initiated in 1995 to evaluate best management practices for returning CRP land to crop production. The CRP grasses (mixed species, warm-season grasses) were controlled better by tillage than herbicides, and good grass control is essential for optimum crop production. Removal of the old residue by burning or mowing had no positive effect on wheat yields. Soil water content is very low following destruction of the CRP grasses. Sufficient time should be allowed between destruction of the CRP grasses and planting of the first crop to allow accumulation of soil water. Residual soil inorganic N levels are extremely low in CRP land and supplemental N fertilization (greater than normal amounts) will be required for optimal growth of the initial crop.

Introduction

In Kansas, 2.9 million acres were enrolled in the Conservation Reserve Program (CRP); this was the third greatest participation by any state. The majority (>50%) of the CRP acres in Kansas are in the western one-third of the state. Hamilton County had the highest CRP enrollment of over 125,000 acres. Stanton, Morton, and Greeley counties had over 80,000 acres. Over 90% of the CRP land in Kansas is planted to grass. Based on past experience with an earlier land retirement program, the "Soil Bank", most acres planted to grass will return to crop production. The southwest and west-central Kansas crop reporting districts have almost 1.2 million acres enrolled in the CRP (over 40% of the Kansas total). The principal crop grown on land prior to enrollment in the CRP was winter wheat. With the expiration of CRP contracts, many of these acres will return to wheat production.

Procedures

This study was initiated in the spring of 1995 in west-central Kansas near Tribune, KS. The study area was enrolled in the CRP and had an established stand of warm-season grasses. Primary species were sideoats grama, little bluestem, blue grama, buffalograss, and switchgrass, which are typical for the area. Soil type was a Richfield silt loam with less than 1% slope. The objectives of the project were to determine best management practices for returning CRP land to crop production. The variables evaluated were residue pretreatment (burn, mow, or leave standing), grass control methods (tillage or chemical control); and N fertilization. The burn treatments were done in late April 1995. The mow treatments were done in early July and late September 1995.

The no-till treatment for 1996-97 wheat received three applications of glyphosate (2 qt/a) plus ammonium sulfate and surfactant (mid-July 1995, early July 1996, and late August 1996). The conventional-tillage treatment was offset disked twice (July and August 1995) and sweep plowed four times (September 1995, June, July, and September 1996). Reduced-tillage treatments received one application of glyphosate (2 qt/a) plus ammonium sulfate and surfactant either in July or September 1995. The reduced-tillage treatment that received glyphosate in July was offset disked in August 1995 and sweep plowed in September 1995. The other reduced-tillage treatment was offset disked in July 1995. Both reduced-tillage treatments were sweep plowed three times in 1996 (June, July, and September). Winter wheat (TAM 107 at 45 lb/a) was planted on

September 13, 1996 with starter fertilizer (100 lb/a of 11-52-0 applied with the seed). Stand establishment was adequate in all treatments. Fertilizer N was applied in December at rates of 0, 50, 100, and 150 lb N/acre, and the check plot received no N.

Results

Grass control ratings were taken in early September 1996 prior to planting of winter wheat . The warm-season grasses were eliminated by conventional tillage and 90% controlled in no-till. With reduced tillage, grass control was 90% when the residue had been burned but only about 70% when the residue had been mowed. Very little grass was present in any treatment in spring 1997.

Wheat yields were much better where the grass was controlled with tillage than with herbicides (Table 3). With reduced tillage, grain yields were intermediate between those of conventional and no-till. However, initiating grass destruction with tillage rather than chemicals tended to improve grain yield.

Mowing the residue prior to tillage/chemical application had little effect on grain yield. Burning the residue tended to slightly decrease yields (if any effect at all).

Nitrogen applications significantly improved grain yield. Grain yields averaged across all treatments were increased 150% by application of 150 lb N/acre. All treatments responded to N application.

Acknowledgments

We to thank Ross Kuttler for providing the land for this study. The other participants were the Natural Resource Conservation Service, Monsanto, and Farm Journal.

Table 3. Winter wheat yields on CRP as affected by tillage/chemical treatments and nitrogen, west-central Kansas, 1997. Ross Kuttler cooperator.

Treatment		Grain Yield				
		0 lb N/a	50 lb N/a	100 lb N/a	150 lb N/a	Mean
		bu/a				
Mow	Till	17	29	37	40	31
Mow	Till-Chem	17	26	28	34	26
Mow	Chem-Till	10	18	31	30	22
Mow	Chem	8	17	27	32	21
Burn	Till	16	27	34	37	29
Burn	Till-Chem	15	28	30	38	28
Burn	Chem-Till	12	23	28	33	24
Burn	Chem	4	15	21	28	17
LS	Till	24	30	36	44	33
LS	Chem	7	16	28	34	21
Mean		13	23	30	35	25
	Nrate $LSD_{.05}$	2				
	Treatment $LSD_{.05}$	8				

LS = residue was left standing.
Interaction of trt*N rate was not significant.

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EFFECTS OF STOCKOSORB AGRO APPLICATIONS ON YIELDS AND ECONOMIC RETURNS OF WINTER WHEAT AND GRAIN SORGHUM IN CENTRAL KANSAS

C.A. Thompson

Summary

Stockosorb AGRO is a potassium based, high molecular weight, cross-linked polyacrylamide produced by Stockhausen, Inc. in Germany. The water absorption capacity of the crystal is many times its weight in water. Agricultural use for enhancing crop production in small grains and sorghum is relatively new. Application methods to date include broadcast and incorporation, subsurface (6 in. deep) broadcast, and furrow banding with the seed. Limited evidence indicates that the polyacrylamide may last for more than one season.

Two years of results using Stockosorb AGRO on wheat and sorghum (dryland and irrigated) favor banding with the seed at planting over broadcast and incorporation or subsurface broadcast. Larger yield increases and higher economic returns resulted from the band-type placement. Responses to banded Stockosorb AGRO occurred at rates of 1, 2, and 3 lb/a. Banded rates were equivalent to 24, 48, and 72 lb/a rates applied broadcast. Yield response in wheat was more consistent when starter fertilizer or nitrogen (N) fertilizer was added in the band with the Stockosorb AGRO. Sorghum receiving banded N fertilizer with Stockosorb AGRO in the seed furrow showed signs of increased production over that receiving separate applications of these products.

When the Stockosorb crystals absorb soil moisture, the gel-like substance formed also incorporates water-soluble nutrients. Thus, when plant roots grow into the gel, both water and soil nutrients are available for uptake. Increased crop production may occur under proper management.

Wheat or sorghum stands were not affected adversely by any of the treatments. With the low-banded rates, even distribution of the Stockosorb AGRO in the seed row presents a challenge similar to that associated with banding low pesticide rates.

Introduction

Availability of plant nutrients often declines under droughty conditions or under conditions where soil nutrients can leach easily below the root zone of the growing crop. Any material or method that extends potentially the time or amount of nutrient uptake can affect plant growth and grain yields. Because of their high absorption capacity, cross-linked polyacrylamides may fit into crop management systems. Linear polyacrylamides have been used for decades in paper manufacturing, food processing, and wastewater treatment. More recently, linear polyacrylamides have been used in the agricultural industry for erosion control. Recent studies have indicated that a long-chain high molecular weight, cross-linked polymer, called Stockosorb AGRO (produced by Stockhausen, Inc), may be cost-efficient in enhancing crop production.

Procedures

Broadcasting Stockosorb AGRO, regardless of rate, was done by hand. Applying Stockosorb AGRO 6 in. below the soil surface was accomplished with a 20-ft-wide sweep unit with a fan that allowed for uniform application. A 200 h.p. tractor was required to apply the subsurface treatments. High Stockosorb AGRO rates, regardless of application method, were applied one time, relying on carryover for the next cropping seasons. Prepackaged furrow-banded treatments were applied with a cone/spinner mechanism mounted on the drill. Sand was mixed with the banded treatments to promote uniform distribution of the Stockosorb AGRO product with the seed. Selected plots were flood irrigated from a water wagon. Water was retained on those plots by perimeter berms constructed after crop emergence.

The soil type was Harney silt loam for most of the studies. The starter fertilizer study and the triticale hay study were located on an Armo silt loam. The variety Ike was used in all wheat studies, Jenkins winter triticale was used in the hay study, and DeKalb DK39Y (medium-early) was used in the grain sorghum studies. A grain drill was used to plant all crops in a 12-in. row spacing. Treatments were replicated four times. Wheat was seeded at 1 bu/a, triticale at 75 lb/a, and sorghum at 80,000 seeds/a. Fifty pounds of 18-46-0 was applied as starter fertilizer. Ammonium nitrate (34-0-0) was the N fertilizer source. Fine Stockosorb AGRO crystals were obtained by using the material that passed through a 2-mm screen. Large Stockosorb crystals were obtained by using the material retained on a 2-mm screen. The six center rows of wheat and sorghum were harvested with a Massey MF-8 plot combine equipped with a 72-in. header. The SAS GLM procedure was used to analyze the data.

Small Grain Results

Stockosorb AGRO Rates x Placement

The effects of applying Stockosorb AGRO broadcast and subsurface under dryland and irrigated managements for winter wheat over a 2-year period are reported in Figure 1. Although significant yield increases were obtained with Stockosorb AGRO in both years, these increases were not large enough to provide a positive economic return. The only exception to this was under dryland management at the 10 lb/a broadcast rate where an 8.7 bu/a yield increase over the control was obtained. If the positive effects of a single application last over several cropping seasons and significant yield increases continue, the initial cost could be prorated over enough seasons to be economically feasible. For this to happen, however, the grower must absorb the initial costs and realize that an economic return may not be forthcoming for 2 or more years.

Stockosorb AGRO x Starter Fertilizer

The banding effect of 2 lb/a Stockosorb AGRO with the wheat seed applied with and without starter fertilizer under dryland and irrigated conditions is shown in Figure 2. The largest yield increases and economic returns occurred under dryland conditions. This may be expected because droughty conditions are more likely to occur under dryland cropping. Thus, the moisture/nutrient holding capacity of the gel under dryland would be more likely to positively affect crop performance. The combined effect of Stockosorb AGRO and starter fertilizer on yield and profit was higher than effects of either of the materials applied alone.

The 2-year combined effects of three rates of Stockosorb AGRO applied with and without starter fertilizer to wheat under dryland conditions (Figure 3) showed gradual increases in yield and profit with each increment of Stockosorb AGRO applied alone. When combined with starter fertilizer, the 2 or 3 lb/a Stockosorb AGRO showed no significant yield advantage over the 1 lb/a rate. Thus, the economic return was highest when the 1 lb/a rate was applied with starter fertilizer.

Stockosorb AGRO x Nitrogen Fertilizer

The combined effects of banding Stockosorb AGRO and N fertilizer with the wheat seed at planting under dryland and irrigated conditions are shown in Figure 4. Both dryland and irrigated conditions resulted in significant yield increases to the applied materials. However, the yield increase from Stockosorb AGRO alone was significantly less under irrigation than under dryland conditions. Wheat responded well to banded nitrogen under dryland and irrigated conditions. Under dryland conditions, the yield increase and economic return from combining Stockosorb AGRO and N fertilizer was significantly higher than those from either product applied alone.

The response of dryland wheat to Stockosorb rates and N fertilizer is reported in Figure 5. The highest yield increase resulted from combining 3 lb/a Stockosorb AGRO with 20 lb N/a. However, the highest net return came from combining 1 lb/a Stockosorb AGRO with 20 lb N/a. Economic returns were highest when any of the Stockosorb AGRO rates were combined with the single N rate.

<u>Stockosorb AGRO Rates x Placement for Triticale Hay</u>

Results comparing broadcast- and band-type treatments for triticale hay are shown in Figure 6. The total lb/ft^2 of Stockosorb AGRO broadcast at 24 lb/a was equivalent to 1 lb/a banded in the furrow with the seed. The economic return was significantly higher from banding than from the broadcast treatments. All Stockosorb AGRO rates, regardless of placement, resulted in significantly higher yields than the control.

Small Grain Conclusions

Broadcast or subsurface applications of Stockosorb AGRO resulted in higher input costs and lower net returns per acre than banding with the seed at planting. Band-type placement of low Stockosorb AGRO rates in combination with starter or N fertilizer produced consistent yield increases and positive net returns. Studies to date indicate that it is not necessary to exceed the 2 lb/a Stockosorb AGRO rate. The cost effectiveness of using Stockosorb AGRO for small grain production will depend of the price of the product, the resulting yield increase, commodity price at harvest, and cost of application. For the first year or two, applying Stockosorb AGRO in strip-type applications (one or more fields) is recommended. If results are positive, expanded use is warranted.

Grain Sorghum Results

<u>Stockosorb AGRO Rates x Placement</u>

Comparisons of broadcast versus subsurface treatments for 2 years are reported in Figure 7. Even though yield increases were obtained with several rates, the net returns compared to the control were negative for all Stockosorb AGRO treatments. Because results are averages of 2 years, input costs are prorated by year.

<u>Stockosorb AGRO x Nitrogen Fertilizer</u>

The results of comparing Stockosorb AGRO with and without N fertilizer under dryland and irrigated conditions for the 1997 season are reported in Figure 8. The largest yield increases and greatest net returns under dryland and irrigated conditions were obtained by combining Stockosorb AGRO with N fertilizer. Stockosorb AGRO applied alone resulted in a higher net return under dryland management than under irrigated management. But when N was applied alone, net return was higher under irrigation than under dryland management.

The results of four Stockosorb AGRO rates applied with and without N fertilizer under dryland management for the 1996 and 1997 seasons are reported in Figure 9. Positive responses were obtained to most Stockosorb AGRO rates applied alone or in combination with N fertilizer. The highest net return came from the combination of 3 lb/a Stockosorb AGRO with N fertilizer.

<u>Stockosorb AGRO x Particle Size</u>

The effects of three Stockosorb AGRO particle sizes under dryland and irrigated conditions for 1997 are reported in Figure 10. Yield and net return increases from Stockosorb AGRO over the control, were significant for dryland and irrigated. However, yield and net return differences between Stockosorb AGRO particle sizes were not significant, despite the trend favoring the larger particle size.

Under dryland management, the results from 2 years of Stockosorb AGRO size comparison are shown in Figure 11. The yield difference between the 2 and 3 lb/a Stockosorb AGRO rates was not significant. However, sorghum did appear to respond better to the larger particle size at the low rate.

Grain Sorghum Conclusion

Yield responses to 10 to 100 lb/a rates of Stockosorb AGRO applied broadcast or subsurface were not positive; therefore, these methods are not recommended. However, crop performance was affected positively when low rates of Stockosorb AGRO were combined with N fertilizer in the seed furrow at planting. The results may be more than simply an additive effect. The total effect of the combined products in some cases was greater than the sum of the two effects taken independently, suggesting that the results were synergistic. This is good news for crop producers trying to control input costs without reducing net returns. Until more is learned, exceeding the 2 lb/a Stockosorb AGRO rate does not appear justified.

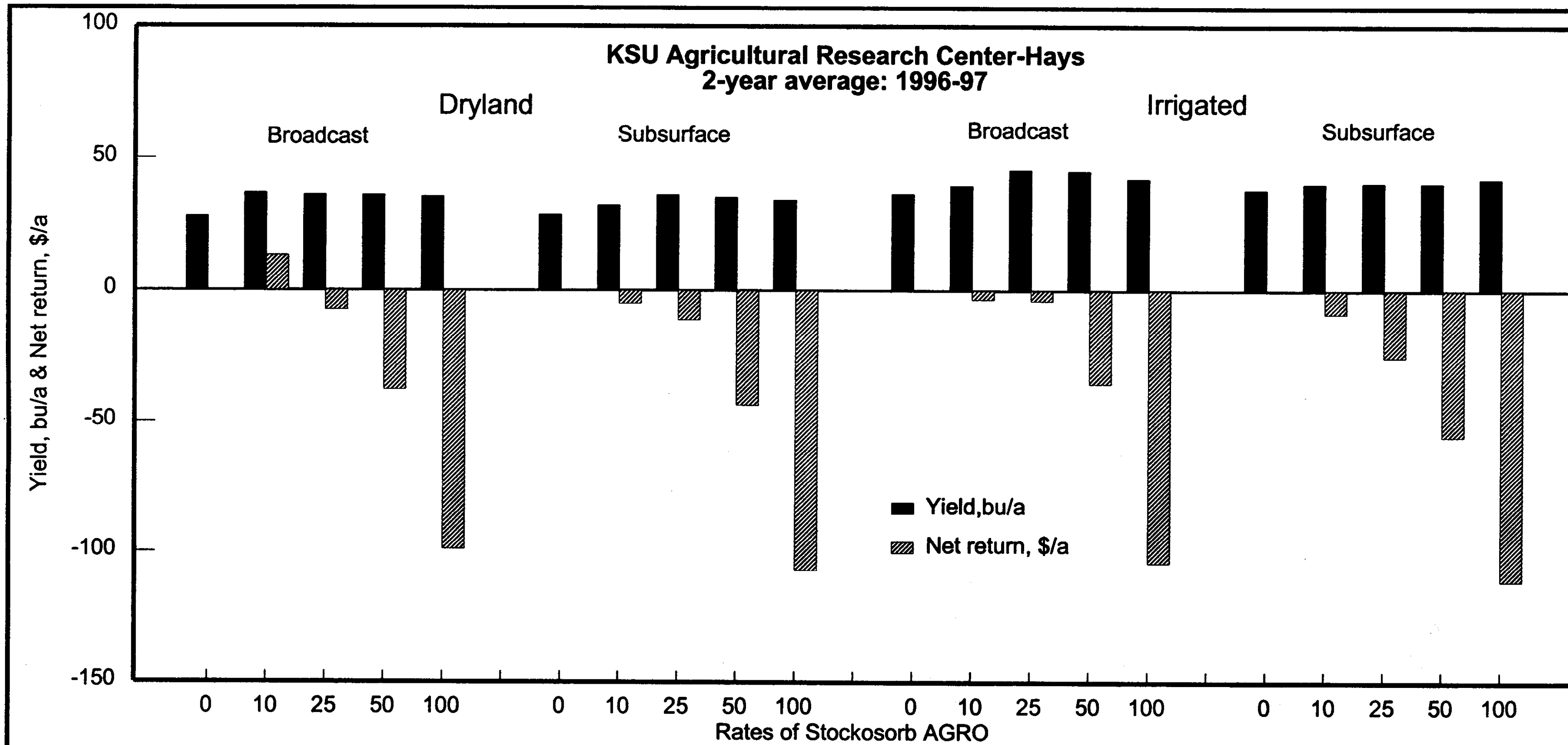


Fig. 1. Effects of two application methods and five Stockosorb AGRO rates on dryland & irrigated winter wheat. Wheat @ $3.00/bu; Stockosorb AGRO @ $1.20/lb/yr; broadcast @ $1.50/a/yr; subsurface @ $3.50/a/yr.

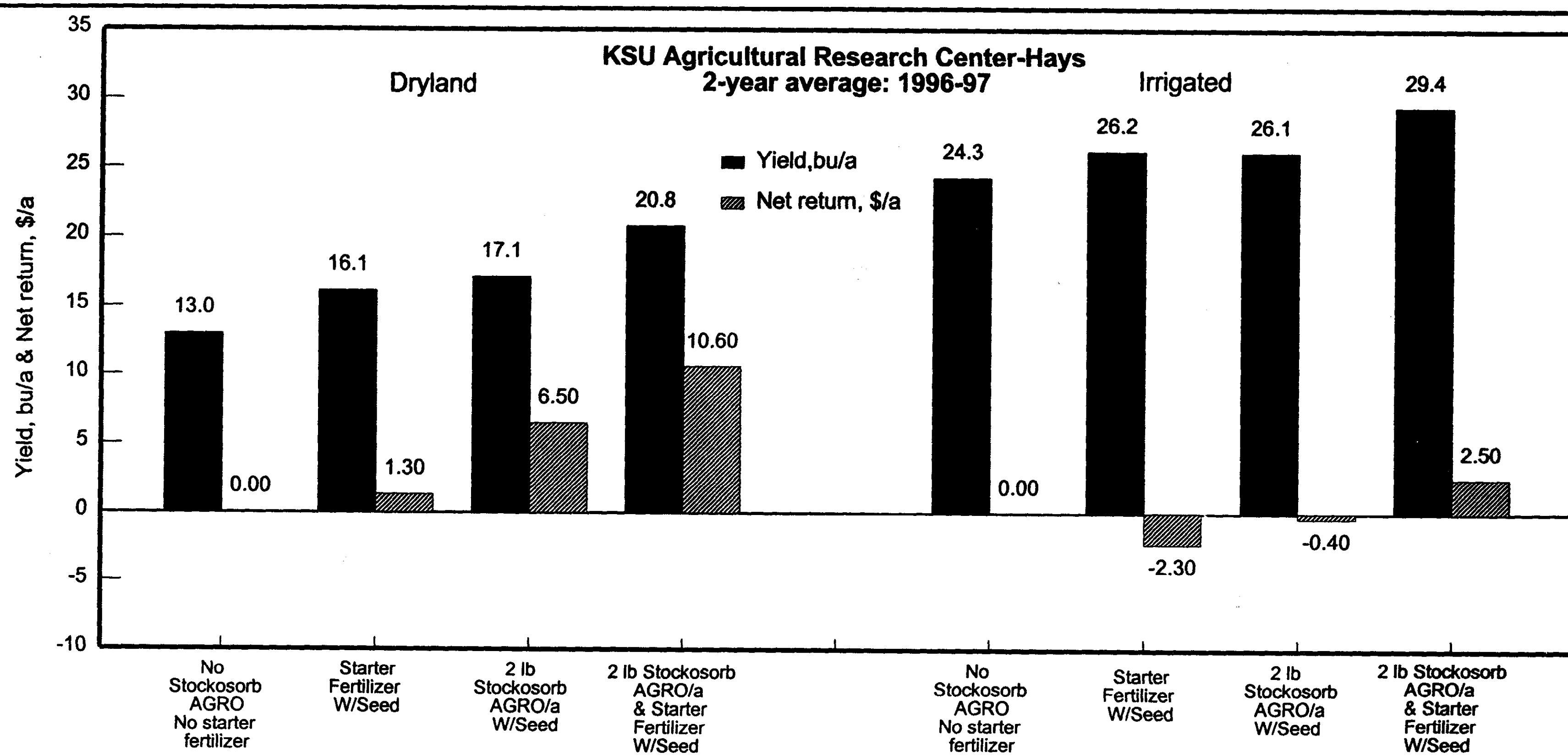


Fig. 2. Effects of Stockosorb AGRO and starter fertilizer on dryland & irrigated winter wheat. Starter fertilizer @ 50 lb/a 18-46-0; wheat @ $3.00/bu; Stockosorb AGRO @ $2.40/lb; starter fertilizer @ $7.00/a; banding @ $1.00/a.

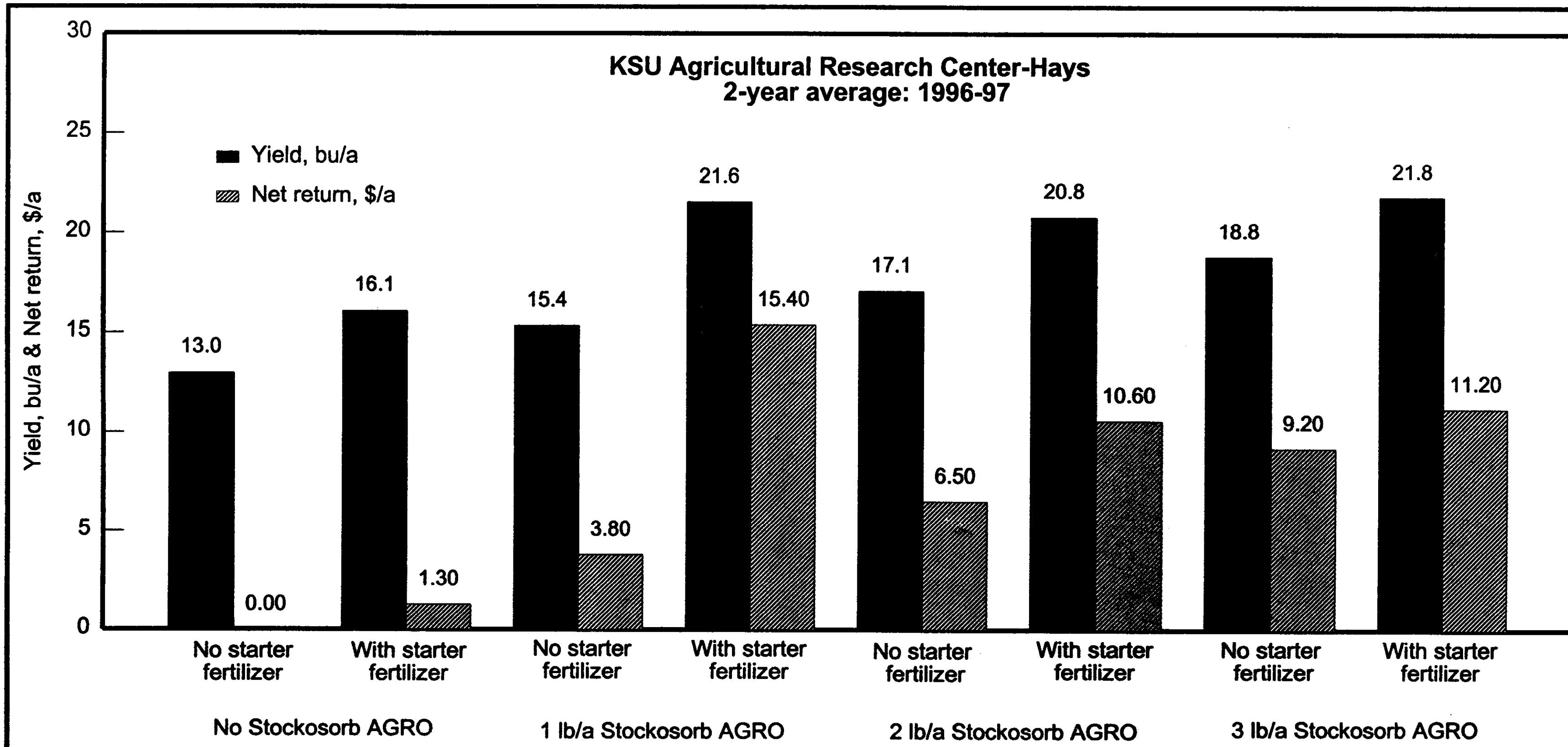


Fig. 3. Effects of Stockosorb AGRO rates and starter fertilizer on dryland winter wheat. Starter fertilizer @ 50 lb/a 18-46-0; wheat @ \$3.00/bu; Stockosorb AGRO @ \$2.40/lb; starter fertilizer @ \$7.00/a; banding @ \$1.00/a.

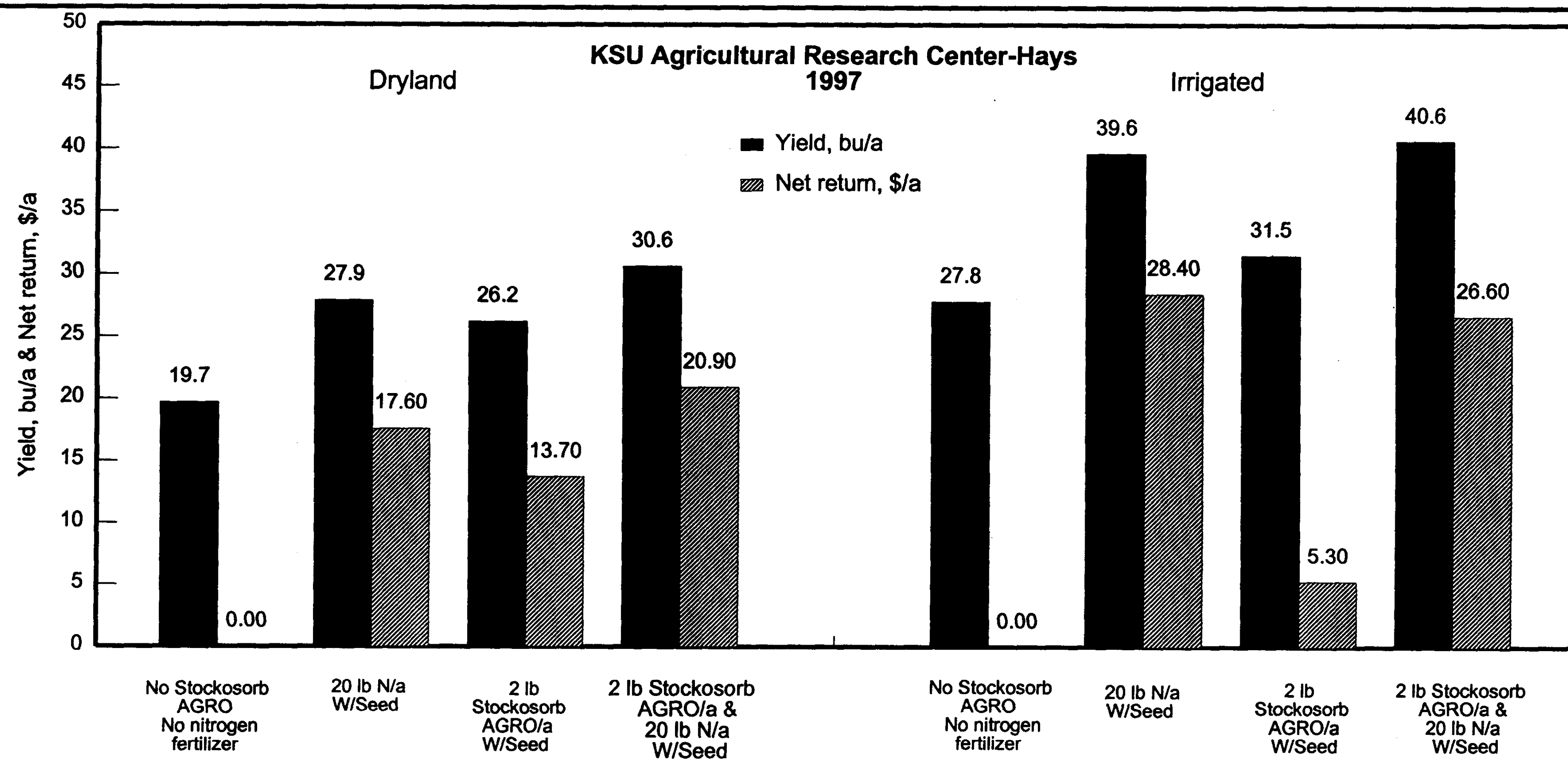


Fig. 4. Effects of Stockosorb AGRO and nitrogen fertilizer on dryland & irrigated winter wheat. Nitrogen fertilizer as am. nitrate; wheat @ $3.00/bu; Stockosorb AGRO @ $2.40/lb; nitrogen fertilizer @ $6.00/a; banding @ $1.00/a.

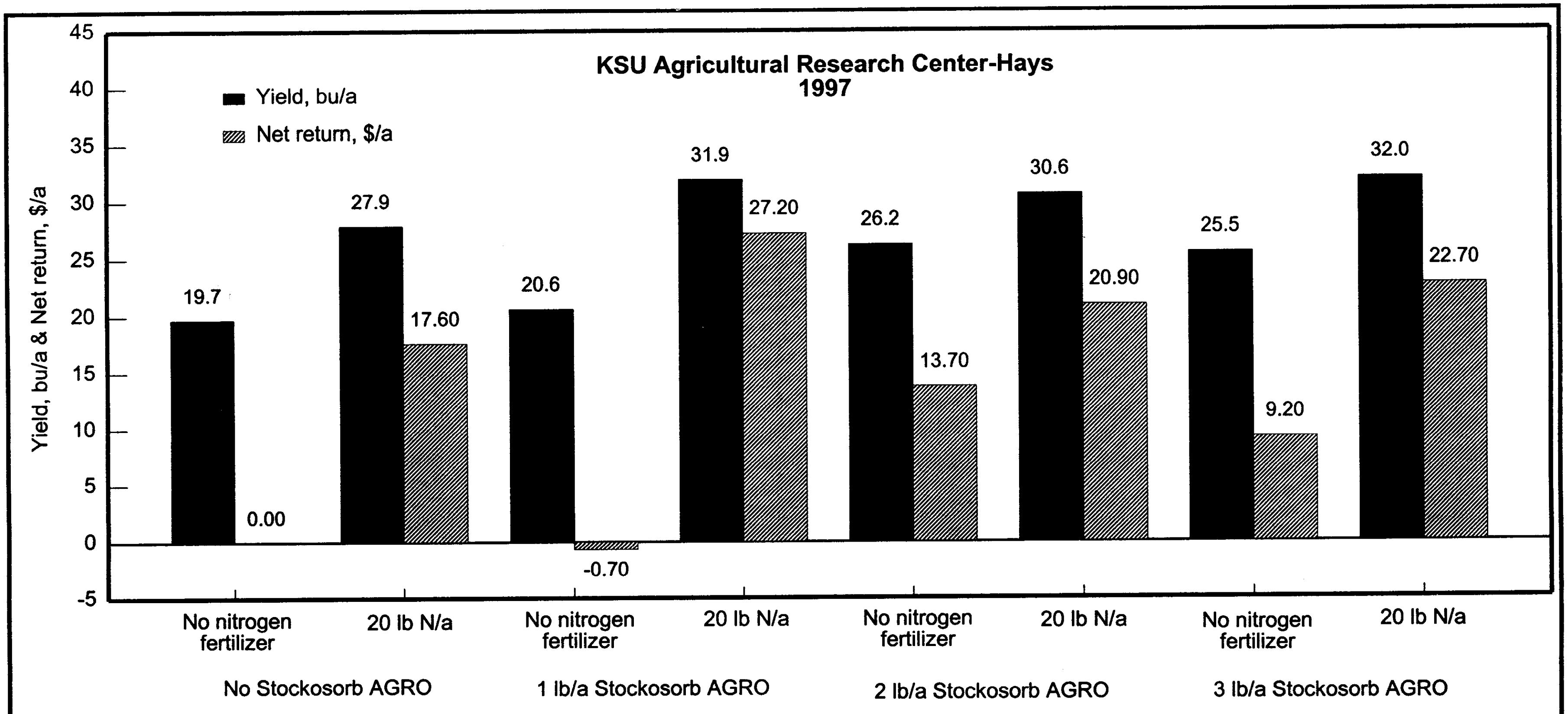


Fig. 5. Effects of Stockosorb AGRO rates and nitrogen fertilizer on dryland winter wheat. Nitrogen fertilizer as am. nitrate; wheat @ $3.00/bu; Stockosorb AGRO @ $2.40/lb; nitrogen fertilizer @ $6.00/a; banding @ $1.00/a.

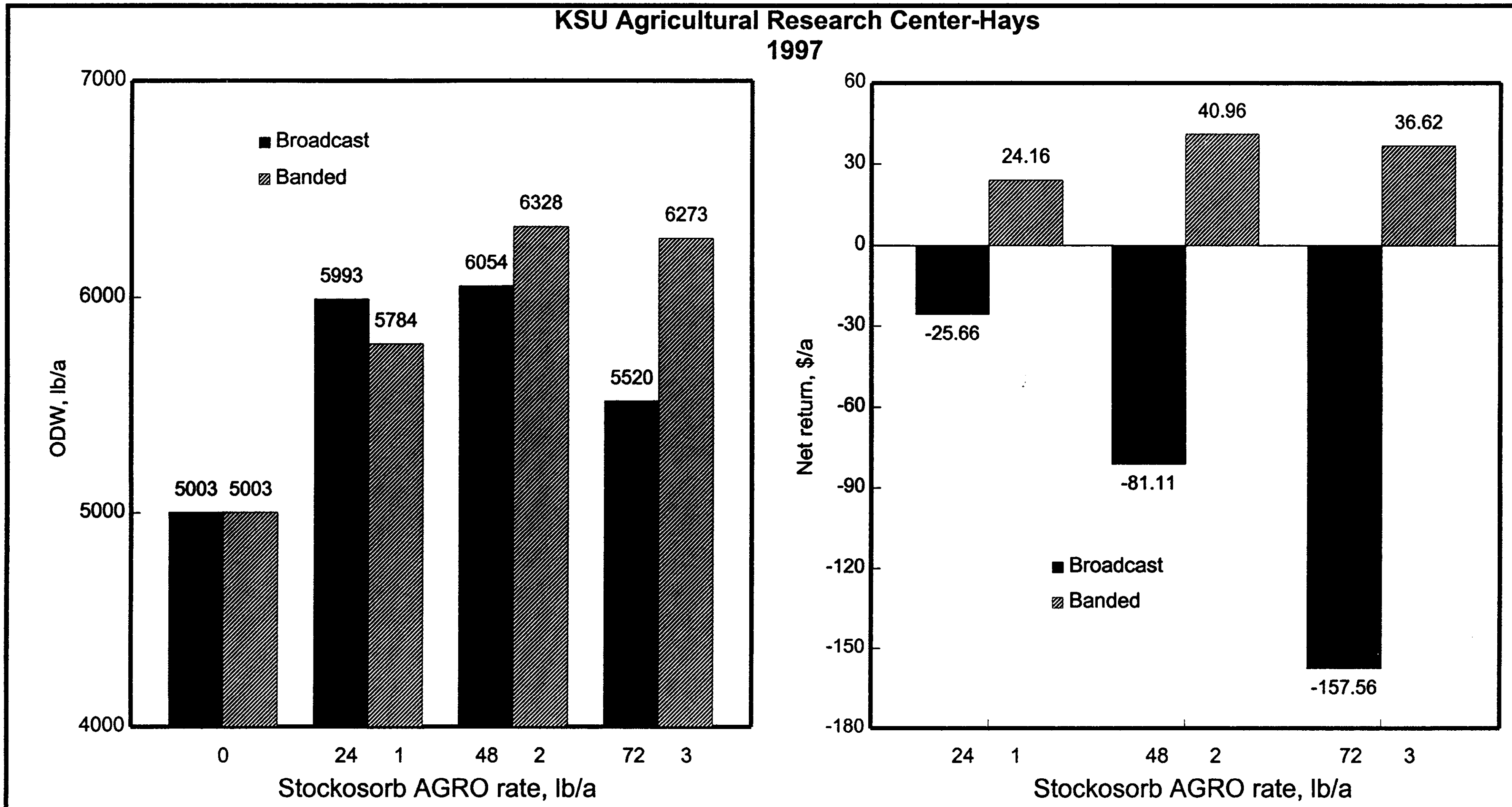


Fig. 6. Effects of two application methods of Stockosorb AGRO rates on dryland triticale hay. Triticale @ $60.00/ton (@ 15% moisture); Stockosorb AGRO @ $2.40/lb; broadcast @ $3.00/a; banding @ $1.00/a.

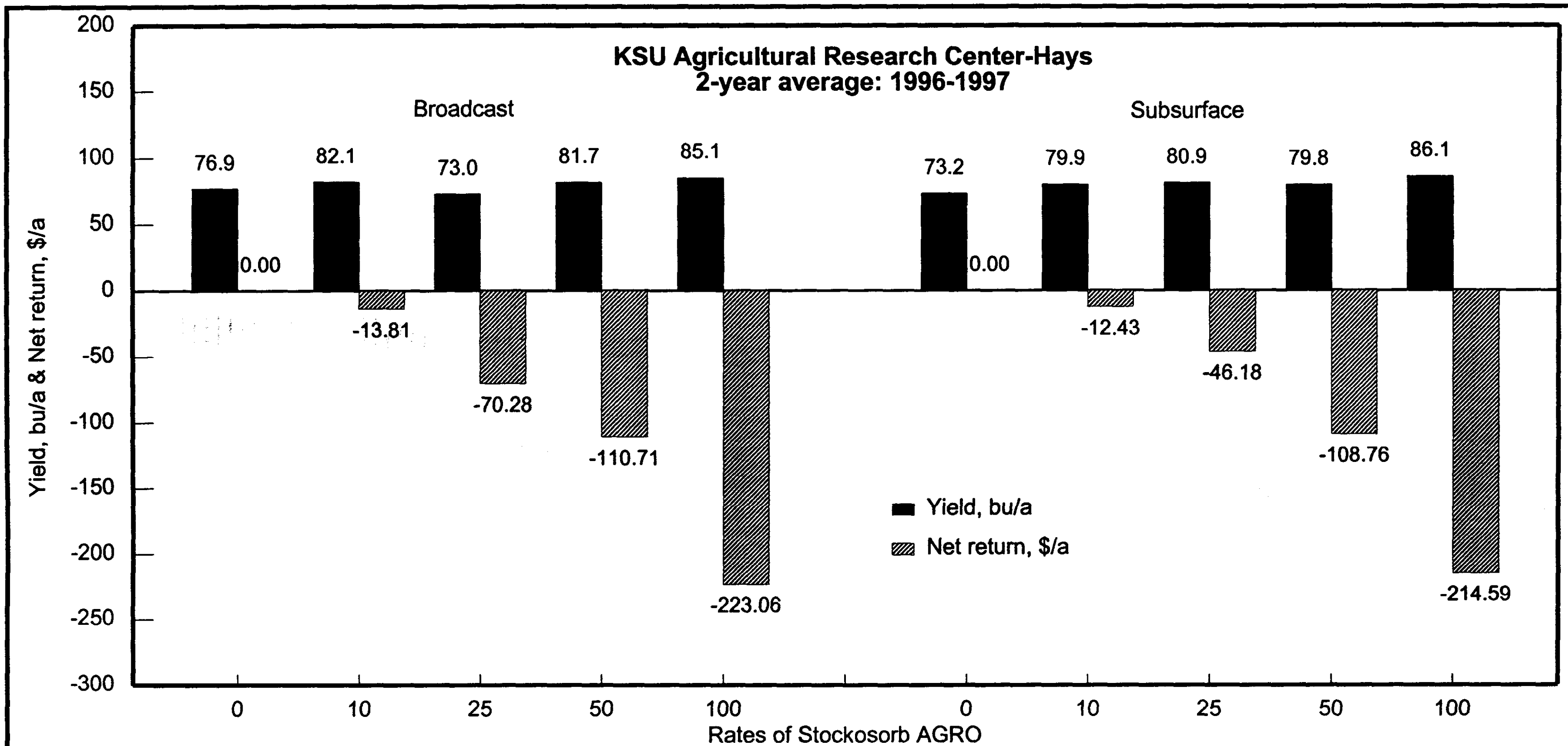


Fig. 7. Effects of two application methods and five Stockosorb AGRO rates on dryland grain sorghum. Sorghum @ $2.25/bu; Stockosorb AGRO @ $1.20/lb/yr; broadcast @ $1.50/a/yr; subsurface @ $3.50/a/yr.

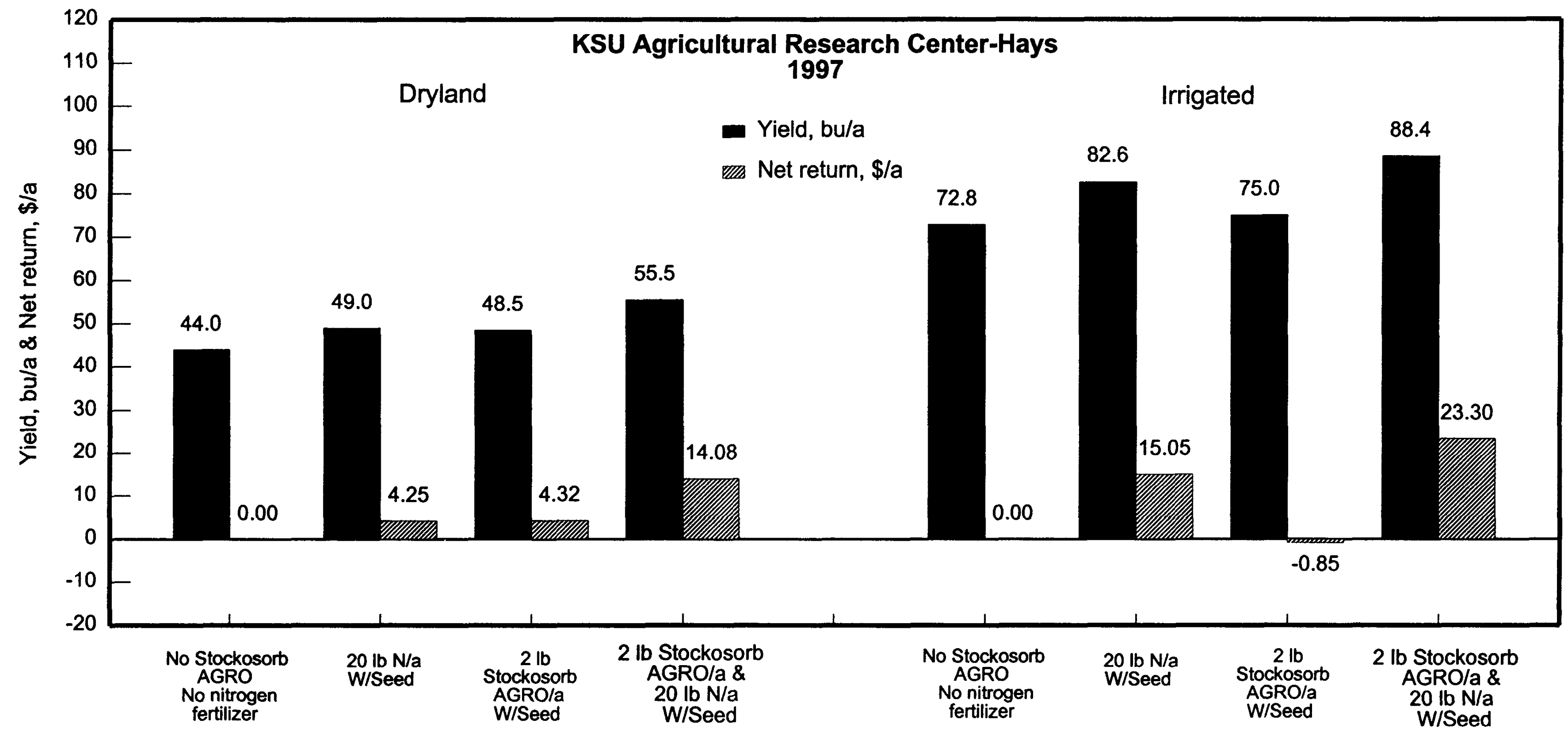


Fig. 8. Effects of Stockosorb AGRO and nitrogen fertilizer on dryland & irrigated grain sorghum. Nitrogen fertilizer as am. nitrate; sorghum @ $2.25/bu; Stockosorb AGRO @ $2.40/lb; nitrogen fertilizer @ $6.00/a; banding @ $1.00/a.

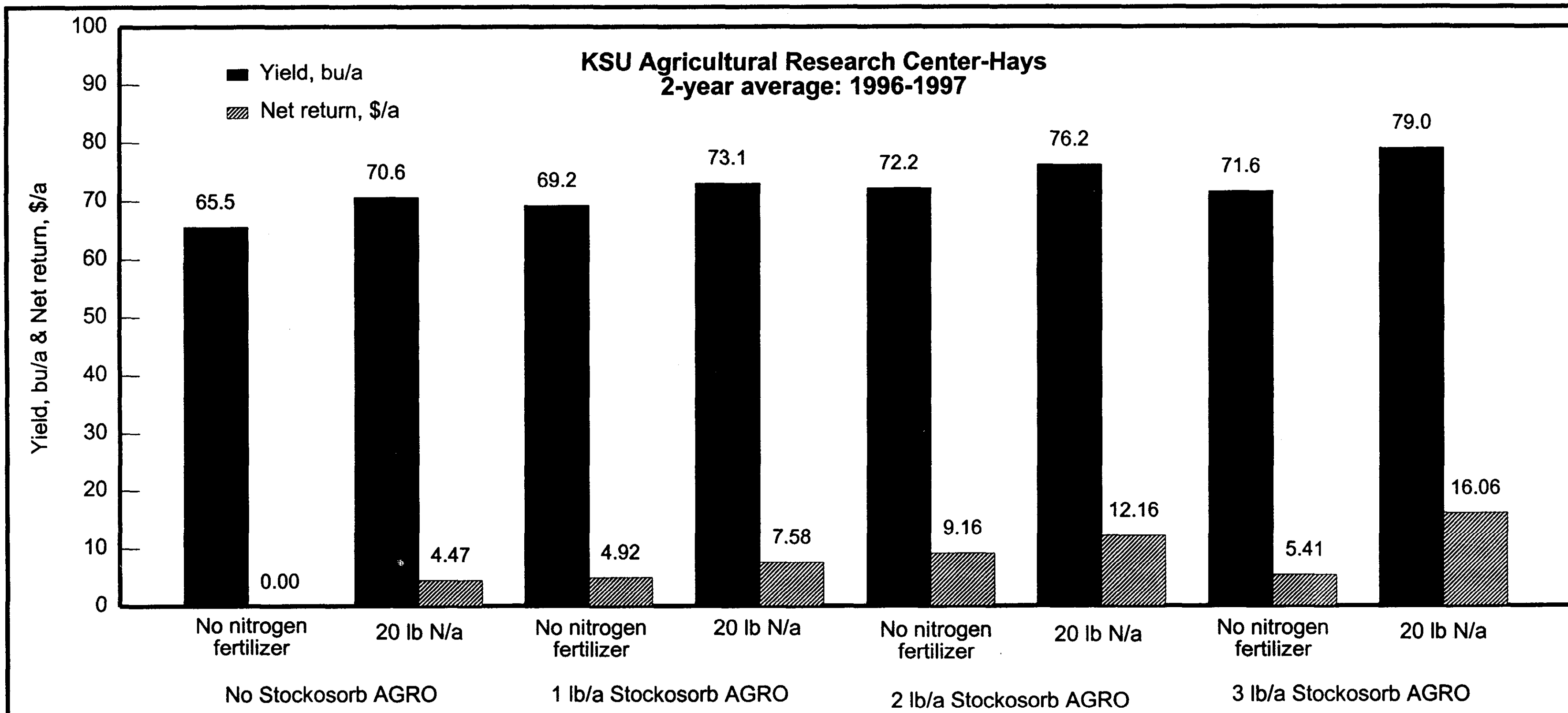


Fig. 9. Effects of Stockosorb AGRO rates and nitrogen fertilizer on dryland grain sorghum. Nitrogen fertilizer as am. nitrate; sorghum @ $2.25/bu; Stockosorb AGRO @ $2.40/lb; nitrogen fertilizer @ $6.00/a; banding @ $1.00/a.

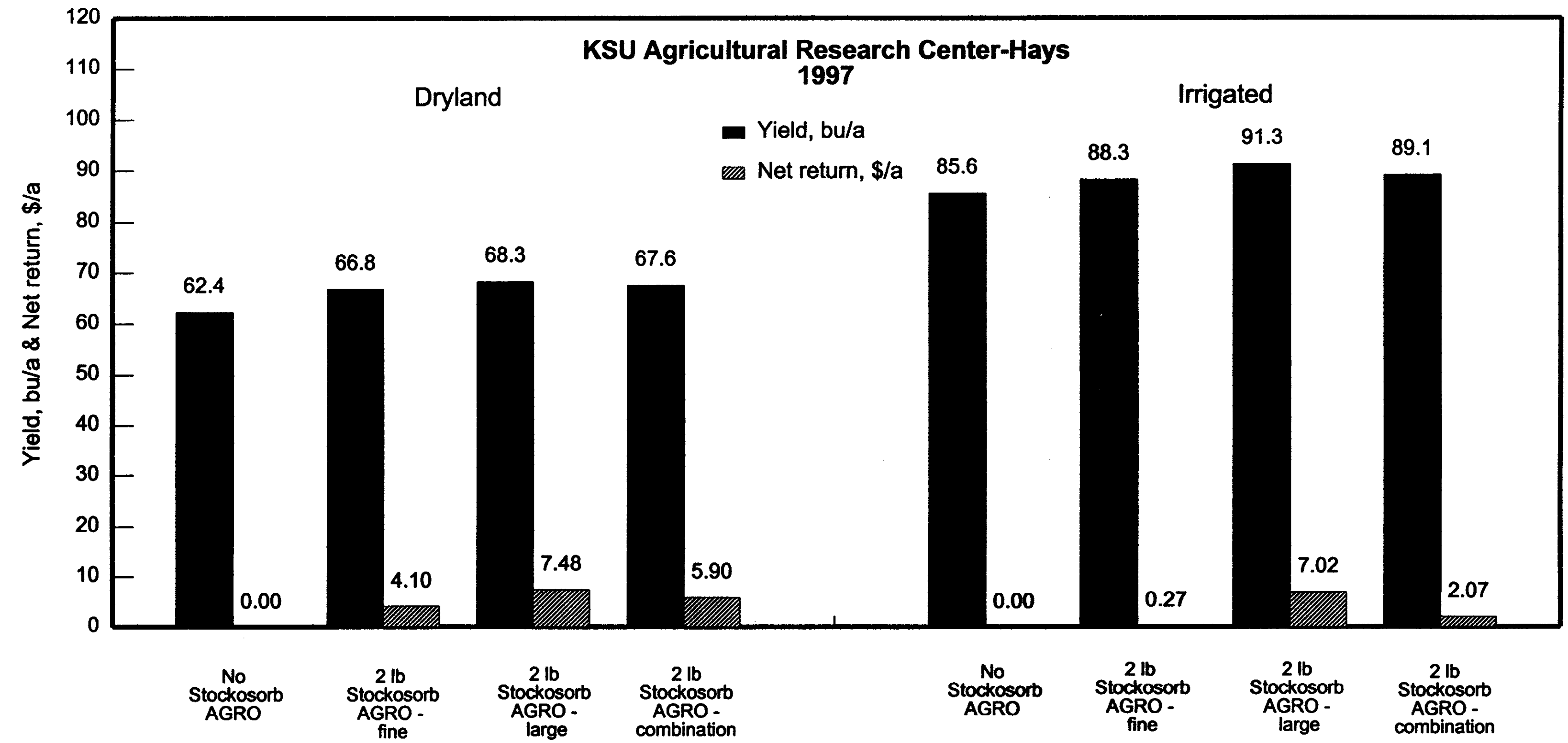
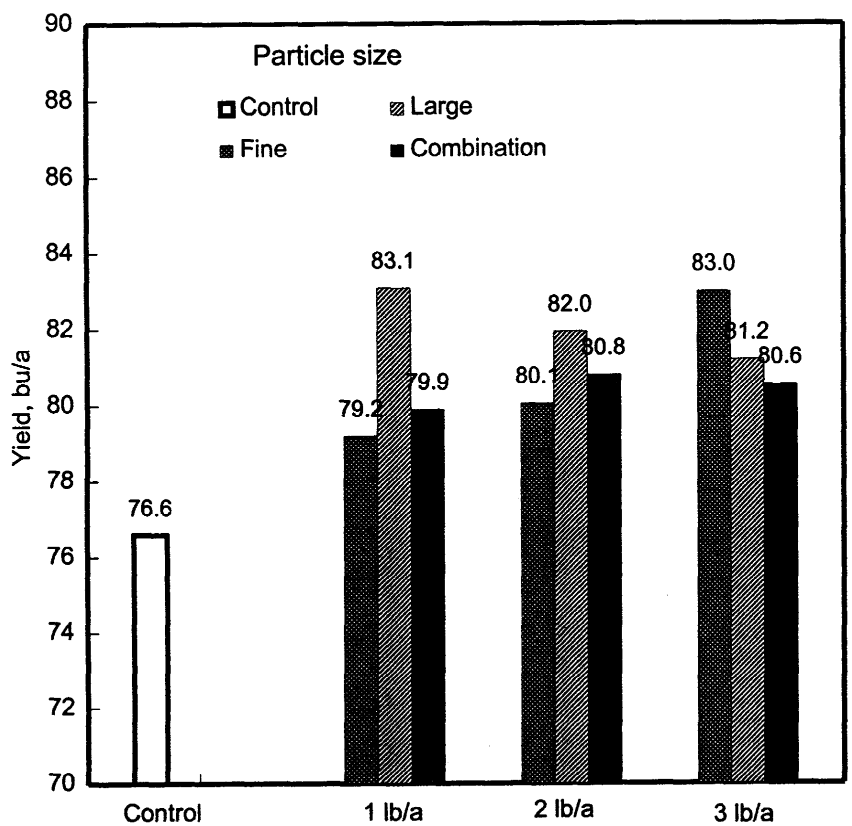


Fig. 10. Effects of Stockosorb AGRO applied in three particle sizes on dryland & irrigated grain sorghum. Sorghum @ $2.25/bu; Stockosorb AGRO @ $2.40/lb; banding @ $1.00/a.

KSU Agricultural Research Center-Hays
2-year average: 1996-97



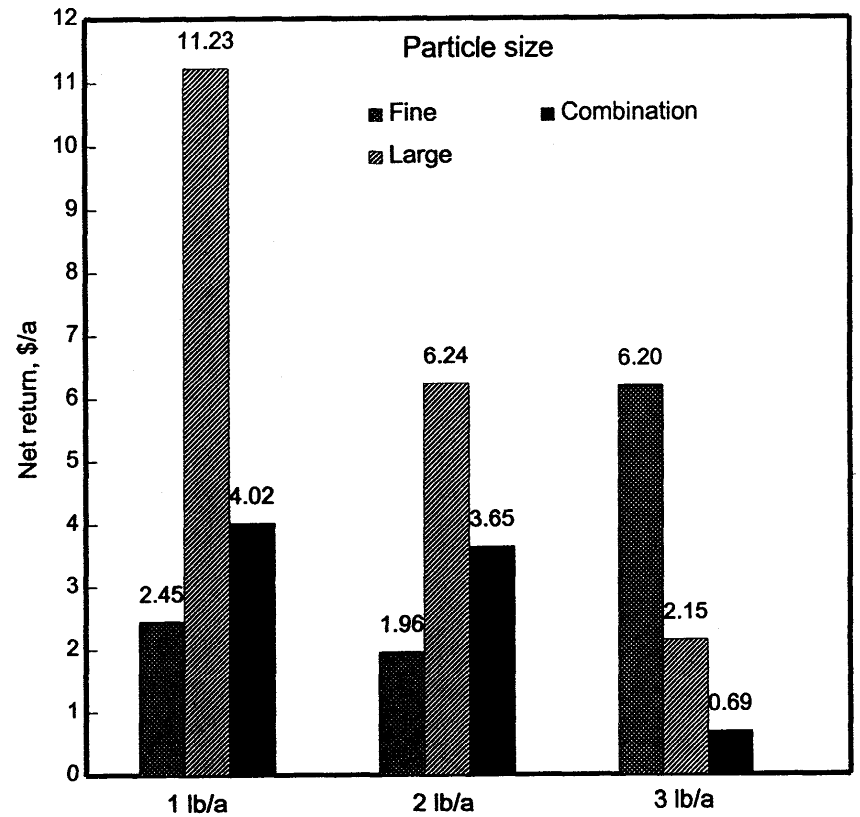


Fig. 11. Effects of three Stockosorb AGRO rates applied in three particle sizes on dryland grain sorghum. Sorghum @ $2.25/bu; Stockosorb AGRO @ $2.40/lb; banding @ $1.00/a.

SOIL FERTILITY RESEARCH
KANSAS RIVER VALLEY EXPERIMENT FIELD

EFFECTS 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 time and rate on irrigated soybeans. Soybean yields for the 0 N control plot were 71.8 bu/a in 1996 and 65.7 bu/a in 1997. Fertigation at the R1 and R3 growth stages resulted in yields of 73.7 and 73.8 bu/a in 1996, but this slight yield increase was not statistically significant. Fertigation at R5 resulted in no significant yield difference. No significant difference in yield was observed in 1997 with any treatment. Leaf N content at R6 and 1996 oil contents in seed were not affected by the treatments. This study will be continued in 1998.

Introduction

Irrigated soybean yields in Kansas commonly exceed 60 bu/a. Nitrogen (N) 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 research was designed to determine the optimum N rate 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, and UAN was applied as a fertigation treatment at R1, R3 (beginning pod), and R5 (beginning seed). The treatments were arranged in a randomized complete block design with four replications. A minimum of 0.5 inches 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

No significant differences in soybean yields because of N application time or N rate occurred in either year as shown in Table 1. However, in 1996, we observed a slight trend to increased yields with fertigation treatments at R1 and R3 growth stages. Nitrogen application time or N rates also had no effect on leaf N content at R6 in either year or the oil content of seed in 1996. This research will be continued next year.

Table 1. Effects of nitrogen application times and rates on irrigated soybean leaf N, oil content, and yield, Topeka, KS.

N Application Time	N Rate	Oil	R6 Leaf N		Yield	
		1996	1996	1997	1996	1997
	lbs/a	%	----------%----------		----------bu/a-----------	
None	0	22.5	5.66	3.39	71.8	65.7
UAN, Fertigation, R1	30	22.2	5.28	3.56	73.9	60.6
UAN, Fertigation, R1	60	22.3	5.56	3.53	73.5	61.8
UAN, Fertigation, R3	30	22.2	5.28	3.67	72.4	63..3
UAN, Fertigation, R3	60	22.0	5.53	3.59	75.1	67.1
UAN, Fertigation, R5	30	21.9	5.54	3.50	74.0	65.6
UAN, Fertigation, R5	60	21.8	5.54	3.64	69.3	60.5
LSD(.05)		NS	NS	NS	NS	NS
N Application Time:						
UAN, Fertigation, R1		22.3	5.42	3.54	73.7	61.2
UAN, Fertigation, R3		22.1	5.41	3.63	73.8	65.2
UAN, Fertigation, R5		21.9	5.54	3.56	71.6	63.1
LSD(.05)		NS	NS	NS	NS	NS
N RATE:						
	30	22.2	5.40	3.57	72.9	63.1
	60	22.1	5.48	3.54	71.5	63.6
LSD(.O5)		NS	NS	NS	NS	NS

MACRONUTRIENT FERTILITY ON IRRIGATED CORN FOLLOWING SOYBEANS

L. D. Maddux and P. L. Barnes

Summary

A corn-soybean cropping sequence was evaluated from 1983 through 1996 (7 years of corn; 7 years of soybeans) for the effects of N, P, and K fertilization on the corn crop. The 7-year average showed a corn yield increase with increasing N rates up to 160 lbs N/a. Previously applied N at 160 lbs/a also resulted in an average soybean yield increase of 3.1 bu/a. Corn and soybeans both showed yield responses to P, but only soybean had significant 7-year average yield increases (3.3 and 4.5 bu/a for 30 and 60 lbs P_2O_5/a). Potassium fertilization increased average corn and soybean yields by 6 and 2.3 bu/a. Nitrogen increased V6 N content and yield of corn in 1997. No significant response to residual soil P was obtained, probably because of the almost 41 lbs P_2O_5/a applied in the starter to all plots. Plant K content at V6 was increased with K fertilization, but no yield response was obtained.

Introduction

A study was initiated in 1972 at the Topeka Unit to evaluate the effects of nitrogen (N), phosphorus (P), and potassium (K) on irrigated soybeans. The study was changed to a corn and soybean cropping sequence and planted to corn in 1983. The objectives of the study are to evaluate the effects of applications of N, P, and K made to a corn crop on (a) grain yields of corn and the following soybean crop and (2) soil test values.

Procedures

The initial soil test in March, 1972 on this silt loam soil was 47 lbs/a of available P and 312 lbs/a of exchangeable K in the top 6 in. of the soil profile. Rates of P were from 50 and 100 lbs P_2O_5/a from 1971 - 1975 and 30 and 60 lbs P_2O_5/a from 1976 - 1995. In 1997, the broadcast rates of P were dropped and a starter of 120 lbs/a of 10-34-0 (12 lbs N/a + 41 lbs P_2O_5/a) was applied to all plots. Rates of K were 100 lbs K_2O/a from 1971 to 1975, 60 lbs K_2O/a from 1976 to 1995, and 150 lbs K_2O/a in 1997. Rates of N included a factorial arrangement of 0, 40, and 160 lbs N/a (with single treatments of 80 and 240 lbs N/a). The 40 lbs/a N rate was changed to 120 lbs N/a. N, P, and K treatments were applied every year to soybeans from 1971 to 1982 and every other year (odd years) to corn from 1983 to 1995.

Corn hybrids planted were BoJac 603 - 1983; Pioneer 3377 - 1985, 1987, 1989; Jacques 7820 - 1991 and 1993, Mycogen 7250CB - 1995; and DeKalb 626 - 1997. Soybeans planted were Douglas - 1984; Sherman - 1986, 1988, 1990, 1992, and 1996; and Edison - 1994. Corn was planted in mid-April, and soybeans were planted in early to mid-May. Herbicides were applied preplant, incorporated each year. The plots were cultivated, furrowed, and furrow irrigated as needed. Whole plant samples were taken at the 6-leaf stage of growth (V6). A Gleaner E plot combine was used for harvest.

Results

Average corn and soybean yields for the 14-year period from 1983 through 1996 (7-year averages) are shown in Table 2. The 7-year average corn yield showed no significant response to P fertilization, although significant responses were obtained in 1985 and 1993. An average increase of 6 bu/a (significant at the 6% level of probability) was obtained over the 7 years for 60 lbs/a of applied K_2O.

Previously applied N of 160 lbs/a resulted in an average soybean yield increase of 3.1 bu/a. Soybeans responded to P fertilization with average yield increases of 3.3 and 4.5 bu/a with 30 and 60 lbs P_2O_5/a.

Potassium fertilization of soybeans resulted in an average yield increase of 2.3 bu/a.

In 1997, V6 N content increased up to the 172 lbs N/a rate following the previous soybean crop of approximately 70 bu/a (Table 3). However, corn yields of 194 bu/a were obtained for both the 132 and 172 lbs N/a treatments. Corn yield obtained with starter fertilizer only (12 lbs N/a) was only 92 bu/a. No significant yield differences occurred in residual P, probably because of the almost 41 lbs P_2O_5/a applied in the starter to all plots. However, we observed a trend of increased P content in the V6 plant tissue with increasing rates of previously applied P (increasing soil P levels). Plant K content at V6 increased when K fertilizer was applied in 1997, although no yield response was observed this year. A P x K interaction occurred. Higher yields generally were obtained when both P and K were applied than when only one was applied. The one exception was the 132-60-0 vs 132-60-150 treatments. These results indicate the importance of soil testing and maintaining a balanced fertility program.

Table 2. Effects of nitrogen, phosphorus, and potassium applications on corn and soybean yields in a corn-soybean cropping sequence, Topeka[1].

Fertilizer Applied			7-Year Average Yield	
N	P_2O_5	K_2O	Corn	Soybean
-------------lbs/a-------------			bu/a	bu/a
0	0	0	87	63.9
0	0	60	86	65.6
0	30	0	93	69.0
0	30	60	86	69.8
0	60	0	84	69.6
0	60	60	92	72.3
40	0	0	129	66.3
40	0	60	126	67.7
40	30	0	123	66.7
40	30	60	138	72.8
40	60	0	124	70.9
40	60	60	132	71.4
160	0	0	171	68.8
160	0	60	177	70.0
160	30	0	168	70.5
160	30	60	181	73.8
160	60	0	167	71.3
160	60	60	178	74.2
80	30	60	151	71.5
240	30	60	182	71.7
LSD(.05)			17	5.1
NITROGEN MEANS:				
0			88	68.4
40			129	69.3
160			174	71.5
LSD(.05)			7	2.5
PHOSPHORUS MEANS:				
	0		129	67.1
	30		131	70.4
	60		129	71.6
LSD(.05)			NS	4.5
POTASSIUM MEANS:				
		0	127	68.6
		60	133	70.9
LSD(.05)			NS[2]	2.5

[1] Fertilizer applied to corn in 1983, 1985, 1987, 1989, 1991, 1993, and 1995 and to soybeans for 11 years prior to 1983.

[2] Significant at the 6% level of probability.

Table 3. Effects of nitrogen, phosphorus, and potassium applications on plant N, P, K and yield in a corn-soybean cropping sequence, Topeka[1].

Fertilizer Applied			V6 Plant Nutrient Content			Corn
N	P_2O_5[2]	K_2O	N	P	K	Yield
--------------lbs/a------------			%	%	%	bu/a
0	0	0	3.36	0.446	3.24	93
0	0	150	3.59	0.448	3.95	95
0	30	0	3.35	0.508	2.87	101
0	30	150	3.72	0.528	4.24	87
0	60	0	3.52	0.522	3.25	86
0	60	150	3.85	0.505	4.48	89
120	0	0	4.21	0.486	3.41	200
120	0	150	4.15	0.486	4.01	181
120	30	0	4.07	0.468	3.35	189
120	30	150	4.20	0.466	3.75	208
120	60	0	4.37	0.498	3.40	195
120	60	150	4.15	0.519	3.92	190
160	0	0	4.38	0.483	3.45	203
160	0	150	4.24	0.472	3.79	177
160	30	0	4.38	0.497	3.07	184
160	30	150	4.24	0.435	3.84	205
160	60	0	4.45	0.483	3.11	191
160	60	150	4.11	0.507	3.84	204
80	30	150	4.31	.490	4.39	187
240	30	150	4.18	.445	3.86	206
LSD(.05)			0.44	NS	0.60	27
NITROGEN MEANS:						
0			3.56	0.499	3.67	92
120			4.19	0.484	3.64	194
160			4.30	0.479	3.52	194
LSD(.05)			NS	NS	NS	19
PHOSPHORUS MEANS:						
	0		3.99	0.474	3.64	158
	30		3.99	0.484	3.52	162
	60		4.07	0.506	3.67	159
LSD(.05)			NS	NS	NS	NS
POTASSIUM MEANS:						
		0	4.01	0.488	3.24	160
		150	4.03	0.487	3.98	159
LSD(.05)			NS	NS	0.37	NS

[1] Fertilizer applied to corn in 1983, 1985, 1987, 1989, 1991, and 1993 and to soybeans for 11 years prior to 1983.
[2] Phosphorus was applied only in starter in 1997 to these previous P rates.

SOIL FERTILITY RESEARCH
SOUTHEAST AGRICULTURAL RESEARCH CENTER

EFFECTS OF RESIDUAL NITROGEN RATE AND PLACEMENT ON EASTERN GAMAGRASS UNDER ONE-CUT OR TWO-CUT HARVEST SYSTEMS

J. L. Moyer and D. W. Sweeney

Summary

Forage yields were increased for 3 years after 3 prior years of 90 lb/a nitrogen (N) applications. Three years of knifing N increased yield for the next 2 years compared to broadcast application. One-cut and two-cut harvest systems responded similarly, but the one-cut system yielded more in 2 of 3 years.

Introduction

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

Procedures

Established (15-year-old) 'Pete' eastern gamagrass was fertilized with 54 lb P_2O_5/a and 61 lb K_2O/a in each of the previous 6 years and burned each spring except 1996. From 1992 to 1994, no N or N (urea-ammonium nitrate, 28% N) treatments of 45 or 90 lb/a were applied in late April to 8 ft x 20 ft plots by broadcast or knife (4-inch) placement. Nitrogen was not applied in 1995-1997 so that residual responses could be tested.

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

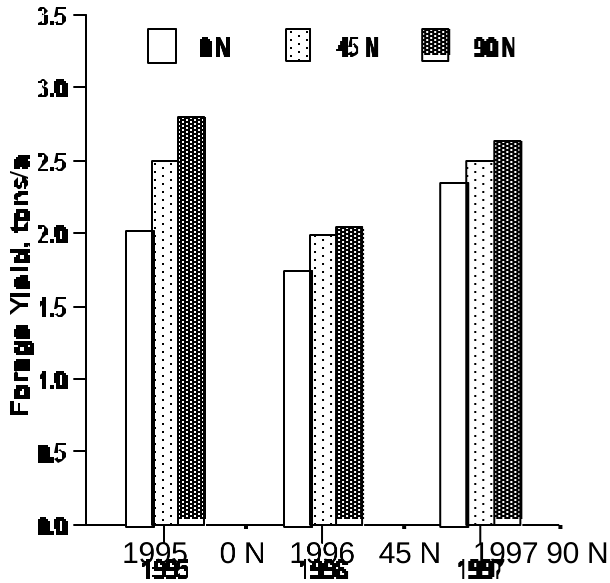
Results

No significant (P<.05) interactions were found among previous treatment factors for yield in the years 1995-1997. However, interactions of treatment effects with year occurred often, so means of each treatment are shown by year in the following figures.

Yields in 1995 were increased (P<.05) by 23% with the first 45 lb/a increment of previous N and by an additional 12% with the next 45-lb increment (Fig. 1). Previous N application did not significantly (P<.05) increase 1996 yield. However, in 1997, previous applications of 90 lb N/a resulted in greater forage yield compared to the control. The lower response in 1996 probably resulted primarily from the below-average precipitation for late 1995 through the summer of 1996.

Knifing N for 3 years (1992-94) resulted in 15% additional 1995 yield and 17% more 1996 yield compared to previous broadcast applications (Fig. 2). In 1997, we observed no significant effect of previous knife compared to broadcast applications of N.

The one-cut harvest system resulted in a 17% greater (P<.05) total yield than the two-cut system in 1995, a 94% yield advantage in 1996, but no difference in 1997 (Fig 3). The difference in 1996 was partly because the below-average precipitation for late 1995 through the summer of 1996 affected recovery of the two-cut more than that of the one-cut system.



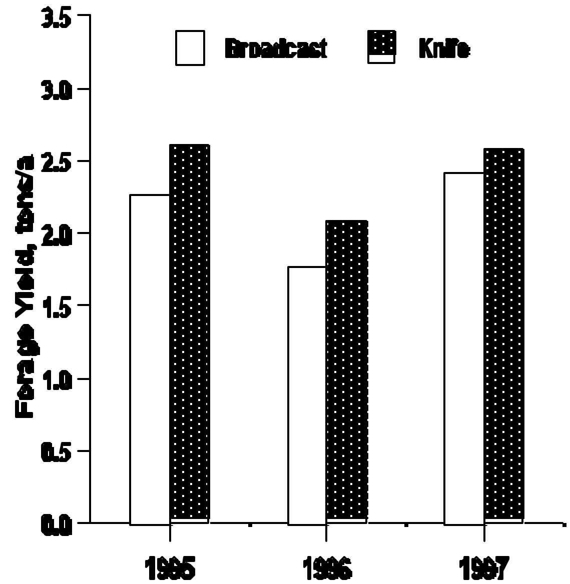


Figure 1. Eastern gamagrass forage yields (12% moisture) in 1995-1997 from different N application rates in 1992-1994, Southeast Agricultural Research Center.

Figure 2. Eastern gamagrass forage yields (12% moisture) in 1995-1997 with residual nitrogen from different nitrogen placements in 1992-1994, Southeast Agricultural Research Center.

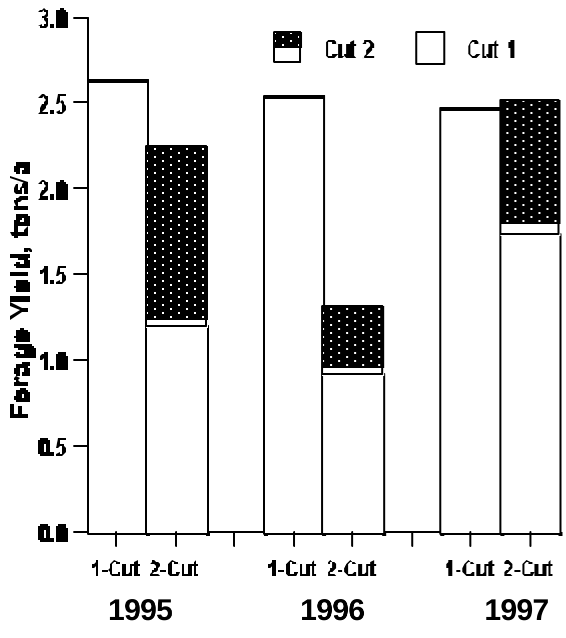


Figure 3. Eastern gamagrass forage yields (12% moisture) in 1995-1997 under two harvest systems, Southeast Agricultural Research Center.

EFFECTS OF PREVIOUS CROP, NITROGEN RATE, AND NITROGEN METHOD ON NITROGEN REQUIREMENT FOR WHEAT

K.W. Kelley and D.W. Sweeney

Summary

Wheat yields were influenced significantly by previous crop, tillage method, fertilizer nitrogen (N) placement, and N rate. In the first study (Table 1), where both conventional- and no-tillage systems were evaluated, grain yields were highest for wheat following soybean with conventional tillage and lowest for wheat planted no-till following grain sorghum. Applying fertilizer N (28% UAN) below crop residues with a coulter-knife applicator also significantly increased grain yield compared with broadcast fertilizer N treatments, regardless of previous crop or tillage system. In the second study (Table 2), where only conventional tillage was evaluated, wheat grain yields also were influenced by previous crop and N rate. Wheat yields averaged 83 bu/a following corn, 78 bu/a following soybean, and 70 bu/a following grain sorghum. Applying fertilizer N (28% UAN) below crop residues with a coulter-knife applicator again resulted in significantly higher grain yield compared to preplant broadcast or dribble applications of UAN solution or broadcast urea. Grain yields increased linearly with increasing fertilizer N rates, regardless of previous crop.

Introduction

This research seeks to evaluate how the previous crop (corn, grain sorghum, or soybean) affects the utilization of applied nitrogen (N) fertilizer by winter wheat. In southeastern Kansas, wheat often is planted after a summer crop as a means of crop rotation; however, previous crop and the quantity of stalk residue affects N efficiency. Placement of fertilizer as well as various N rates were evaluated in both conventional- and no-till previous cropping systems.

Procedures

Conventional- and No-Tillage (Table 1)

The experiment was a split-plot design with previous crop (soybean and grain sorghum) and tillage method (no-till and conventional) as main plots and a factorial arrangement of N rates (60 and 120 lbs N/a) and N placement methods (broadcast and knifed) as subplots. All N treatments were fall-applied and, in conventional tillage, were incorporated shallowly with a field cultivator prior to wheat pl anting. In conventional-tillage plots, crop residues were incorporated partially with a tandem-disk prior to applying fertilizer N treatments. Urea ammonium nitrate 28% N solution (UAN) was the N source, except for one comparison treatment where urea was used as a split application (fall and late-winter). Knifed N treatments were banded on 17 in. centers at a depth of 4 to 6 in. Both conventional- and no-till plots were planted with a no-till drill at a seeding rate of 75 lbs/a.

Conventional Tillage (Table 2)

The experiment was a split-plot design, in which the main plots were previous crops (corn, grain sorghum, or soybean) and subplots included a factorial arrangement of three N rates (40, 80, and 120 lb N/a) with four placement methods - 1) broadcast urea, 2) broadcast liquid 28% N, 3) dribble liquid 28% N on 17-in. centers, and 4) knife liquid 28% N on 17-in. centers at a depth of 4 to 6 in. All N treatments were fall-applied and incorporated with a field cultivator prior to wheat planting. Crop residues were incorporated partially with disk tillage prior to fertilizer N applications. Soil type was a Parsons silt loam with 2.8% O.M. All plots also received 60 lbs/a of P_20_5 and 75 lbs/a K_20.

Results

Conventional and No-Tillage (Table 1)

Wheat yield was influenced significantly by previous crop, tillage method, N rate, and N placement. Yield averaged 10 bu/a higher for wheat following soybean compared to wheat following grain sorghum. Conventional tillage also resulted in higher grain yield than no-till, regardless of previous crop. Yield component analyses (data not shown) indicated that number of wheat heads per unit area was significantly higher in conventional-tillage than no-till systems.

However, both fertilizer N placement and N rate also affected grain yields dramatically for all previous crop and tillage systems. Grain yields were significantly higher when liquid 28 % N was placed below crop residues with a coulter-knife applicator compared with broadcast N applications. Plant N analyses for 1997 are still pending as of this date; however, aboveground, whole-plant, dry matter weights (not shown) were significantly higher with knifed fertilizer N treatments, suggesting that wheat was able to utilize fertilizer N more efficiently. Urea used as a split application (60 lb N/a in fall and 60 lb N/a in late winter) gave similar results to those of the 120 lb N/a rate of UAN applied all in the fall.

Conventional Tillage (Table 2)

Wheat yields were influenced significantly by previous crop and N rate. Grain yields averaged 83 bu/a following corn, 78 bu/a following soybean, and 70 bu/a following grain sorghum. In 1997, cool weather and lack of severe leaf rust infection after heading were conducive for high grain yields.

Grain yields were highest for knifed applications of 28% UAN, regardless of previous crop. Grain yields were not significantly different among broadcast UAN, dribble UAN, and broadcast urea fertilizer N treatments. Grain yields increased linearly with increasing N rates, regardless of previous crop. Plant N analyses of the 1997 crop are still pending. However, differences in wheat yield within previous crops appear to be related primarily to increased fertilizer N utilization following corn and soybeans compared to greater immobilization of fertilizer and soil N for wheat following grain sorghum. Soil analyses (0- 12 in. depth) also showed that residual soil nitrate-N levels prior to wheat fertilization were significantly higher following corn (36 lb N/a) than following soybeans or grain sorghum (12 lb N/a). This difference likely influenced grain yields to some extent.

Table 1. Effects of previous crop, tillage method, nitrogen rate, and nitrogen method on nitrogen requirements for winter wheat, Parsons, KS, 1997.

N Rate	N Method	N Source	Wheat Yield after Grain Sorghum NT	Grain Sorghum CT	Soybean NT	Soybean CT
lb/a			------------------------ bu/a ------------------------			
0	---	---	26.9	34.5	38.0	43.2
60	B'Cast	UAN	38.0	51.7	48.8	62.0
60	Knife	UAN	53.2	61.5	66.7	73.6
120	B'Cast	UAN	56.3	64.7	69.6	75.5
120	Knife	UAN	68.6	73.6	77.8	81.6
120[1]	B'Cast	Urea	57.8	68.8	70.8	72.4
Avg.			50.1	59.1	61.9	68.1

Means: (No N and 120 N as urea omitted)	
Grain sorghum	58.4
Soybean	69.4
LSD (0.05):	2.4
Conventional tillage	68.0
No-till	59.9
LSD (0.05):	2.4
60 lb N/a	56.9
120 lb N/a	71.0
LSD (0.05):	2.0
B'Cast	58.3
Knife	69.6
LSD (0.05):	2.0

[1]60 lb N/a applied in fall and 60 lb N/a topdressed in Feb.
UAN = urea ammonium nitrate 28% N solution.
All plots received 60 lbs/a P_20_5 and 75 lbs/a K^20.
NT = no tillage, CT = conventional tillage (disk)
Planting date: Oct. 16, 1996.
Variety: Karl 92

Table 2. Effects of previous crop, nitrogen rate, and nitrogen method on N requirement for winter wheat, Parsons, KS, 1997.

N Rate	N Method	Wheat Yield after Corn	Grain Sorghum	Soybean
lb/a		---------------- bu/a	----------------	
0	---	57.7	42.8	50.6
40	B'Cast-Urea	77.2	58.1	69.4
80	B'Cast-Urea	83.9	67.9	81.4
120	B'Cast-Urea	91.1	84.2	89.6
40	B'Cast-UAN	75.6	54.6	68.0
80	B'Cast-UAN	83.7	73.2	78.4
120	B'Cast-UAN	93.4	82.0	85.9
40	Dribble-UAN	74.3	58.8	66.6
80	Dribble-UAN	84.6	74.2	82.5
120	Dribble-UAN	90.2	81.9	91.0
40	Knife-UAN	81.9	67.5	77.3
80	Knife-UAN	90.5	82.2	87.4
120	Knife-UAN	95.6	89.0	92.3
Avg*		83.1[a]	70.5[c]	78.5[b]
Means:				
40 lb/a N		77.3	59.7	70.3
80 lb/a N		85.7	74.4	82.4
120 lb/a N		92.6	84.3	89.7
LSD (0.05):		2.1	2.1	2.1
B'Cast-Urea		84.1	70.1	80.1
B'Cast-UAN		84.3	69.9	77.4
Dribble-UAN		83.0	71.6	80.0
Knife-UAN		89.3	79.5	85.7
LSD (0.05):		2.1	2.1	2.1

*Means followed by a different letter are significant at the 5% level of probability.
All N treatments were fall-applied and incorporated with tillage prior to wheat planting.
UAN = urea ammonium nitrate 28% N solution.
All plots received 60 lb/a P_20_5 and 75 lb/a K_20.
Planting date: Oct 16, 1996.
Variety: Karl 92.

EFFECT OF POLYASPARTATE ON FERTILIZER-USE EFFICIENCY OF NO-TILL GRAIN SORGHUM[1]

D.W. Sweeney and M.B. Kirkham

Summary

First-year results suggest that polyaspartate (PA) applied with the starter increased N uptake, the number of kernels/head, and grain sorghum yield. Nitrogen rate affected plant nutrient uptake as well as yield and yield components but did not interact with PA placement.

Introduction

Amisorb is a long-chain polyaspartate compound. It is not a growth regulator but rather is thought to enhance plant nutrient uptake when applied with fertilizers by promoting more root mass and root hairs. Public concerns about effects of fertilizer loss on soil and water quality emphasize the importance of improving efficiency of nutrient uptake by agricultural crops. New products such as polyaspartate compounds should be tested to determine their effectiveness on improving fertilizer uptake by crops and, thus, reducing the potential of fertilizer loss that causes environmental problems.

Procedures

The experiment was established on a Parsons silt loam at the Parsons Field of the Southeast Agricultural Research Center in 1996. The experiment was a 4x4 factorial arrangement of a randomized complete block with six replications. The factors were polyaspartate (PA) application method and nitrogen (N) rates. The PA application method included no PA and PA at 2 qt/a applied with the starter, applied with the fluid N, or applied with both the starter and fluid N. The N rates were the sums of the N in the starter and in the fluid N application to give totals of 40, 80, 120, and 160 lb N/a. The starter was a mix of 13-13-13 and 0-0-60 to supply 25 lb N, 25 lb P_2O_5, and 60 lb K_2O that was applied to all treatments in the 4x4 factorial. The fluid N source was 28% N knifed at a depth of 4 inches into no-till grain sorghum residue. Two additional control plots were included in each replication: one that received 25 lb P_2O_5 as 0-46-0 and 60 lb K_2O as 0-0-60 as a starter but with no N or PA and the second that received the P and K in the starter with PA but no N. Grain sorghum was planted with no tillage on June 26, 1996.

Results

Applying PA with the starter resulted in nearly 9 bu/a more grain sorghum yield than starter with no PA (Table 1). Placing PA with the fluid N or with the starter + fluid N did not significantly increase yield above that with no PA. Kernel weight and the number of heads/a were not affected by PA, but PA with the starter resulted in 12% more kernels/head than no PA.

In general, grain sorghum yield increased with increasing N rate (Table 1), although additional yield response to N rates more than 80 lb/a appeared to be small. The number of heads/a and kernels/head appeared to follow a similar trend. Yield or yield components were not affected by an interaction between PA placement and N rate.

Nitrogen uptake at the soft dough stage was significantly greater with PA applied with the starter compared to no PA or PA applied with the fluid N or with both the starter and fluid N (Fig. 1). This appeared to coincide with the greater number of kernels/head and greater yield with PA applied with the starter. Perhaps the greater N in the plant reduced seed abortion in the top of the head and, thus, increased yield. However, with only 1 year of data, this is unclear. Phosphorus (P) and

[1] Research partially supported by AmiLar International, Inc.

potassium (K) uptakes were unaffected by PA placement (data not shown). Increasing N rate increased N, P, and K uptakes (data not shown), but no interaction occurred between N rate and PA placement.

Table 1. Effects of polyaspartate (PA) placement and nitrogen rate on yield and yield components of grain sorghum, Southeast Agricultural Research Center, 1996.

Treatment	Yield	Kernel Weight	Kernels/Head	Heads/A
PA Placement	bu/a	mg		
None	65.6	24.5	1240	51100
Starter Only	74.5	26.3	1390	51800
Fluid N	69.7	26.2	1320	51400
Starter + Fluid	67.3	26.3	1310	49400
LSD (0.10)	5.4	NS	100	NS
N Rate (lb/a)				
40	55.0	25.2	1240	45000
80	72.3	25.9	1370	51600
120	70.5	26.7	1260	53800
160	78.6	27.5	1370	53300
LSD (0.05)	6.4	0.8	110	3100
Controls				
No PA - no N	36.6	25.9	900	39900
Starter - no N	37.5	23.6	950	43100
PxN Interaction	NS	NS	NS	NS

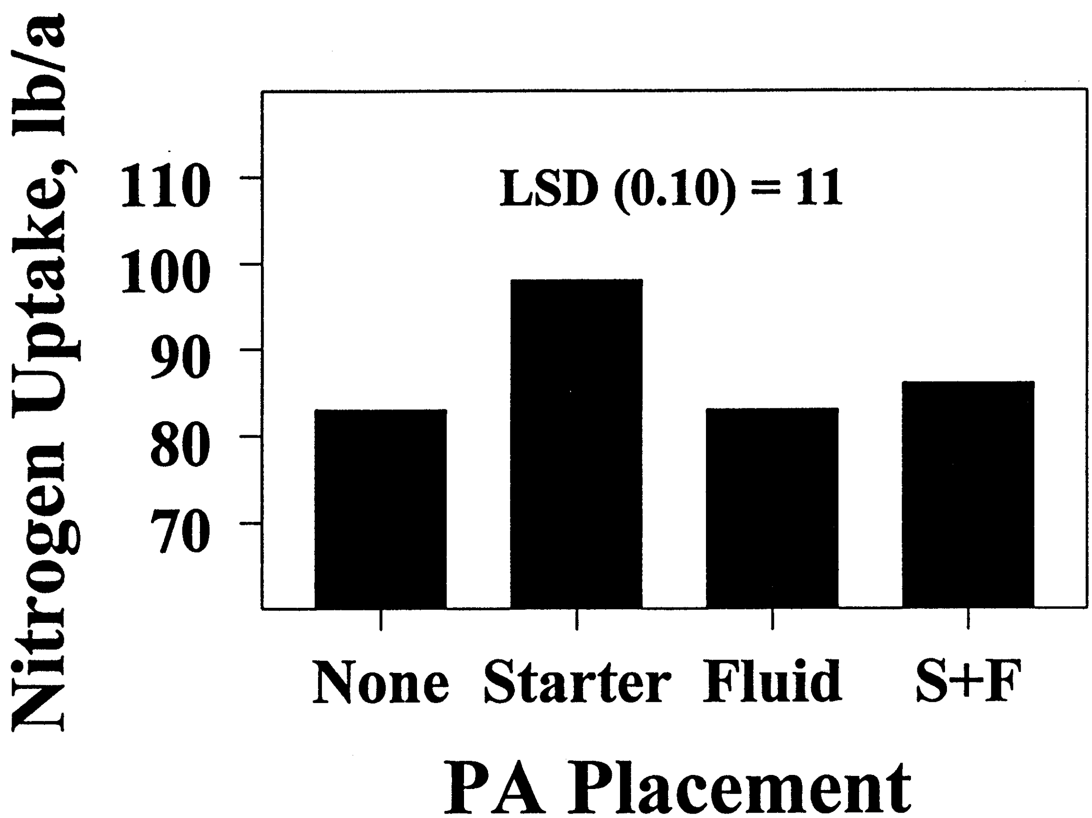


Figure 1. Effect of polyaspartate (PA) placement on nitrogen uptake by grain sorghum at the soft dough growth stage.

SOIL FERTILITY RESEARCH
NORTH CENTRAL EXPERIMENT FIELDS

EVALUATION OF AMISORB FOR CORN AND GRAIN SORGHUM

W.B. Gordon

Summary

Amisorb applied at 2 qt/a with starter fertilizer (30 lb N and 30 lb P_2O_5/a) applied 2 inches to the side and 2 inches below the seed at planting increased grain yield of irrigated corn compared to starter alone or starter plus ACA or Asset. 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 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 conducted on a Crete silt loam soil at the Irrigation Experiment Field near Scandia. The grain sorghum experiment was conducted at the North Central Kansas Experiment Field, near Belleville also on a Crete silt loam soil. The corn experiment was located on a site that had been ridge-tilled for 5 years. The grain sorghum experiment was conducted under dryland, no-tillage conditions. Treatments in the corn study consisted of a no starter check, starter alone (30 lb N and 30 lb P_2O_5), starter plus 2 qt/a Amisorb, starter plus Asset (6 oz/a), and starter plus ACA (10 oz/a). Asset is a product manufactured by Setre Chemical Co. containing 2.00% water-soluble magnesium. ACA is a product offered by United Agri Products and contains by weight 15% N and 17% zinc. Treatments in the grain sorghum study included a no-starter check, starter alone, and starter plus 2 qt/a Amisorb. 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 starter fertilizer sources. Nitrogen as anhydrous ammonia was knifed in the row middles immediately after planting to bring all corn plots to a total of 180 lb N/a and all sorghum plots to a total of 120 lb N/a. Analysis by the KSU Soil Testing Lab showed that initial soil pH was 6.4, organic matter was 1.9%, Bray-1 P was 30 ppm, and exchangeable K was 310 ppm in the top 6 inches of soil at the corn experiment site. Soil test results at the grain sorghum site were: pH 6.6%, Bray-1 P 45 ppm, and exchangeable K 308 ppm. The corn hybrid Pioneer 3394 was planted on 28 April, and the grain sorghum hybrid Dekalb 45 was planted on 21 May.

Results

Starter fertilizer increased corn grain yield by 34 bu/a over the no-starter check (Table 1). Addition of 2 qt/a Amisorb to starter fertilizer increased grain yields by 6 bu/a over the starter alone treatment. Addition of Asset or ACA to the starter fertilizer mix did not significantly improve grain yield over the starter alone treatment.

Starter fertilizer increased growth and nutrient uptake of grain sorghum compared to the no-starter check (Table 2). The addition of Amisorb to the starter fertilizer mix did not improve dry matter production, nutrient uptake, or yield of grain sorghum.

Table 1. Starter fertilizer and Amisorb effects on yield, 6-leaf stage whole plant dry matter, and nutrient uptake of corn, Scandia, KS, 1997.

Treatment	Yield	6-Leaf Whole Plant Dry Weight	6-Leaf Whole Plant N	6-Leaf Whole Plant P
	bu/a	--------------------------lb/a------------------------------		
Amisorb + starter*	218a**	206a	18.6a	2.2a
Starter alone	212 b	178 b	15.3 b	1.8 b
Starter +Asset	210 b	175 b	15.3 b	1.8 b
Starter + ACA	209 b	189ab	16.5ab	1.9ab
No starter	178 c	136 c	10.6 c	1.3 c
CV%	1.4	9.5	9.9	10.2

*Starter fertilizer consisted of 30 lb N and 30 lb P_2O_5/a
** Means followed by the same letter are not significantly different at the 5% level of probability.

Table 2. Starter fertilizer and Amisorb effects on yield, 6-leaf whole plant dry matter, and nutrient uptake of grain sorghum, Belleville 1997.

Treatment	Yield	6-Leaf Whole Plant Dry Weight	6-Leaf Whole Plant N	6-Leaf Whole Plant P
	bu/a	--------------------------lb/a--------------------------------		
Starter + Amisorb	122a**	485a	10.6a	1.2a
Starter alone*	122a	488a	10.8a	1.2a
No starter	95 b	337 b	6.1 b	0.7 b
CV%	3.7	2.6	4.5	1.3

*Starter fertilizer consisted of 30 lb N and 30 lb P2O5/a
**Means followed by the same letter are not significantly different at the 0.05 level of probability.

RESPONSES OF CORN AND GRAIN SORGHUM HYBRIDS TO STARTER FERTILIZER

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

Summary

Two studies evaluated starter fertilizer applications 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 and 12 grain sorghum hybrids grown with or without starter fertilizer. Starter fertilizer (30 lb N and 30 lb/a P_2O_5) was applied 2 inches to the side and 2 inches below the seed at planting. In both the corn and sorghum experiments, 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 sorghum hybrids but had no effect on 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 ability to extract and use nutrients. These studies evaluated 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 studies 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 was 2.4%, Bray-1 P was 43 ppm, and exchangeable K was 380 pm in the top 6 inches of soil. Analysis in the grain sorghum area showed that pH was 6.5, organic matter was 2.5%, Bray-1 P was 45 ppm, and exchangeable K was 420 ppm. Both 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 or grain sorghum hybrids. The split plots consisted of starter (30 lb N and 30 lb P_2O_5/acre) or no starter fertilizer. 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 starter fertilizer sources. Nitrogen as anhydrous ammonia was knifed in 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 1997, corn was planted on 22 April and grain sorghum was planted on 19 May.

Results

<u>Corn Study</u>

Starter fertilizer improved early-season growth and nutrient uptake of all hybrids tested (Table 3). When averaged over hybrids, dry matter at the 6-leaf stage averaged 178 lb/a without starter and 360 lb/a with starter. Dryland corn in central Kansas normally is planted as early in April as possible, so that pollination occurs in June when temperature and moisture conditions are more favorable than in July, when conditions are normally hot and dry. Any practice that promotes earliness often increases yield. 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). When averaged over the 3 years of the experiment , the average yield increase for the seven hybrids that responded to starter fertilizer was 17 bu/a.

Grain Sorghum Study

Starter fertilizer improved the early-season growth and nutrient uptake of all hybrids tested (Table 5). When averaged over hybrids, dry matter at the 6-leaf stage was 158 lb/a greater with starter than without. Starter fertilizer can be quite helpful in improving early-season growth in cool soils. In northern Kansas, an early frost can occur 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 8 of the 12 hybrids tested (Table 6). Starter fertilizer increased grain yield of some hybrids but had no effect on yield of other hybrids (Table 6). When averaged over the 3 years of the experiment, average yield increase of responding hybrids was 15 bu/a.

Table 3. Mean effects of corn hybrids and starter fertilizer on whole-plant dry weight and nitrogen and phosphorus uptakes at the 6-leaf stage of growth, Belleville, KS, 1997.

Hybrid	Dry Weight	N Uptake	P Uptake
	------------------------------lb/a-------------------------		
Pioneer 3563	236	7.2	0.79
Pioneer 3489	245	7.9	0.88
Pioneer 3346	248	7.9	0.80
Pioneer 3394	250	8.1	0.85
Cargill 6327	265	8.2	0.86
Cargill 7777	268	9.0	0.88
Dekalb 591	251	7.2	0.76
Dekalb 626	245	7.5	0.90
Dekalb 646	240	7.5	0.80
Northrup King 7333	246	8.2	0.90
Northrup King 6330	238	7.9	0.75
ICI 8599	230	6.9	0.76
LSD(0.05)	12	0.4	0.05
Starter			
With	360	5.2	1.15
Without	178	10.3	0.48
LSD(0.05)	27	0.85	0.08

Table 4. Starter fertilizer effects on grain yield and number of days from emergence to mid-silk of corn hybrids, Belleville, KS, 1997.

Hybrid	Starter	Yield, 1997	Yield 1995-1997	Number of Days to Mid-silk, 1997
		-------------------bu/a---------------		
Pioneer 3563	With	85	106	74
	Without	84	105	74
Pioneer 3489	With	120	135	78
	Without	111	116	72
Pioneer 3346	With	115	142	80
	Without	102	122	74
Pioneer 3394	With	112	144	80
	Without	98	127	75
Cargill 6327	With	98	124	79
	Without	97	124	80
Cargill 7777	With	128	161	82
	Without	116	149	76
Dekalb 591	With	110	141	79
	without	95	122	72
Dekalb 626	With	101	124	79
	Without	102	124	79
Dekalb 646	With	106	127	82
	Without	105	126	81
Northrup King 7333	With	126	126	76
	Without	110	110	82
Northrup King 6330	With	137	137	75
	Without	120	120	79
ICI 8599	With	120	120	77
	Without	120	120	77
Hybrid x Starter LSD(0.05)		7	9	2

Table 5. Mean effects of grain sorghum hybrids and starter fertilizer on whole-plant dry weight and N and P uptakes at the 6-leaf stage of growth, Belleville, KS, 1997.

Hybrid	Dry Weight	N Uptake	P Uptake
	----------------------------------	lb/a	------------------------------
Pioneer 8699	302	9.5	0.98
Pioneer 8505	320	9.5	0.99
Pioneer 8310	329	8.9	1.02
Dekalb 48	340	10.5	1.10
Dekalb 40Y	325	10.0	1.25
Dekalb 39Y	298	9.6	1.12
Dekalb 51	320	9.5	1.08
Dekalb 55	325	9.8	1.10
Pioneer 8522Y	305	9.7	0.99
Northrup King KS 383Y	308	9.8	1.05
Northrup King 524	315	9.7	1.04
Northrup King 735	318	9.5	1.04
LSD(0.05)	NS*	NS	NS
<u>Starter</u>			
With	396	12.3	1.31
Without	232	7.1	0.80
LSD(0.05)	25	0.8	0.49

* 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, 1997.

Hybrid	Starter	Yield, 1997	Yield, 1995-1997	Number of Days to Mid-Bloom, 1997
		-------------bu/a-------------		
Pioneer 8699	With	108	109	56
	Without	104	107	57
Pioneer 8505	With	139	138	56
	Without	129	122	61
Pioneer 8310	With	155	133	65
	Without	144	118	71
Dekalb 48	With	139	129	62
	Without	128	115	69
Dekalb 40Y	With	150	131	63
	Without	137	113	70
Dekalb 39Y	With	118	104	62
	Without	118	103	62
Dekalb 51	With	149	134	62
	Without	136	115	68
Dekalb 55	With	149	130	66
	Without	134	115	72
Pioneer 8522Y	With	138	127	63
	Without	129	115	69
Northrup King KS 383Y	With	126	117	62
	without	126	117	62
Northrup King KS 524	With	136	128	61
	Without	128	114	67
Northrup King KS 735	With	152	128	65
	Without	151	127	65
Hybrid x Starter LSD(0.05)		5	7	2

RESPONSES OF CORN AND GRAIN SORGHUM HYBRIDS TO STARTER FERTILIZER COMBINATIONS

W.B. Gordon and G.M. Pierzynski

Summary

In previous research at the North Central Kansas Experiment Field, we found that some corn and grain sorghum hybrids grown under reduced-tillage conditions responded to starter fertilizer containing nitrogen (N) and phosphorus (P) and others did not. Little information is available concerning variability in responsiveness among corn and grain sorghum hybrids to starter containing a complete complement of nutrients. These studies evaluated the responses of four corn hybrids (Pioneer 3563, Pioneer 3346, Dekalb 591, and Dekalb 646) and four grain sorghum hybrids (Pioneer 8699, Northrup King KS 735, Dekalb 40Y, and Dekalb 48) to starter fertilizer combinations containing N, P, potassium (K), sulfur (S), and zinc (Zn). The corn experiment was conducted on a Carr fine sandy loam soil located in the Republican River Valley near Scandia, KS. The grain sorghum experiment was conducted at the North Central Kansas Experiment Field located near Belleville on a Crete silt loam soil. Starter fertilizer containing N and P increased V-6 stage dry weight compared to the no-starter check treatment for all corn hybrids tested. Grain yield of two of the corn hybrids (Pioneer 3563 and Dekalb 646) did not respond to starter fertilizer, regardless of elemental composition. Starter fertilizer containing N and P increased grain yield of Pioneer 3346 and Dekalb 591 by 33 and 48 bu/a, respectively, compared to the no-starter check treatment. The addition of 10 lb/a S to the starter fertilizer mix resulted in grain yield increases for Pioneer 3346 and Dekalb 591. Additions of K and Zn to the starter fertilizer did not result in any additional benefit. Starter fertilizer increased V-6 stage dry matter production in all grain sorghum hybrids tested. Starter fertilizer containing N and P increased grain yield of Dekalb 40Y and Dekalb 48 by 36 and 19 bu/a, respectively. Grain yield of two grain sorghum hybrids (Pioneer 8699 and Northrup King KS 735) did not respond to starter fertilizer. Additions of K, S, and Zn to the starter fertilizer mix did not significantly increase dry matter production or grain yield for any grain sorghum hybrid.

Introduction

Conservation-tillage production systems are being used by an increasing number of farmers in the central Great Plains. Early season growth is often poorer in these systems than in conventionally tilled systems. Cool soil temperature at planting time can reduce nutrient uptake of crops. Placing fertilizer in close proximity to the seed at planting time can alleviate the detrimental effects of cool soil temperature on plant growth and development. Previous research at the North Central Kansas Experiment Field, found that some corn and grain sorghum hybrids respond well to the application of starter fertilizer, whereas, other hybrids do not respond at all. These experiments were conducted using starters containing only N and P. Little is known about variability in responsiveness among corn and grain sorghum hybrids to starters containing a complete complement of nutrients. The objectives of these experiments were to determine the variability in starter fertilizer responsiveness among corn and grain sorghum hybrids grown under reduced-tillage conditions and to ascertain whether that variability is influenced by starter fertilizer composition.

Procedures

The ridge-tilled, furrow-irrigated corn study was conducted on a farmers field in the Republican River Valley near Scandia, KS on a Carr sandy loam soil. Analysis by the KSU Soil Testing Lab showed that initial soil pH was 7.2, organic matter content was 1%, Bray-1 P was 21 ppm, and exchangeable K was 280 ppm in the surface 6 inches of soil. The site had been in ridge-tillage for 4 years prior to the establishment of this study. The grain sorghum study was conducted at the North Central Kansas Experiment Field, located near Belleville, on a Crete silt loam soil. Soil test values for this site were: pH 6.5, organic matter content 2.5%, Bray-1 P 44 ppm, and exchangeable K 350 ppm in the top 6 inches of soil. The experimental site had been in no-tillage production for 3 years prior to the establishment of this no-tillage, dryland grain sorghum experiment. Corn hybrids used were: Pioneer 3563, Pioneer 3346, Dekalb 591, and Dekalb 646. Grain sorghum hybrids included in the experiment were: Pioneer 8699, Northrup King KS 735, Dekalb 40Y, and Dekalb 48. The liquid starter fertilizer treatments used in both experiments are given in Table 7.

Starter fertilizer was applied 2 inches to the side and 2 inches below the seed at planting. The corn experiment was planted on 28 April at the rate of 30,000 seed/a. The grain sorghum study was planted on 18 May at the rate of 64,000 seed/a. Immediately after planting, N was balanced on all plots to give a total of 200 lb/a in the corn study and 150 lb/a in the grain sorghum study. The N source used in the experiments was urea ammonium nitrate solution (28% UAN), the P source was ammonium polyphosphate (10-34-0), the K source was KCL, the S source was ammonium thiosulfate, and the Zn source was a liquid Zn-NH_3 complex.

Results

Corn Study

Starter fertilizer containing N and P improved V-6 stage dry matter production of all hybrids tested compared to the no-starter check treatment (Table 8). Additional response was achieved with the addition of S to the starter fertilizer mix. Additions of K and Zn did not result in any additional increase.

Two hybrids (Pioneer 3563 and Dekalb 646) did not show any yield response to starter fertilizer (Table 9). This is consistent with the results of previous studies using these hybrids. Starter fertilizer containing N and P increased grain yield of Pioneer 3346 and Dekalb 591 by 33 and 48 bu/a, respectively when compared to the no-starter check. Addition of S to the starter fertilizer mix resulted in an additional 9 bu/a yield for Pioneer 3346 and additional 10 bu/a for Dekalb 591, when compared to starter fertilizer containing only N and P.

Grain Sorghum Study

Starter fertilizer containing N and P increased V-6 stage dry matter of all grain sorghum hybrids tested compared to the no-starter check treatment (Table 10). Additions of K, S, and Zn to the starter fertilizer mix did not significantly improve V-6 dry matter production on this medium-textured silt loam soil.

Starter fertilizer containing N and P increased grain yield of Dekalb 40Y and Debalb 48 by 37 and 19 bu/a, respectively, compared to the no-starter check treatment (Table 11). Grain yield of two grain sorghum hybrids (Pioneer 8699 and Northrup King KS 735) did not respond to starter fertilizer. Additions of K, S, and Zn to the starter fertilizer mix did not significantly further increase grain yield over the increases achieved with N and P.

Conclusion

Starter fertilizer improved early-season growth in all hybrids included in the experiment. However, this response did not translate into increased grain yield for all hybrids.

Results of this work suggest that responses to starter fertilizer can be economical for some hybrids even on soils that are not low in available nutrients, particularly when corn and grain sorghum are planted in a high-residue production system.

Table 7. Starter fertilizer treatments, Scandia and Belleville, KS.

Treatment	N	P_2O_5	K_2O	S	Zn
	- - - - - - - - - - - -	- - - -	lb/a - - - -	- - - - - -	- - - - -
1	0	0	0	0	0
2	30	30	0	0	0
3	30	30	20	0	0
4	30	30	0	10	0
5	30	30	0	0	1
6	30	30	20	10	1

Table 8. Means of starter fertilizer combination effects on V-6 stage whole plant dry weight of corn hybrids, Scandia, KS, 1997.

Hybrid					V-6 Whole Plant Dry Weight
					lb/a
Pioneer 3563					347
Pioneer 3346					340
Dekalb 591					329
Dekalb 646					359
LSD(0.05)					18
Starter Combination					
N	P_2O_5	K_2O	S	Zn	
--------------lb/a------------					
0	0	0	0	0	162
30	30	0	0	0	351
30	30	20	0	0	370
30	30	0	10	0	413
30	30	0	0	1	360
30	30	20	10	1	407
LSD(0.05)					21

Table 9. Starter fertilizer combination effects on grain yield of corn hybrids, Scandia, KS.

Hybrid	Starter Fertilizer Combination					Yield 1997	Yield 1996-1997
	------------lb/a-------------					--------bu/a--------	
Pioneer 3563	N	P_2O_5	K_20	S	Zn		
	0	0	0	0	0	180	201
	30	30	0	0	0	181	202
	30	30	20	0	0	187	205
	30	30	0	10	0	182	201
	30	30	0	0	1	189	205
	30	30	20	10	1	186	204
Pioneer 3346	0	0	0	0	0	140	147
	30	30	0	0	0	173	190
	30	30	20	0	0	167	187
	30	30	0	10	0	182	204
	30	30	0	0	1	170	190
	30	30	20	10	1	180	204
Dekalb 591	0	0	0	0	0	137	151
	30	30	0	0	0	185	200
	30	30	20	0	0	187	200
	30	30	0	10	0	195	212
	30	30	0	0	1	182	199
	30	30	20	10	1	196	213
Dekalb 646	0	0	0	0	0	188	195
	30	30	0	0	0	183	194
	30	30	20	0	0	181	192
	30	30	0	10	0	182	194
	30	30	0	0	1	187	197
	30	30	20	10	1	183	193
LSD(0.05)						7	9

Table 10. Means of starter fertilizer combinations effects on V-6 stage whole plant dry weight of grain sorghum hybrids, Belleville, KS, 1997.

Hybrid					V-6 Whole Plant Dry Weight
					lb/a
Pioneer 8699					573
Northrup King KS 735					557
Dekalb 40Y					544
Dekalb 48					563
LSD(0.05)					NS*
Starter Combination					
N	P_2O_5	K_2O	S	Zn	
------------lb/a---------					
0	0	0	0	0	327
30	30	0	0	0	612
30	30	20	0	0	603
30	30	0	10	0	611
30	30	0	0	1	606
30	30	20	10	1	596
LSD(0.05)					66

* Not significant at the 0.05 level of probability.

Table 11. Starter fertilizer combination effects on grain yield of grain sorghum hybrids, Belleville, KS.

Hybrid	Starter Fertilizer Combination					Yield, 1997	Yield, 1996-1997
	---------------lb/a-------------					------------bu/a------------	
Pioneer 8699	N	P_2O_5	K_2O	S	Zn		
	0	0	0	0	0	123	127
	30	30	0	0	0	118	123
	30	30	20	0	0	127	127
	30	30	0	10	0	122	126
	30	30	0	0	1	120	124
	30	30	20	10	1	126	127
Northrup King KS 735	0	0	0	0	0	117	122
	30	30	0	0	0	123	125
	30	30	20	0	0	115	120
	30	30	0	10	0	119	122
	30	30	0	0	1	118	121
	30	30	20	10	1	119	123
Dekalb 40Y	0	0	0	0	0	91	101
	30	30	0	0	0	128	131
	30	30	20	0	0	128	131
	30	30	0	10	0	130	131
	30	30	0	0	1	126	130
	30	30	20	10	1	132	133
Dekalb 48	0	0	0	0	0	97	107
	30	30	0	0	0	116	129
	30	30	20	0	0	122	133
	30	30	0	10	0	123	132
	30	30	0	0	1	117	129
	30	30	20	10	1	124	132
LSD(0.05)						9	1

SOIL FERTILITY RESEARCH
SOUTH CENTRAL EXPERIMENT FIELD

WHEAT YIELDS AS AFFECTED BY PREVIOUS CROP, NITROGEN RATE, AND TILLAGE

W. F. Heer

Summary

The predominant cropping systems in South Central Kansas have been continuous wheat and wheat-grain sorghum- fallow. With continuous wheat, tillage is used to control diseases and weeds. In the wheat-sorghum fallow system, only two crops are produced every 3 years. Other crops (corn, soybean, sunflower, winter cover crops, and canola) can be placed in these cropping systems. To determine how winter wheat yields are affected by these crops, winter wheat was planted in rotations following them. Yields were compared to those of continuous winter wheat under conventional (CT) and no-till (NT) practices. Initially, the CT, continuous wheat yields were greater then those from the other systems. However, over time, wheat yields following soybeans have increased, reflecting the effects of reduced weed and disease pressures and increased soil nitrogen. However, continuous CT winter wheat seems to out-yield NT winter wheat regardless of the previous crop.

Introduction

In South Central Kansas, continuous hard red winter wheat and winter wheat - grain sorghum - fallow are the predominate cropping systems. The summer-fallow period following sorghum is required because the sorghum crop is harvested in late fall, after the optimum planting date for wheat in this region. Average annual rainfall is only 29 inch/yr, with 60 to 70% occurring between March and July. Therefore, soil moisture is often not sufficient for optimum wheat growth in the fall. No-tillage (NT) systems often increase soil moisture by increasing infiltration and decreasing evaporation. However, higher grain yields associated with increased soil water in NT have not always been observed. Cropping systems with winter wheat following several alternative crops would provide improved weed control through additional herbicide options and reduced disease incidence by interrupting disease cycles as well as provide producers with several options under the 1995 Farm Bill. However, fertilizer nitrogen (N) requirement for many crops is often greater under NT than conventional tillage (CT). Increased immobilization and denitrification of inorganic soil N and decreased mineralization of organic soil N have been related to the increased N requirements under NT. Therefore, evaluation of N rates on hard red winter wheat in continuous wheat and in cropping systems 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 cropping systems, where wheat follows short- season corn, was established in 1986. The second (established in 1990) has winter wheat following soybeans. Both cropping systems use NT seeding into the previous crop's residue. All three systems have the same N rate treatments.

Procedures

The research was conducted at the KSU South Central Experiment Field, Hutchinson. Soil was an Ost loam. The sites had been in wheat before initiation of the cropping systems. The research was replicated five times using a randomized block design with a split-plot arrangement. The main plot was crop, and the subplots were six N levels (0, 25, 50, 75, 100, and 125 lbs/a). Nitrogen treatments were broadcast applied as NH_4NO_3 prior to planting. Phosphate was applied in the row at planting. All crops were produced each year of the study. Crops are planted at the normal time for the area. Plots are harvested at maturity to determine grain yield, moisture, and test weight.

Continuous Wheat

These plots were established in 1987. The conventional tillage treatments are plowed immediately after harvest and then disked as necessary to control weed growth. The fertilizer rates are applied with a Barber metered screw spreader prior to the last tillage on the CT and seeding on the NT plots. The plots are cross-seeded to winter wheat. As a result of an infestation of cheat in the 1993 crop, the plots were planted to oats in the spring of 1994. The fertility rates were maintained, and the oats were harvested in July. Winter wheat has been planted in the plots since the fall of 1994.

Wheat after Corn

In this cropping system, winter wheat is planted after a short-season corn has been harvested in late August to early September. This early harvest of short-season corn allows the soil profile water to be recharged (by normal late summer and early fall rains) prior to planting of winter wheat in mid October. Fertilizer rates are applied with the Barber metered screw spreader in the same manner as for the continuous wheat.

Wheat after Soybeans

Winter wheat planted after a maturity group I soybean has been harvested in early to mid September in this cropping system. As with the corn, this early harvest again allows the soil profile water to be recharged prior to planting of winter wheat in mid October. Fertilizer rates are applied with the Barber metered screw spreader in the same manner as for the continuous wheat.

Winter wheat also is planted after canola and sunflowers to evaluate the effects of these two crops on the yield of winter wheat. Uniform N fertility is used, therefore, the data are not presented.

Results

Continuous Wheat

Continuous winter wheat data from the plots are summarized by tillage and N rate in Table 1. Wheat yields in the CT and NT treatments were comparable for the first 4 years. In the fifth year (1992), cheat started to become a serious yield-limiting factor in the NT treatments. By 1993, it had almost completely taken over the NT treatments. As a result of the cheat problem, the plots were planted to oats in the spring of 1994. This allowed for a significant reduction in cheat. The results for 1995 were not affected by cheat but more by the climatic conditions of the year. The cool wet winter with lush growth was followed by a warm period. This then was followed by cold wet weather during the seed setting and grain filling periods. The data reflect these conditions. The yield increases that occurred with increasing N rate did not materialize that year. These weather conditions contributed to the NT treatments having greater yield reductions than the CT. Conditions in 1996 and 1997 proved to be excellent for winter wheat production in spite of the dry fall of 1995 and the late spring freezes in both years.

Wheat after Corn

Wheat yield increases with increasing N rates were observed in wheat following corn in 1988 and 1990 (Table 2). 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 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 showed 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 substantial 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. In 1996, the corn prior to wheat was dropped and cover crops were added to this cropping system.

Wheat after Soybeans

Wheat yields after soybeans also reflect the differences in N rate. However, if the wheat yields from this cropping system are compared with those from wheat following corn, the effects of residual N from soybean production in the previous year can be seen. This is especially true for the 0 to 75 lb N rates in 1993 and the 0 to 125 lb rates in 1994 (Table 3). Yields in 1995 reflect the added N from the previous soybean crop, increasing with N rate similar to those in 1994. As the rotation continues to cycle, the differences at each N rate probably will stabilize after four to five cycles, with a potential to reduce fertilizer N applications by 25 to 50 lbs/a where wheat follows soybeans.

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 in continuous winter wheat regardless of tillage or in the wheat after soybeans. Corn will have the potential to produce grain in favorable years (cool and moist) and silage in non-favorable (hot and dry) years. In very dry summers, extremely low grain sorghum yields can occur.

The major weed control problem in the wheat after corn system is with grasses. This was expected, and work is being done to determine the best herbicides and time of application to control grasses.

Table 1. Wheat yields by tillage and nitrogen rate in a continuous wheat cropping system, Hutchinson, KS.

	Yield																			
	1988		1989[1]		1990		1991		1992		1993[2]		1994[3]		1995		1996		1997	
N Rate[4]	CT[5]	NT	CT	NT	CT	NT	CT	NT	CT	NT	CT	NT	CT	NT	CT	NT	CT	NT	CT	NT
lb/a	- bu/a -																			
0	39	32	35	12	58	50	53	53	40	26	28	2	34	25	26	16	46	23	47	27
25	44	41	38	28	60	57	72	70	42	40	31	3	55	52	28	12	49	27	56	45
50	40	39	35	27	57	57	74	60	45	38	28	3	59	63	30	9	49	29	53	49
75	48	46	37	27	60	58	66	62	45	51	31	11	72	73	30	16	49	29	50	46
100	46	50	37	31	58	61	65	56	45	42	27	10	66	76	23	15	46	28	51	44
125	41	48	36	30	55	59	67	57	44	44	26	4	64	76	23	12	45	25	48	42
LSD*(0.01)	NS	10	NS	11	NS	NS	9	9	NS	13	NS	5	17	17	NS	6	NS	NS	8	8

* 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] ANOVA for three replications.
[2] Severe cheat infestation in NT treatments.
[3] Yields for oat crop.
[4] Nitrogen rate in lb/a
[5] CT = conventional tillage; NT = no-tillage

Table 2. Wheat yields after corn by nitrogen rate, 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 3. Wheat yields after soybeans by nitrogen rate, Hutchinson, KS.

	Yield						
N Rate	1991	1992	1993	1994	1995	1996[1]	1997
lb/a	- - - - - - -	- - - - - - -	- - - -	-bu/a	- - - -	- - - - - - -	- - - - - - -
0	51	31	24	23	19	35	13
25	55	36	34	37	26	36	29
50	55	37	41	47	34	36	40
75	52	37	46	49	37	36	44
100	51	35	45	50	39	36	45
125	54	36	46	52	37	36	47
LSD(0.01)	NS	4	6	2	1	1	4
CV (%)	7	6	9	5	7	2	9

* 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] Spring wheat yields.

SOIL FERTILITY RESEARCH
HARVEY COUNTY EXPERIMENT FIELD

EFFECTS OF TERMINATION DATE OF HAIRY VETCH WINTER COVER CROP AND NITROGEN RATES ON GRAIN SORGHUM

M.M. Claassen

Summary

Dry matter yields of 2.66 tons/a and 2.99 tons/a were produced by hairy vetch planted in mid-September following winter wheat and terminated on April 25 (DOT 1) and May 14 (DOT 2), respectively. The corresponding potential N contributions were 147 lb/a and 188 lb/a for the succeeding sorghum crop. In a season with ample rainfall, delayed vetch termination tended to result in higher sorghum leaf N levels and grain yields, but treatment differences were not always significant. The positive effects of DOT 1 and DOT 2 vetch on the yield of sorghum without fertilizer N were equivalent to about 70 lb/a and 89 lb/a of N. Sorghum yields after vetch averaged over N rates were 6 to 10 bu/a more than yields without a preceding cover crop.

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 nitrogen (N). This experiment was conducted to investigate the effect of hairy vetch and N fertilizer rates on the supply of N to the succeeding grain sorghum crop, as well as to assess sorghum yield response when the vetch is terminated at different times ahead of sorghum planting.

Procedures

The experiment was established on a Geary silt loam soil on which unfertilized winter wheat was grown in 1995 and 1996. Reduced tillage practices with a disk and field cultivator were used to control weeds and prepare a seedbed. Hairy vetch plots were planted on September 13, 1996 at 15 lb/a in 8 in. rows with a grain drill equipped with double-disk openers.

Rainfall shortly after planting favored fall stand establishment of hairy vetch. Precipitation during the entire vetch growing season was near to or slightly above normal. Volunteer wheat was controlled by a mid-March application of Fusilade + crop oil concentrate (2 oz ai/a + 1% v/v). One set of vetch plots was terminated early by disking on April 25 (DOT 1). Hairy vetch in a second set of plots was terminated in like manner on May 14 (DOT 2).

Vetch forage yield was determined by harvesting a 1 sq m area from each plot immediately before termination. Nitrogen fertilizer treatments were broadcast as ammonium nitrate on June 23, 1997. All plots received 35 lb/a of P_2O_5, which was banded as 0-46-0 at planting. Pioneer 8505 grain sorghum treated with Concep III safener and Gaucho insecticide was planted at approximately 42,000 seeds/a after rain delay on July 3, 1997. Weeds were controlled with a preemergence application of Microtech + atrazine (2.5 + 0.25 lb ai/a). Grain sorghum was combine harvested on November 6.

Results

Initial soil nitrate N (0 to 2 ft) and available P (0 to 6 in.) averaged 19 lb/a and 40 lb/a, respectively, and organic matter level was 2.1%. Hairy vetch provided excellent fall ground cover (63%) to provide protection from soil erosion (Table 1). At DOT 1, vetch was about 16 to 18 in. tall and had not reached bloom stage. A few plants were beginning to bloom at DOT 2. Average hairy vetch dry matter yields were 2.66 tons/a at DOT 1 and nearly 3.0 tons/a at DOT 2. The average N contents were 2.76% and 3.15%, respectively. Consequently, the average potential amounts of N to be mineralized for use by the sorghum crop were 147 lb/a and 188 lb/a.

Disking to terminate hairy vetch growth did not adversely affect soil moisture at the surface because of ample spring rains, which ultimately delayed planting. Sorghum stands averaged 39,560 plants/a and were relatively uniform across treatments (Table 2). At low N rates, leaf N at boot to early heading stage was higher in sorghum after vetch than in sorghum without a prior vetch cover crop. Highest leaf N values occurred in sorghum following DOT 2 vetch. However, the effect of vetch termination date on leaf N was not always significant or consistent. The overall effect of N rate on leaf N was significant. A trend of increasing leaf N as N rate increased was consistent in sorghum without prior vetch. However, approximately 66 lb/a of N fertilizer was required to significantly increase leaf N in the absence of the cover crop. In sorghum following vetch, leaf N did not increase meaningfully above a N rate of 30 lb/a. At the zero N rate, vetch at DOT 1 and DOT 2 increased sorghum leaf N equivalent to that with 27 lb/a and 66 lb/a of fertilizer N. Sorghum following vetch required 1 to 2 days fewer to reach half bloom than sorghum without a preceding cover crop. Averaged over N rates, sorghum yields were 6 to 10 bu/a more after vetch than where no cover crop had been grown. Highest yields were attained with 90 lb N/a in sorghum without prior vetch and with 30 lb N/a in sorghum following vetch. The positive effects of DOT 1 and DOT 2 vetch on the yield of sorghum without fertilizer N were equivalent to about 70 lb/a and 89 lb/a of N, respectively. A small, but significant, increase in the number of heads per plant accounted for most of the treatment effects on yield.

Table 1. Initial soil test values, hairy vetch fall ground cover, and hairy vetch yield at spring termination, Hesston, KS, 1997.

Cover Crop/ Termination	N Rate[1]	Initial Soil NO_3-N[2]	Avail. Soil P	Soil Organic Matter	Fall Ground Cover[3]	Hairy Vetch[4] Yield	N	P
	lb/a	lb/a	lb/a	%	%	ton/a	lb/a	lb/a
None	0	19	39	1.9	--	--	--	--
	30	18	41	2.0	--	--	--	--
	60	19	39	2.1	--	--	--	--
	90	17	40	2.3	--	--	--	--
Vetch-April 25	0	20	37	2.0	59	2.75	145	13
	30	19	39	2.1	60	2.85	157	14
	60	22	42	2.1	62	2.45	148	12
	90	18	33	2.0	59	2.58	138	11
Vetch-May 14	0	18	54	2.1	66	3.11	215	20
	30	18	35	2.2	62	3.08	155	13
	60	17	45	2.1	71	3.28	210	20
	90	17	32	2.0	61	2.47	173	15
LSD .05		NS	NS	NS	NS	0.53	68	7
Means: Cover Crop/ Termination								
None		18	40	2.1	--	--	--	--
Vetch-April 25		20	38	2.1	60	2.66	147	12
Vetch-May 14		18	42	2.1	65	2.99	188	17
LSD .05		NS	NS	NS	NS	0.27	34	4
N Rate								
0		19	43	2.0	63	2.93	180	16
30		18	38	2.1	61	2.97	156	13
60		20	42	2.1	67	2.87	179	16
90		18	35	2.1	60	2.53	155	13
LSD .05		NS	NS	NS	NS	NS	NS	NS

[1] N applied as 34-0-0 June 23, 1997.
[2] Mean nitrate nitrogen (0 - 2'), available P (0-6") and organic matter (0-6") on Sept. 11, 1996, 2 days before hairy vetch planting.
[3] Vetch cover estimated by 6" intersects on one 40' line transect per plot on November 13, 1996.
[4] Oven dry weight and N and P contents determined just prior to respective vetch terminations.

Table 2. Effects of hairy vetch termination date and nitrogen rate on nutrient uptake, maturity, and yield of grain sorghum, Hesston, KS, 1997.

Cover Crop/ Termination	N Rate[1]	Stand	Leaf N[2]	Leaf P[2]	Half Bloom	Heads/ Plant	Grain Yield[4]	Mois
	lb/a	1000's/a	%	%	days[3]		bu/a	%
None	0	39.9	2.60	0.345	59	1.00	90.8	19.2
	30	39.5	2.62	0.363	60	1.03	97.3	19.2
	60	39.8	2.78	0.395	59	1.07	101.8	18.8
	90	39.3	2.91	0.407	59	1.18	107.0	18.4
Vetch-April 25	0	39.3	2.66	0.377	58	1.05	103.3	18.7
	30	39.3	2.85	0.394	58	1.13	108.3	18.4
	60	39.3	2.80	0.394	58	1.19	101.8	18.1
	90	38.7	2.86	0.392	59	1.13	105.4	18.4
Vetch-May 14	0	40.2	2.80	0.400	58	1.12	106.4	18.0
	30	39.7	2.93	0.408	57	1.15	110.5	18.0
	60	40.0	3.01	0.422	57	1.24	111.4	17.8
	90	39.7	2.60	0.395	58	1.15	107.0	18.1
LSD .05		NS	0.20	0.022	1.7	0.11	8.8	0.7
Means: Cover Crop/ Termination								
None		39.6	2.72	0.377	59	1.07	99.2	18.9
Vetch-April 25		39.2	2.79	0.389	58	1.13	104.7	18.4
Vetch-May 14		39.9	2.83	0.406	57	1.16	108.8	18.0
LSD .05		NS	NS	0.011	0.8	0.055	4.4	0.3
N Rate								
0		39.8	2.69	0.374	58	1.06	100.2	18.6
30		39.5	2.80	0.388	58	1.10	105.4	18.5
60		39.7	2.86	0.404	58	1.17	105.0	18.2
90		39.2	2.79	0.398	59	1.15	106.4	18.3
LSD .05		NS	0.12	0.013	NS	0.064	NS	NS

[1] N applied as 34-0-0 June 23, 1997.
[2] Leaf N and P at late boot to early heading stage. Leaf P adjusted for initial soil P.
[3] Days from planting to half bloom.
[4] Grain yield adjusted to 12.5% moisture and constant initial soil N and P.

EFFECTS OF HAIRY VETCH WINTER COVER CROP, TILLAGE, AND NITROGEN RATE ON GRAIN SORGHUM

M.M. Claassen

Summary

Hairy vetch planted in mid-September following winter wheat produced 2.05 tons of dry matter by the time it was terminated in the following May. Vetch contained an average of 128 lb/a of nitrogen (N). Method of vetch termination (no-till vs disk) had no effect on grain sorghum flag-leaf N concentrations or on yields. Vetch significantly increased sorghum leaf N and also increased sorghum grain yield by nearly 22 bu/a in the absence of fertilizer N. The apparent N contribution to sorghum yield by the vetch was approximately 58 lb/a.

Introduction

Hairy vetch can be utilized as a winter cover crop after wheat and prior to grain sorghum planted in the following spring. The amount of N contributed by hairy vetch to grain sorghum in this cropping system remains under investigation. Termination of vetch by tillage prior to sorghum planting can cause significant loss of surface soil moisture. On the other hand, use of herbicides to terminate the vetch may not allow adequate release of N from vetch in the absence of tillage. This experiment was conducted to evaluate effects of hairy vetch termination method and N rate on grain sorghum N uptake and yield.

Procedures

The experiment site was located on a Smolan silt loam on which a vetch-grain sorghum-winter wheat cropping system had been established initially in the fall of 1994. Wheat grown in 1996 had not been fertilized. In this second cycle, hairy vetch was no-till planted on September 13, 1996, into wheat stubble in which weeds and volunteer plants had been controlled with Roundup. A grain drill with double disk openers on 7 in. spacing was used to seed the vetch at 15 lb/a. In the following spring, vetch forage yield was determined by harvesting 1 sq m areas in 12 representative plots just prior to vetch termination. Vetch was sprayed on May 15 at very early boom stage with Roundup + 2,4-D_{LVE} + Premier 90 nonionic surfactant (0.375 + 0.71 lb ae/a + 0.5%). Tillage plots were disked on May 17. Rains delayed N application and planting. Nitrogen fertilizer treatments were broadcast as ammonium nitrate on July 4. Pioneer 8500 grain sorghum treated with Concep II safener and Gaucho insecticide was planted at approximately 42,000 seeds/a on the same day. Weeds were controlled with preemergence application of Microtech + atrazine (2.0 + 0.25 lb ai/a). Grain sorghum was combine harvested on November 7.

Results

Fall rains promoted vetch emergence and stand establishment. Seasonal precipitation for vetch was near to or slightly above normal. At the time of termination, vetch was 22 to 25 in. tall and had produced an average dry matter yield of about 2 tons/a with an average N content of 3.12% (Table 3). As a result, the potential amount of N to be mineralized for use by the sorghum crop averaged 128 lb/a. Sorghum stands averaged about 36,700 plants/a and were not affected by tillage or vetch treatments. Rainfall during the summer months was above normal. Sorghum reached half bloom 1 day earlier following vetch than after no cover crop. Also, half bloom for no-till sorghum was about 1 day earlier in comparison with sorghum in tilled plots. Vetch significantly increased the N concentration of sorghum flag leaves at the zero N rate but not at 60 lb N/a. In sorghum following vetch, leaf N response to fertilizer was inconsistent at the 30 lb N/a rate, but reached a maximum of 2.77 to 2.85% with 60 lb N/a. Tillage had no effect on leaf N level in sorghum. Grain yields increased by nearly 22 bu/a in unfertilized sorghum after vetch vs no vetch. This positive effect of vetch was equivalent to approximately 58 lb/a of N.

Yield increase correlated with a slight increase in the number of heads per plant. Both vetch and N fertilizer increased sorghum grain test weight slightly.

Table 3. Effects of hairy vetch cover crop, tillage, and nitrogen rate on grain sorghum, Hesston, KS, 1997.

Cover Crop	Tillage System[1]	N Rate	Vetch Yield[2] Forage	Vetch Yield[2] N	Sorghum Stand	Leaf N	Half Bloom	Heads/ Plant	Grain Yield
			ton/a	lb/a	1000's/a	%[3]	days[4]		bu/a[5]
None	NT	0	----	---	37.8	2.26	61	1.03	73.3
		60	----	---	36.7	2.77	59	1.12	101.5
		90	----	---	37.6	2.78	57	1.14	102.9
	Disk	0	----	---	36.3	2.22	62	1.08	72.8
		60	----	---	36.5	2.77	60	1.20	95.0
		90	----	---	36.8	2.72	59	1.23	105.2
Hairy	NT	0	1.71	109	37.3	2.56	58	1.09	94.7
Vetch		30	2.10	129	36.1	2.57	58	1.22	105.1
		60	2.14	134	37.5	2.85	58	1.23	104.2
		90	2.21	137	36.7	2.63	58	1.26	110.0
	Disk								
		0	2.11	132	35.7	2.55	60	1.22	94.8
		30	2.10	131	36.5	2.72	59	1.20	99.2
		60	1.84	115	35.8	2.77	59	1.30	100.5
		90	2.17	135	36.4	2.76	59	1.26	97.6
LSD .05			NS	NS	NS	0.24	1.9	0.11	14.5
Main Effect Means:									
Cover Crop									
None			----	---	36.9	2.59	60	1.13	91.8
Hairy Vetch			2.05	128	36.6	2.69	59	1.23	100.3
LSD .05			----	---	NS	0.10	0.9	0.05	6.5
Tillage System									
No Till			2.04	127	37.3	2.64	59	1.15	97.7
Disk			2.05	128	36.2	2.63	60	1.21	94.3
LSD .05			NS	NS	0.9	NS	0.9	0.05	NS
N Rate									
0			1.91	121	36.8	2.40	60	1.11	83.9
30			2.10	130	----	----	--	----	-----
60			1.99	124	36.6	2.79	59	1.21	100.3
90			2.19	136	36.9	2.73	58	1.22	103.9
LSD .05			NS	NS	NS	0.13	1.1	0.06	8.0

[1] NT plots without vetch were tilled lightly at 10 and 7 weeks before planting.
[2] Oven dry weight and N content determined prior to application of specified N rates.
[3] Flag leaf N content at late boot to early heading.
[4] Days from planting to 50% bloom.
[5] Mean yields from three replications adjusted to standard 12.5% moisture.

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 1997 indicate that ammonium nitrate and AgrotaiN (urea with a urease inhibitor) outperformed urea at three of four corn sites and both grain sorghum sites. The poor performance of urea likely was due to volatilization losses of N following fertilizer application. Time of N application had minimal impact on corn or sorghum yields in 1997.

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 and 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 two grain sorghum sites were established in 1997. Nitrogen rates (varied depending on crop and cropping sequence) and N sources (urea, AgrotaiN, and ammonium nitrate) were evaluated. AgrotaiN is urea with a urease inhibitor and is available commercially. All N was surface broadcast either in early to mid-March (early) or right after planting (planting). All sites were no-till. Corn was planted in mid to late April, and grain sorghum in May.

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. Grain protein data were not available from all sites at time of printing.

Results

Corn results are summarized in Tables 1-4, and grain sorghum results in Tables 5-6.

Corn and grain sorghum yields (both dryland and irrigated) were average to excellent. AgrotaiN and ammonium nitrate produced higher yields and higher grain protein than urea at three of four corn sites and both grain sorghum sites. The urease inhibitor in AgrotaiN 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, and these results indicate N losses from urea this year.

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 AgrotaiN often outperformed urea where N fertilizers were broadcast in high residue, no-till production systems.

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 of continuous no-till corn, North Agronomy Farm, Manhattan, KS, 1997.

N Rate	N Source	6-Leaf N	Tassel N	Grain Yield	Grain Protein
lb/a		- - - - - %	- - - - -	bu/a	%
0	--	2.90	1.41	18	7.8
50	Urea	3.92	1.80	53	6.6
100	Urea	4.13	2.17	53	7.3
150	Urea	3.98	2.19	64	7.9
50	AgrotaiN*	3.94	1.77	56	6.9
100	AgrotaiN	4.00	2.22	64	8.0
150	AgrotaiN	4.04	2.48	77	9.3
50	Am. nit.	3.97	2.21	61	6.8
100	Am. nit.	4.13	2.46	57	9.4
150	Am. nit.	4.20	2.63	72	9.9
	LSD (0.10)	0.19	0.27	9	0.8
Mean Values:					
N	50	3.94	1.93	57	6.8
Rate	100	4.09	2.28	58	8.2
	150	4.07	2.44	71	9.0
	LSD (0.10)	0.10	0.16	5	0.4
N	Urea	4.01	2.05	56	7.3
Source	AgrotaiN	4.00	2.16	66	8.1
	Am. nit.	4.10	2.43	63	8.7
	LSD (0.10)	NS	0.16	5	0.4

* AgrotaiN is urea + NBPT

Table 2. Nitrogen management of no-till corn following corn, Kansas River Valley Experiment Field, Topeka, KS, 1997.

N	N	Time of	6-Leaf	Tassel	Grain	
Rate	Source	Application	N	N	Yield	Protein
lb/a			- - - - - % - - - - -		bu/a	%
0	--	--	4.29	1.82	73	6.7
75	Urea	Early	4.18	2.33	151	6.9
150	Urea	Early	4.35	2.86	183	7.8
75	AgrotaiN	Early	4.35	2.44	148	7.0
150	AgrotaiN	Early	4.18	2.87	194	8.1
75	Am. nit.	Early	4.27	2.47	166	7.0
150	Am. nit.	Early	4.33	2.88	195	8.0
75	Urea	Planting	4.05	2.17	127	6.8
150	Urea	Planting	4.34	2.44	159	7.1
75	AgrotaiN	Planting	4.35	2.42	148	6.9
150	AgrotaiN	Planting	4.31	2.71	183	7.7
75	Am. nit.	Planting	4.37	2.35	155	7.0
150	Am. nit.	Planting	4.31	2.95	177	8.2
	LSD (0.10)		NS	0.19	20	0.3
Mean Values:						
N	75		4.26	2.36	145	6.9
Rate	150		4.30	2.79	182	7.8
	LSD (0.10)		NS	0.08	8	0.1
N	Urea		4.23	2.45	155	7.1
Source	AgrotaiN		4.30	2.60	168	7.4
	Am. nit.		4.32	2.66	173	7.6
	LSD (0.10)		NS	0.10	10	0.2
Time of	Early		4.27	2.64	172	7.5
Application	Planting		4.29	2.51	154	7.3
	LSD (0.10)		NS	NS	8	0.1

Table 3. Nitrogen management of no-till corn following wheat, Sandyland Experiment Field, St. John, KS, 1997.

N	N	Time of	6-Leaf	Tassel	Grain	
Rate	Source	Application	N	N	Yield	Protein
lb/a			- - - - - % - - - - -		bu/a	%
0	--	--	3.17	2.03	181	6.5
75	Urea	Early	3.74	2.41	215	7.3
150	Urea	Early	3.45	2.65	226	7.9
75	AgrotaiN	Early	3.58	2.60	213	7.7
150	AgrotaiN	Early	3.70	2.71	221	8.6
75	Am. nit.	Early	3.66	2.62	217	7.7
150	Am. nit.	Early	3.78	2.68	213	8.1
75	Super urea	Early	3.79	2.62	225	7.7
150	Super urea	Early	3.91	2.70	232	8.4
75	Urea	Planting	3.62	2.38	202	7.4
150	Urea	Planting	3.78	2.58	218	7.9
75	AgrotaiN	Planting	3.64	2.43	215	6.9
150	AgrotaiN	Planting	3.80	2.65	209	7.6
75	Am. nit.	Planting	3.79	2.49	209	7.5
150	Am. nit.	Planting	3.95	2.85	236	8.2
75	Super urea	Planting	3.66	2.41	211	7.1
150	Super urea	Planting	4.06	2.75	226	8.3
	LSD (0.10)		0.26	0.14	18	0.4
Mean Values:						
N	75		3.69	2.49	213	7.4
Rate	150		3.80	2.69	223	8.1
	LSD (0.10)		0.10	0.05	7	0.1
N	Urea		3.65	2.50	215	7.6
Source	AgrotaiN		3.68	2.60	214	7.7
	Am. nit.		3.79	2.66	219	7.9
	Super urea		3.86	2.62	223	7.9
	LSD (0.10)		0.13	0.07	NS	0.2
Time of	Early		3.70	2.62	220	7.9
Application	Planting		3.79	2.57	216	7.6
	LSD (0.10)		NS	NS	NS	0.1

Table 4. Nitrogen management of no-till corn following corn, Cornbelt Experiment Field, Powhattan, KS, 1997.

N Rate	N Source	Time of Application	6-Leaf N	Tassel N	Grain Yield
lb/a			- - - - - %	- - - - -	bu/a
0	--	--	2.96	2.46	56
60	Urea	Early	3.13	2.61	76
120	Urea	Early	3.25	2.75	92
60	AgrotaiN	Early	3.37	2.69	89
120	AgrotaiN	Early	3.39	2.93	100
60	Am. nit.	Early	3.26	2.85	95
120	Am. nit.	Early	3.33	3.05	95
60	Urea	Planting	3.22	2.75	82
120	Urea	Planting	3.63	2.93	100
60	AgrotaiN	Planting	3.31	2.92	85
120	AgrotaiN	Planting	3.57	3.12	103
60	Am. nit.	Planting	3.29	2.90	92
120	Am. nit.	Planting	3.69	3.22	99
	LSD (0.10)		0.30	0.22	9
Mean Values:					
N	60		3.26	2.78	87
Rate	120		3.47	3.00	98
	LSD (0.10)		0.13	0.09	3
N	Urea		3.31	2.76	88
Source	AgrotaiN		3.41	2.91	94
	Am. nit.		3.39	3.01	95
	LSD (0.10)		NS	0.12	4
Time of	Early		3.29	2.81	91
Application	Planting		3.45	2.97	93
	LSD (0.10)		0.13	0.09	NS

Table 5. Nitrogen management of no-till grain sorghum following grain sorghum, North Central Experiment Field, Belleville, KS, 1997.

N Rate	N Source	Time of Application	6-Leaf N	Grain Yield
lb/a			%	bu/a
0	--	--	1.57	59
60	Urea	Early	2.17	108
120	Urea	Early	2.25	125
60	AgrotaiN	Early	2.10	107
120	AgrotaiN	Early	2.37	137
60	Am. nit.	Early	2.15	109
120	Am. nit.	Early	2.25	127
60	Urea	Planting	2.22	101
120	Urea	Planting	2.19	121
60	AgrotaiN	Planting	2.25	110
120	AgrotaiN	Planting	2.37	129
60	Am. nit.	Planting	2.17	115
120	Am. nit.	Planting	2.39	126
	LSD (0.10)		0.12	10
Mean Values:				
N	60		2.18	108
Rate	120		2.30	128
	LSD (0.10)		0.05	4
N	Urea		2.21	114
Source	AgrotaiN		2.27	121
	Am. nit.		2.24	119
	LSD (0.10)		NS	5
Time of	Early		2.22	117
Application	Planting		2.26	119
	LSD (0.10)		NS	NS

Table 6. Nitrogen management of no-till grain sorghum following wheat, Sandyland Experiment Field, St. John, KS, 1997.

N Rate	N Source	Time of Application	Boot N	Grain Yield
lb/a			%	bu/a
0	--	--	1.87	113
75	Urea	Early	2.25	155
150	Urea	Early	2.44	162
75	AgrotaiN	Early	2.25	159
150	AgrotaiN	Early	2.54	175
75	Am. nit.	Early	2.90	166
150	Am. nit.	Early	2.94	184
75	Super urea	Early	2.44	158
150	Super urea	Early	2.73	170
75	Urea	Planting	2.58	158
150	Urea	Planting	2.53	158
75	AgrotaiN	Planting	2.52	165
150	AgrotaiN	Planting	2.72	174
75	Am. nit.	Planting	2.55	165
150	Am. nit.	Planting	2.88	180
75	Super urea	Planting	2.67	169
150	Super urea	Planting	2.99	180
LSD (0.10)			0.25	13
Mean Values:				
N	75		2.49	162
Rate	150		2.72	173
LSD (0.10)			0.08	5
N	Urea		2.45	158
Source	AgrotaiN		2.51	168
	Am. nit.		2.82	174
	Super urea		2.71	169
LSD (0.10)			0.12	7
Time of	Early		2.56	166
Application	Planting		2.67	168
LSD (0.10)			0.08	NS

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 AgrotaiN) were evaluated. All N was surface broadcast. The tillage systems used were no-till or conventional. Results in 1997 indicate that flag leaf N concentrations and grain yields were higher with conventional tillage. The lower yields in no-till were due primarily to the poor performance of urea. Where ammonium nitrate or AgrotaiN was used, no-till yields were similar to those with conventional tillage. Apparently, N efficiency was reduced by volatilization losses from urea under no-till conditions. Yields were good in 1997 and were increased by N application up to 120 lb/a.

Introduction

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

This long-term study was altered slightly in 1995 to evaluate N sources, including ammonium nitrate, urea, and AgrotaiN, which is urea plus a urease inhibitor.

Procedures

Three N sources at three rates each (30, 60, 120 lb N/a) were used. These were ammonium nitrate, urea, and 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 (Pioneer 8505), flag leaf sampling, and harvesting were done on May 19, July 24, and October 1, respectively.

Results

Results are summarized in Table 7. Grain yield, flag leaf N, and grain protein were increased significantly by N application up to 120 lbs. Ammonium nitrate and AgrotaiN produced higher leaf N concentrations and grain yields than urea, particularly in no-till. Apparently, N loss via volatilization was significant from urea. As in years past, flag leaf N concentrations were significantly higher for conventional tillage compared to no-till. In 1997, grain yields with conventional tillage were higher than those with no-till because of the poor performance of urea in no-till. When AgrotaiN or ammonium nitrate was used as a N source in no-till, yields were very similar to those with conventional tillage. Maturity was delayed in no-till plots compared to conventional-tillage in 1997.

Table 7. Nitrogen management and tillage effects on continuous grain sorghum, North Agronomy Farm, Manhattan, KS, 1997.

N Rate	N Source	Tillage	Leaf N	Grain Yield	Grain Protein
lb/a			%	bu/a	%
0	--	No-till	1.27	31	6.1
30	Am. nit.	No-till	1.62	61	5.4
60	Am. nit.	No-till	1.91	74	6.5
120	Am. nit.	No-till	2.49	97	8.3
30	Urea	No-till	1.54	44	6.3
60	Urea	No-till	1.96	63	6.2
120	Urea	No-till	2.20	86	7.6
30	AgrotaiN	No-till	1.85	52	6.4
60	AgrotaiN	No-till	1.87	73	6.4
120	AgrotaiN	No-till	2.46	98	8.1
0	--	Conventional	1.61	35	5.9
30	Am. nit.	Conventional	1.75	59	6.0
60	Am. nit.	Conventional	2.31	88	7.5
120	Am. nit.	Conventional	2.55	94	9.6
30	Urea	Conventional	2.04	67	5.9
60	Urea	Conventional	2.03	85	6.7
120	Urea	Conventional	2.53	91	10.2
30	AgrotaiN	Conventional	1.83	60	6.5
60	AgrotaiN	Conventional	2.18	85	7.2
120	AgrotaiN	Conventional	2.40	91	9.9
LSD (0.10)			0.31	10	0.9
Mean Values:					
N	30		1.77	57	6.1
Rate	60		2.04	78	6.8
	120		2.44	93	9.0
LSD (0.10)			0.13	4	0.4
N	Am. nit.		2.11	78	7.2
Source	Urea		2.05	73	7.1
	AgrotaiN		2.10	77	7.4
LSD (0.10)			NS	4	NS
Tillage	No-till		2.00	72	6.8
	Conventional		2.18	80	7.7
LSD (0.10)			0.11	3	0.3

MANAGEMENT ALTERNATIVES FOR GRAIN SORGHUM PRODUCTION ON ACID SOILS

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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 1997 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 in Sedgwick Co., even though the Bray-1 P soil tests were high. Banded P had no effect on yields at Sandyland, probably because of much lower soil Al levels. Lime significantly increased yields at both sites in 1997. Amisorb had no significant effects on yields or plant nutrient concentrations. Grain sorghum hybrid performance results from Sedgwick Co. in 1997 are not yet available.

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 1997. 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 full recommended rate of lime (10,000 lb ECC/a) was applied on June 12, 1995. This was the third year at this site. Grain sorghum (Pioneer 8505) was planted on May 29. 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, 1996. Sorghum (Pioneer 8505) was planted on June 4, 1997. Rates of lime (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 1997 are summarized in Tables 8 and 9. Lime application significantly increased yields at both sites. Visual growth and yield responses to banded P were dramatic at Sedgwick Co., the site with the highest soil Al level. Banded P with the seed at planting increased grain yield at this site. 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 at Sandyland (Table 9).

Considerable differences have been noted among grain sorghum hybrids grown on the acid, high Al soil in Sedgwick Co. in 1995 and 1996. Results from the 1997 hybrid evaluation are not yet available.

Table 8. Effects of lime and phosphorus on grain sorghum, Sedgwick Co., KS, 1997.

Lime Rate	P_2O_5 Rate	Grain 1995	Grain 1996	Grain 1997	3-Year Avg. Yield
lb ECC/a	lb/a	- - - - -bu/a	- - - - -		bu/a
0	0	71	39	88	56
0	35 Band	106	45	115	89
5000	0	75	52	94	74
5000	35 Band	106	59	115	93
10000	0	85	61	119	88
10000	35 Band	110	61	133	101
LSD (0.05)		14	8	18	--
Mean Values:					
Lime	0	86	42	102	76
Rate	5000	90	55	104	83
	10000	98	61	126	95
LSD (0.05)		10	6	13	--
P_2O_5	0	77	51	100	76
Rate	35 Band	107	55	121	94
LSD (0.05)		8	4	10	--

Table 9. Effects of lime, phosphorus, and Amisorb on grain sorghum, Stafford Co., KS, 1997.

Lime Rate	P_2O_5 Rate	Amisorb Rate	1997 Yield
lb ECC/a	lb/a	qt/a	bu/a
0	0	0	106
0	35	0	111
0	0	2	99
0	35	2	109
1500	0	0	117
1500	35	0	109
1500	0	2	120
1500	35	2	106
3000	0	0	123
3000	35	0	123
3000	0	2	126
3000	35	2	124
LSD (0.10)			12
Mean Values:			
Lime	0		106
Rate	1500		113
	3000		124
LSD (0.10)			6
P_20_5	0		115
lb/a		35 Band	114
LSD (0.10)			NS
Amisorb	0		115
	2		114
LSD (0.10)			NS

CHLORIDE FERTILIZATION ON CORN AND GRAIN SORGHUM

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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 1997 to evaluate Cl fertilization on dryland corn and grain sorghum. Results from 1997 indicate that Cl fertilization often can increase corn and grain sorghum yields and leaf tissue Cl concentrations. Yield responses are most consistent when leaf Cl concentrations of the check treatments are below 0.10 - 0.15% Cl.

Procedures

Chloride rates (0, 20, 40 lb/a) and sources (NaCl and KCl) were evaluated on corn (North Agronomy Farm, Riley Co.) and corn and grain sorghum (Cornbelt Experiment Field, Brown Co.). The NaCl was an experimental slow-release material. In Marion Co., Cl rates of 0, 10,20, 30, and 40 lb/a as KCl were evaluated on grain sorghum at two sites. 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 1997 were average to excellent (Tables 10, 11, 12), and some significant yield increases were noted. Chloride fertilization significantly increased leaf tissue Cl concentrations. The slow-release NaCl often produced higher leaf Cl concentrations than KCl, particularly at the tassel/boot sampling time. With the positive results obtained in 1997, this work will be continued in 1998.

Table 10. Effects of chloride fertilization on corn, Riley and Brown counties, KS, 1997.

		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	--	64	0.30	0.16	188	0.17	0.08
20	NaCl	64	0.89	0.21	185	0.58	0.22
40	NaCl	72	1.29	0.29	185	0.88	0.49
20	KCl	69	1.08	0.22	191	0.65	0.21
40	KCl	70	1.06	0.23	186	0.91	0.35
LSD (0.10)		NS	0.33	0.05	NS	0.16	0.14
Mean Values:							
Cl	20	67	0.99	0.22	188	0.62	0.22
Rate	40	71	1.18	0.26	186	0.90	0.42
LSD (0.10)		NS	0.14	0.02	NS	0.06	0.05
Cl	NaCl	68	1.09	0.25	185	0.73	0.36
Source	KCl	69	1.07	0.23	188	0.78	0.28
LSD (0.10)		NS	NS	0.02	NS	NS	0.05

Table 11. Effects of chloride fertilization on grain sorghum, Cornbelt Experiment Field, Powhattan, KS, 1997.

Cl Rate	Cl Source	Yield	Leaf Cl 6-leaf
lb/a		bu/a	%
0	--	102	0.08
20	NaCl	104	1.21
40	NaCl	109	1.45
20	KCl	108	1.19
40	KCl	111	1.37
LSD (0.10)		6	0.14
Mean Values:			
Cl	20	106	1.20
Rate	40	110	1.41
LSD (0.10)		3	0.05
Cl	NaCl	107	1.33
Source	KCl	110	1.28
LSD (0.10)		NS	0.05

Table 12. Effects of chloride fertilization on grain sorghum, Marion Co., KS, 1997.

Cl Rate*	Site A Yield	Site B Yield
lb/a	bu/a	bu/a
0	60	117
10	70	137
20	70	135
30	71	141
40	73	139
LSD (0.10)	9	11

* Cl applied as KCl, broadcast after planting.

SEED PLACEMENT OF STARTER FERTILIZERS FOR CORN

G.M. Pierzynski, G. Rehm, and M. Ashraf

Summary

Interest has increased in placing starter fertilizers directly with the seed when corn is planted using equipment without starter fertilizer disk 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. Use of the highest rate of 10-34-0 and 7-21-7 significantly reduced plant populations compared to the control for a 7 May 1997 planting when the soil moisture content (0-3 in.) was 17.5%. No such differences were found for a 20 April 1997 planting when the soil moisture content was 22.5%. For the 20 April planting, V6 dry matter yields generally were not influenced by the treatments, whereas for the 7 May planting, yields decreased significantly for each increase in 10-34-0 rate. Grain yields were low compared to those of the previous year because of hot, dry conditions in July. We observed some evidence of yield reductions for the 10-34-0 treatments at both planting dates, although yields generally were not responsive to the treatments.

Introduction

This study is being conducted in cooperation with George Rehm at the University of Minnesota. Farmers in Minnesota often place starter fertilizers with corn seed because of the use of large “fold-up” planters that cannot accommodate starter fertilizer disk openers. Seed placement of fertilizers has potential to 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, whereas 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: 20 April 1997 and 7 May 1997. 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 sources (4-10-10, 7-21-7, or 10-34-0) and rates (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. 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.

Results

Soil moisture contents were 22.5% at 0-3 in. and 23.5% at 3-6 in. on 20 April and 17.5% at 0-3 in. and 23.3% at 3-6 in. on 17 May. The treatments had little influence on emergence for the 20 April planting (Figure 1). This result is similar to that found in 1996; when soil moisture is high at planting, seed-placed starter fertilizer has no effect on emergence. For the 7 May planting, however, emergence of the 7-21-7 and 10-34-0 treatments lagged behind that of the control and the 4-10-10 treatments (Figure 2). Again, this is similar to the 1996 data, where delays in emergence were found when the corn was planted into relatively dry soil. At the final count, both the 7-21-7 and 10-34-0 treatments had significantly lower populations compared to the control. Two distinct plateaus occurred in the data, one centered on and corresponding to May 21 and the second on May 24. These plateaus correlate with cool low temperatures. On May 19, 1.63 inches of precipitation fell followed by a morning low of 37^{o} F, and the low on May 24 was 40^{o} F. It is also interesting that soil moisture content was 17.5% in the top 3 inches at the 7 May planting, and 0.68 inches of precipitation was received on 8 May, suggesting that precipitation within a day of planting into dry soil will not prevent the emergence problems.

Dry matter yields at the V6 stage were generally not responsive to the treatments. The exceptions were 10 gal/a of 10-34-0 for the 20 April planting, which was significantly lower than all other treatments except 10-34-0 at 5 gal/a, and the significant reductions in yield for 10 and 15 gal/a of 10-34-0 compared to all other treatments for the 7 May planting (Table 13). Grain yields were low compared to 1996 levels and this is likely due to hot, dry conditions in July shortly after pollination (Table 13). Precipitation in Manhattan for the first 10 months of the year was also below average. Treatment effects were minimal with some significant reductions for the 10-34-0 treatments, similar to the V6 dry matter yields.

Table 13. V6 dry matter and grain yields for two planting dates, Manhattan, KS, 1997.

Starter Fertilizer Source		V6 Dry Matter		Grain	
	Rate	20 April	7 May	20 April	7 May
	gal/a	---------- lb/a ----------		---------- bu/a ----------	
Control	0	305	487	122	137
4-10-10	5	321	526	127	133
	10	352	578	135	121
	15	322	403	134	123
7-21-7	5	353	547	138	131
	10	304	480	126	132
	15	378	452	138	120
10-34-0	5	247	549	109	113
	10	200	318	92	103
	15	323	247	125	112
	LSD (0.05)	88	128	24	22

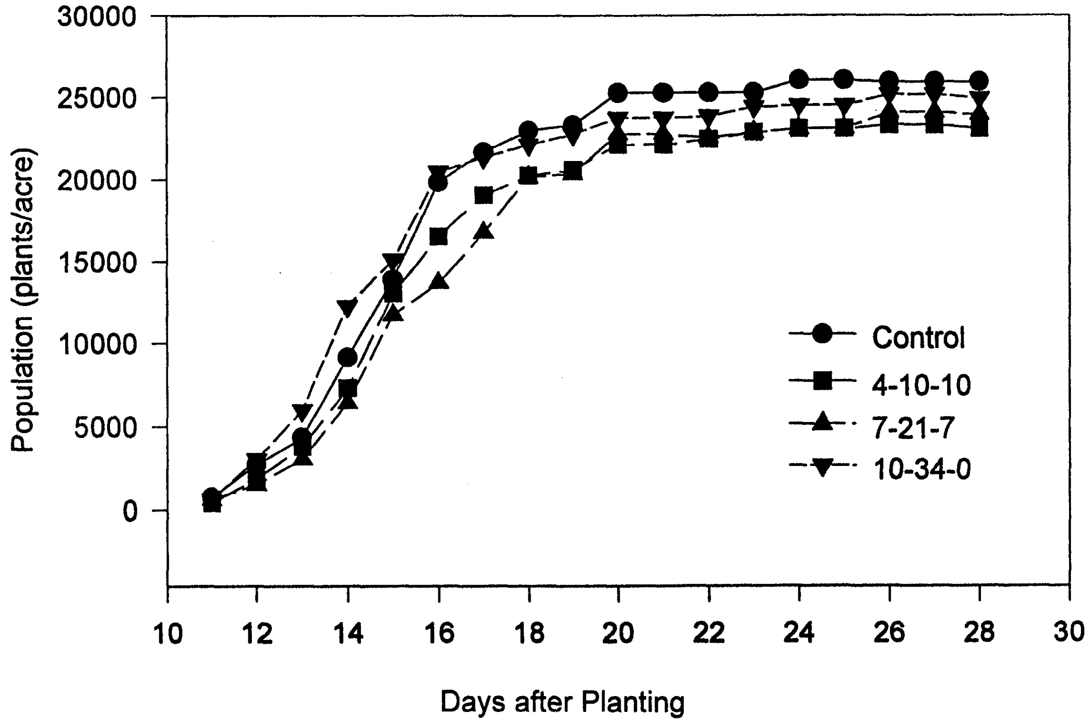


Figure 1. Effects of fertilizer source at 15 gal/a on corn populations, 20 April planting, Manhattan, KS, 1997.

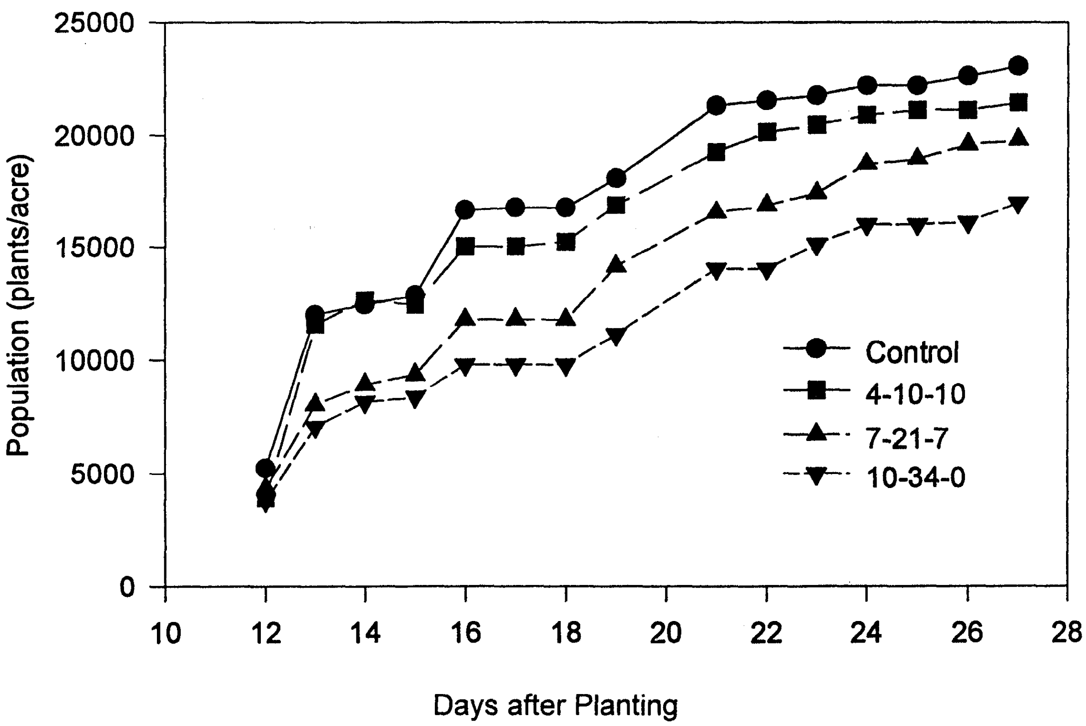


Figure 2. Effects of fertilizer source at 15 gal/a on corn populations, 7 May planting, Manhattan, KS, 1997.

EFFECTS OF NITROGEN SOURCE AND TILLAGE ON SOIL ORGANIC MATTER

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

Summary

This long-term study (7 years) evaluated the effect of 5 years of nitrogen (N) fertilization (cattle manure and ammonium nitrate) and tillage system (no-tillage and conventional tillage) on soil organic matter and mineralization. Soil organic matter was increased significantly by manure. The mineralizable N fraction represented a greater proportion of the total organic N with manure.

Introduction

Crop management strategies such as tillage practices and N sources can modify soil organic matter (SOM) levels. Continuous tillage causes a decline in SOM. Nitrogen fertilization increases crop production and the return of plant residue to the soil. Consequently, greater crop residue augments soil organic N, which can be made available to subsequent crops during mineralization. Soils receiving organic amendments have relatively high N-supplying capacities as compared with those receiving fertilizer or unamended soil.

Procedures

The study was located at the North Agronomy Farm in Manhattan on a Kennebec silt loam. Starting in 1990, two tillage treatments and three sources of N at a rate of 150 lb N/a were applied continuously for 5 years for corn production. In 1995, the original subplots were split in half, and one half did not receive any additional N. The two tillage systems continued as main plots, and residual N sources were added as subplots.

Total C and N was separated into discrete pools of different biological activity using the values of microbial biomass C (MBC) and N (MBN), potentially mineralizable C (C_o) and N (N_o), and total C (TC) and N (TON). The fractions of C_o and N_o excluding MBC and MBN were defined as the nonbiomass active pool.

Results

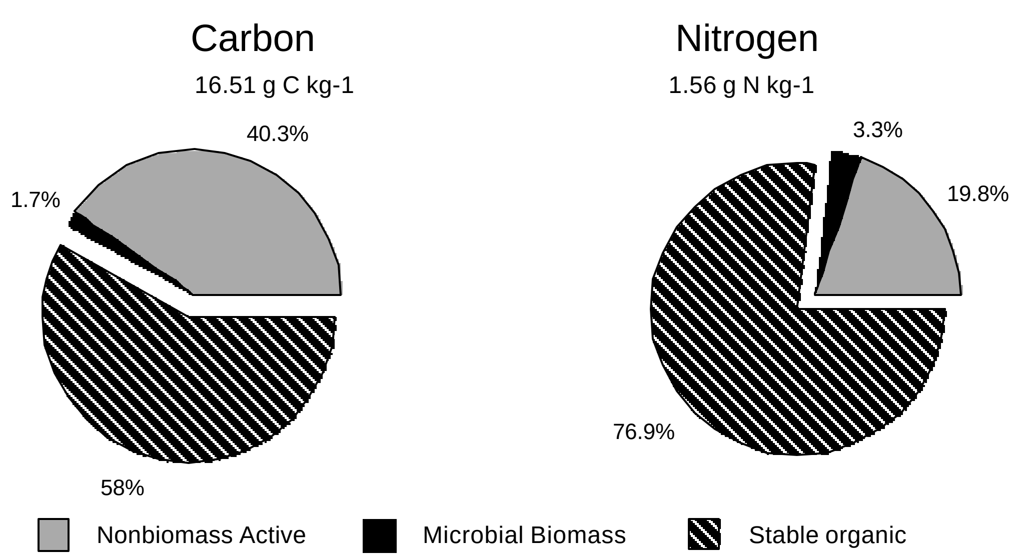
The amounts of organic C and N were not affected significantly by 5 years of continuous tillage (Table 14). No-tillage tended to increase TOC and TON and microbial biomass C and N. Potential mineralizable C (C_o) and N (N_o) were not affected by tillage. Nitrogen fertilization increased significantly the amounts of soil organic C and N. Fertilizer did not increase the N-supplying capacity of the soil. Manure significantly increased SOM and the N mineralization potential of the soil. We have found that 30% of the N mineralization potential is made available to the plant. The proportion of total organic C as microbial biomass C was 1.7%, and total organic N as microbial biomass N was 3.3% (Fig. 3). The nonbiomass active pools represented 40 and 19% of total organic C and N, respectively (Fig. 3). This is the fraction that provides the mineralized N to the plant.

Five years of manure application have enhanced N_o and C_o, which should provide higher levels of TOC and TON in the future because of greater plant yield. Also, because MBN and MBC were not as affected, the C_o and N_o pools are better indicators of trends in SOM. Maintaining the quantity and quality of SOM is important because of its major roles in the physical structure, biological activity, and fertility of the soil.

Table 14 . Levels of N and C in the soil organic matter: total, microbial biomass, and potential mineralizable C and N.

Tillage Treatment	N Source	TON £[1]	TOC £[2]	MBN §[1]	MBC §[2]	N_o ‡[1]	C_o ‡[2]
		----------------	----------------	----g kg^{-1}	----------------	----------------	----------------
No tillage	No nitrogen	1.46	15.56	0.042	0.32	0.28	6.91
	Manure	1.94	20.60	0.093	0.31	0.49	9.19
	Fertilizer	1.53	16.86	0.031	0.27	0.32	6.01
Conventional tillage	No nitrogen	1.31	14.43	0.031	0.24	0.30	5.47
	Manure	1.74	16.81	0.074	0.31	0.43	8.06
	Fertilizer	1.36	14.80	0.032	0.24	0.35	5.91
No-tillage		1.64	17.67	0.008	0.30	0.36	7.37
Conventional tillage		1.47	15.35	0.075	0.26	0.36	6.48
		ns	*	ns	ns	ns	ns
	No nitrogen	1.39	14.99	0.037	0.28	0.29	5.79
	Manure	1.84	18.70	0.084	0.31	0.46	8.33
	Fertilizer	1.45	15.83	0.032	0.26	0.34	5.96
		**	**	**	ns	**	**

*,** significant at 0.1 and 0.05 probability level. ns = no significant
£[1] Total organic C, £[2] Total organic N



§[1] microbial biomass N, §[2] Microbial biomass C
‡[1] Potential mineralizable N, ‡[2] Potential mineralizable C

Figure 3. Distribution of C and N pools in Kennebec silt loam, Manhattan, KS..

PHOSPHORUS MANAGEMENT IN SURFACE SOILS WITH AVAILABLE PHOSPHORUS STRATIFICATION

G.J. Schwab, D.A. Whitney, W.B. Gordon, D.W. Sweeney, G.L. Kilgore, and G.A. Newcomer

Summary

Three field studies were conducted in Bourbon County, Kansas to investigate the effect of phosphorus (P) stratification in surface soil on corn and grain sorghum production. We attempted to determine the effect of physical redistribution of P by using three methods of seed bed preparation - moldboard plowing, conventional tillage, and no-tillage (main plots). Subplots consisting of three P application methods (starter, knifed, and broadcast) and a check were used to determine optimal P placement for stratified profiles. At one corn site, results show that conventional and plowed treatments had higher grain yields than the no-till treatment. At this site, the addition of P, regardless of the placement, also increased grain yield as compared to the no P check. At the other corn site, no significant yield differences were observed for either tillage or P placement. At the grain sorghum site, a significant interaction between tillage and P placement affected grain yield. Phosphorus application as a starter or knifed increased grain yields for the no-till treatments, P application as a 2 x 2 placed starter decreased grain yields (as compared to the check) on conventional tillage, and P application had little effect on the plowed yields. A site in Republic County also was selected to study the effects of P stratification. At this site, P stratification was created using broadcast applications of 100 and 200 lbs P_2O_5/a and light incorporation or no stratification was done (main plots); subplots were the same as at the Bourbon County locations. Results showed that P fertilizer applied to the surface to simulate stratification increased corn yield and earleaf P concentration as compared to the none-stratified check. Phosphorus applied as a starter or knifed also increased grain yields as compared to the check.

Introduction

Conservation-tillage systems do not incorporate broadcast or starter P fertilizer, which leads to high available P levels in the top few inches of soil. Soil samples from Bourbon and Coffey counties have shown as much as 10 to 20 times higher extractable P concentration in the 0-3 in depth than the 3-6 inch depth. It is unclear if the P at the soil surface is as available to the plant as slightly deeper available P, especially during extended periods of dry surface soils. Few studies have been conducted in Kansas to determine optimum P placement in stratified surface layers. This research was initiated to investigate the possibility of physically mixing stratified profiles through tillage to increase P availability and hence plant uptake.

Procedures

Three sites were selected in Bourbon County, Kansas. The Bruner location is classified as a Parsons silt loam, and George and Wilson sites are both Catoosa silt loams. The initial soil test P levels with depths are given in Table 15. To study the effect of redistribution, three main-plot tillage treatments were employed - moldboard plow, conventional tillage (disk and field cultivation), and no-till. On each tillage main plot, four P application methods were imposed consisting of no P, 40 lbs P_2O_5/a starter (2x2), 40 lbs P_2O_5/a deep placed (5 to 6 inches), and 40 lbs P_2O_5/a broadcast. Whole-plant samples were collected at V6 and leaf samples at early tassel (early boot) to determine nutrient content at each stage. Tissue samples were analyzed for N, P, and K concentrations Grain yields were taken at maturity as well as grain moisture content, and test weight, and a grain sample was retained to analyze for N, P, and K concentrations.

An irrigated corn site also was selected in Republic County. This site had a uniformly low available P concentration through the surface profile. At this site, P stratification was created using broadcast applications of 100 and 200 lbs P_2O_5/a and light incorporation or no stratification was done (main plots); subplots were the same as at the Bourbon County locations. With this design, the effects of stratification can be studied without the compounding effect of tillage. Whole plant, tissue, and grain samples were take at the same stages of growth as the Bourbon County sites.

Results

Grain Sorghum

The 1997 growing season in Bourbon County for row crop production was excellent as exhibited by the outstanding yields. No moisture stress period existed during the growing season, which would minimize the response to P placement. Dry matter accumulation at the V6 stage at the Wilson grain sorghum site was significantly higher in the no-till plots as compared to the conventional and plowed plots (Table 16). The treatments receiving 2x2 placed starter had higher V6 dry matter accumulation than the broadcast or the check. Significant differences in tissue N, P, and K concentrations at V6 and early tassel also were observed. A significant tillage by P placement interaction affected the sorghum grain yield. Phosphorus application as a starter or knifed increased grain yields for the no-till treatments, whereas P application decreased grain yields on conventional tillage and had little effect on the plowed yields (Table 16).

Corn Experiment

Corn results are summarized in Tables 17, 18, and 19. A significant P placement by tillage interaction was observed for dry matter at the V6 stage, with the highest accumulation in the plowed plots receiving starter P at the Bruner corn site. The highest tissue P concentration was for no-till plots. Moderate K deficiency also was visually apparent at the V6 stage in the no-till plots. Potassium deficiency was less noticeable in the conventional plots, and no deficiency existed in the plowed plots. At the V6 stage, the plants on the no-till treatments were approximately 6 inches shorter than the plants on the plowed treatments. At early tassel, no signs of K deficiency were observed on any treatment. No significant difference in yields was caused by either tillage or treatment. This lack of difference indicates that, although the no-till treatments were stressed early in the growing season, conditions later in the season favored optimum plant growth.

At the George corn site, a significant tillage by placement interaction affected V6 dry matter accumulation. The plowed check plot produced the most dry matter (Table 18). By the end of the growing season, no significant interactions existed. The highest grain yields were obtained for conventional and plowed plots.

At the Larson site in Republic County (Table 19), dry matter accumulation at V6 stage was higher for the 100 and 200 lbs P_2O_5/a stratified profiles as compared to the none-stratified check. At the early tassel stage, a significant stratification by placement interaction affected earleaf P concentration. Grain yields were significantly increased with the addition of 100 and 200 lbs P_2O_5/a applied to the surface as compared to the check. Knife and starter treatments also increased grain yield over the check. These studies will be continued in 1998 to evaluate second-year effects.

Acknowledgments

Appreciation is expressed to the cooperators, Gale George, Mike Wilson, Charles Bruner, Bob Martin, and Mike Larson, for allowing the research to be conducted on their land and for seedbed preparation and plowing of the strips for the incorporation comparison. Funding support from the Fertilizer Research Fund is greatly appreciated.

Table 15. Initial Bray1-P soil test results with depth, Bourbon and Republic counties, KS, 1997.

Depth	Wilson Site	Bruner Site	George Site	Larson Site
Inches	---------------------------- Bray1-P ppm ----------------------------			
0-2	17	16	27	7
2-4	12	11	16	6
4-6	7	6	5	6
6-9	5	4	4	5
9-12	4	4	4	5

Table 16. Effects of tillage and P placement (40 lbs P_2O_5/a) on grain sorghum V6 dry matter accumulation, tissue nutrient concentrations at the V6 and boot stages, and grain yield, Bourbon County, KS, Wilson site.

Tillage		V6				Flag Leaf			Grain
	Placement	DM	N	P	K	N	P	K	Yield
		lbs/a	%	%	%	%	%	%	bu/a
No-till									
	Check	370	3.7	0.38	2.9	2.1	0.35	1.6	107
	Broadcast	329	3.7	0.37	2.8	2.2	0.32	1.5	112
	Starter	371	3.8	0.41	2.7	2.3	0.36	1.6	123
	Knife	366	3.8	0.40	2.7	2.3	0.35	1.6	126
Conventional									
	Check	256	3.9	0.36	3.4	2.5	0.38	1.7	123
	Broadcast	296	3.9	0.38	3.0	2.5	0.38	1.6	121
	Starter	322	4.0	0.39	3.3	2.5	0.38	1.7	105
	Knife	329	3.9	0.37	3.3	2.3	0.36	1.6	111
Plow									
	Check	252	3.8	0.32	2.9	2.6	0.40	1.6	119
	Broadcast	339	3.9	0.37	3.0	2.5	0.40	1.7	124
	Starter	402	3.9	0.38	3.1	2.4	0.39	1.7	123
	Knife	291	4.0	0.37	2.9	2.7	0.39	1.6	132
Tillage x Placement LSD (0.1)		NS	NS	NS	NS	0.3	NS	NS	16
TILLAGE MEANS:									
	No-till	359	3.7	0.39	2.8	2.2	0.34	1.6	117
	Conv.	301	3.9	0.37	3.2	2.5	0.38	1.7	114
	Plow	321	3.9	0.36	3.0	2.6	0.40	1.7	125
	LSD (0.1)	42	0.1	0.02	0.3	0.2	0.03	0.1	NS
PLACEMENT MEANS:									
	Check	293	3.8	0.35	3.1	2.4	0.37	1.7	116
	Broadcast	322	3.8	0.37	3.0	2.4	0.37	1.6	119
	Starter	365	3.9	0.40	3.0	2.4	0.38	1.7	117
	Knife	329	3.9	0.38	3.0	2.4	0.37	1.6	123
	LSD (0.1)	43	0.1	0.02	NS	NS	NS	0.1	6

Table 17. Effects of tillage and P placement (40 lbs P_2O_5/a) on grain corn V6 dry matter accumulation, tissue nutrient concentrations at the V6 and tassel stages, and grain yield, Bourbon County, KS, Bruner site.

Tillage		V6				Ear Leaf			Grain
	Placement	DM	N	P	K	N	P	K	Yield
		lbs/a	%	%	%	%	%	%	bu/a
No-till									
	Check	85	3.9	0.47	0.97	3.4	0.39	0.79	141
	Broadcast	69	3.9	0.44	0.88	3.3	0.36	0.81	148
	Starter	63	4.0	0.51	0.79	3.2	0.39	0.64	136
	Knife	69	4.0	0.44	1.01	3.3	0.36	0.77	156
Conventional									
	Check	82	3.8	0.38	0.96	3.3	0.37	0.72	165
	Broadcast	99	3.7	0.38	0.93	3.2	0.38	0.75	146
	Starter	109	4.0	0.47	0.94	3.3	0.40	0.74	147
	Knife	85	3.9	0.36	0.92	3.3	0.38	0.71	149
Plow									
	Check	110	3.7	0.35	1.38	3.1	0.33	0.73	144
	Broadcast	111	3.8	0.37	1.30	3.3	0.36	0.81	170
	Starter	173	3.9	0.43	1.27	3.2	0.37	0.74	129
	Knife	104	3.7	0.36	1.26	3.2	0.36	0.78	156
Tillage x Placement	LSD (0.1)	32	NS	NS	NS	NS	NS	NS	NS
TILLAGE MEANS:									
	No-till	72	4.0	0.46	0.91	3.3	0.38	0.76	145
	Conv.	94	3.8	0.40	0.94	3.3	0.38	0.73	152
	Plow	125	3.8	0.38	1.30	3.2	0.36	0.76	150
	LSD (0.1)	22	0.1	.04	0.15	0.1	0.02	NS	NS
PLACEMENT MEANS:									
	Check	93	3.8	0.40	1.10	3.3	0.36	0.75	150
	Broadcast	94	3.8	0.39	1.03	3.3	0.37	0.79	155
	Starter	115	4.0	0.47	1.00	3.2	0.39	0.71	137
	Knife	87	3.8	0.39	1.06	3.2	0.37	0.75	154
	LSD (0.1)	16	0.1	0.02	NS	NS	0.02	0.8	NS

Table 18. Effects of tillage and P placement (40 lbs P_2O_5/a) on grain corn V6 dry matter accumulation, tissue nutrient concentrations at the V6 and tassel stages, and grain yield, Bourbon County, KS, George site.

Tillage		V6				Ear Leaf			Grain
	Placement	DM	N	P	K	N	P	K	Yield
		lbs/a	%	%	%	%	%	%	bu/a
No-till									
	Check	488	4.0	0.47	1.4	3.0	0.34	1.3	111
	Broadcast	649	4.0	0.48	1.4	3.0	0.32	1.2	126
	Starter	715	3.9	0.48	1.5	2.9	0.31	1.3	124
	Knife	552	4.0	0.45	1.8	2.9	0.30	1.4	118
Conventional									
	Check	570	4.0	0.43	1.5	3.0	0.32	1.3	126
	Broadcast	684	3.9	0.42	2.0	3.0	0.33	1.4	132
	Starter	612	3.9	0.42	1.8	2.9	0.32	1.3	142
	Knife	670	4.0	0.42	1.8	3.0	0.31	1.3	144
Plow									
	Check	727	4.0	0.43	2.9	3.0	0.32	1.5	139
	Broadcast	630	4.0	0.45	3.0	3.1	0.34	1.5	132
	Starter	583	4.1	0.46	2.7	3.2	0.35	1.4	130
	Knife	654	4.1	0.45	2.6	3.0	0.33	1.5	141
Tillage x Placement	LSD (0.1)	141	NS	NS	NS	NS	NS	NS	NS
TILLAGE MEANS:									
	No-till	601	4.0	0.47	1.5	2.9	0.32	1.3	120
	Conv.	609	3.9	0.42	1.8	3.0	0.32	1.3	136
	Plow	648	4.0	0.45	2.8	3.1	0.34	1.5	136
	LSD (0.1)	NS	0.1	0.02	0.4	NS	0.02	NS	7
PLACEMENT MEANS:									
	Check	595	4.0	0.44	1.9	3.0	0.33	1.4	125
	Broadcast	654	4.0	0.45	2.1	3.0	0.33	1.4	130
	Starter	637	4.0	0.45	2.0	3.0	0.32	1.3	132
	Knife	592	4.0	0.44	2.1	3.0	0.31	1.4	135
	LSD (0.1)	NS	NS	NS	NS	NS	.02	NS	8

Table 19. Effects of tillage and P placement (40 lbs P_2O_5/a) on grain corn V6 dry matter accumulation, tissue nutrient concentrations at the V6 and tassel stages, and grain yield, Republic County, KS, Larson site.

Stratification		V6				Ear Leaf			Grain
	Placement	DM	N	P	K	N	P	K	Yield
		lbs/a	%	%	%	%	%	%	bu/a
No Stratification									
	Check	657	2.8	0.24	5.0	2.7	0.22	2.0	157
	Broadcast	509	3.0	0.30	5.1	2.8	0.23	2.1	175
	Starter	844	2.8	0.29	4.9	2.5	0.24	2.1	191
	Knife	413	3.1	0.27	5.2	2.8	0.23	2.2	178
100 lbs P_2O_5/a Stratified									
	Check	897	2.9	0.33	4.7	2.5	0.26	2.2	184
	Broadcast	512	2.9	0.38	5.2	2.7	0.26	2.2	183
	Starter	843	2.7	0.35	5.0	2.6	0.26	2.2	201
	Knife	577	3.0	0.36	5.3	2.8	0.28	2.2	194
200 lbs P_2O_5/a Stratified									
	Check	866	2.8	0.36	5.1	2.5	0.26	2.2	188
	Broadcast	620	2.9	0.39	5.2	2.8	0.30	2.2	201
	Starter	843	2.7	0.39	5.0	2.5	0.27	2.1	194
	Knife	537	3.0	0.41	5.1	2.8	0.29	2.2	199
Stratification x Placement LSD (0.1)		NS	NS	NS	NS	NS	.02	NS	NS
STRATIFICATION MEANS:									
	No Strat	606	2.9	0.28	5.0	2.7	0.23	2.1	176
	100 lbs Strat	707	2.9	0.35	5.0	2.7	0.26	2.2	191
	200 lbs Strat	717	2.9	0.39	5.1	2.6	0.28	2.2	196
	LSD (0.1)	84	NS	.02	NS	NS	0.02	0.1	8
PLACEMENT MEANS:									
	Check	807	2.8	0.31	4.9	2.6	0.25	2.2	176
	Broadcast	547	2.9	0.35	5.2	2.7	0.27	2.2	186
	Starter	844	2.7	0.34	5.0	2.6	0.26	2.1	196
	Knife	509	3.1	0.35	5.2	2.8	0.26	2.2	191
	LSD (0.1)	90	0.1	0.02	0.2	0.1	0.01	0.1	9

SOIL TEST RECOMMENDATION STUDY

G.L. Kilgore, G.A. Newcomer, and D.A. Whitney

Summary

Fertilizer recommendations from different laboratories varied considerably. The actual soil test values were not very different. Lime recommendations were very different, too. Most laboratories recommended about 55-60% of KSU recommendations. Some laboratories recommended 2.5-3 times more phosphorus (P) and two times more potassium (K) than KSU. Nitrogen (N) rates for grain sorghum were similar among laboratories. One laboratory, Midwest, also recommended sulfur, zinc, and boron.

After 4 years, the study shows that the Servi-Tech recommendation produced the highest income over fertilizer cost of $726.00/a. The return from the KSU recommendation was $672.54/a. The lowest return was from the KSU recommendation without lime, which should be expected when pH was 5.8. These data show that some laboratories recommend more fertilizer than is needed. That reduces profits and increases nutrients in the top 3 inches of soil, which will result in increased nutrient load in runoff water. Recommendations from KSU, Servi-Tech and University of Missouri-Columbia did not differ much in final yield, but the Servi-Tech and UMC recommendations resulted in increased P accumulation

Introduction

This study was started in the early spring of 1994 to determine the effect of soil test recommendations from several sources on the yield of crops and soil nutrient content over several years. Not all fertilizer dealers or producers use KSU recommendations. We know that the actual fertilizer recommended varies greatly from lab to lab. Our goal was to determine how those different recommendations affected yield, economic results, and soil nutrient levels. This study is on-going, but results summarized here are for 4 years.

Procedures

One large, composite, soil sample 0-6 inches deep was collected from the research area. It was dried, ground, divided, and sent to two university and two commercial soil testing laboratories. The university labs were Kansas State University and the University of Missouri-Columbia. The two commercial labs were Midwest and Servi-Tech. We requested soil tests and recommendations for wheat, grain sorghum, and soybeans. A yield goal for each crop was stated. The original soil test from the KSU lab was: pH 5.8, lime requirement 6,000 lbs. ECC, available P 11 ppm, exchangeable K 75 ppm, Zn 1.4 ppm. Laboratories really didn't vary much in their actual analysis, but recommendations were different. The study consists of three replications, and each year the recommended fertilizers for the intended crop are broadcast and incorporated by the farmer as he normally prepares the seedbed. All tillage, planting, and weed control are done by the cooperating farmer. Mature plants are hand harvested and threshed in a bundle plot thresher. Soil samples are taken after 2 years of fertilizer application. Plots are sampled at 0-3 and 3-6 inch increments. The fertilizer recommendations for soybean and grain sorghum are shown in Tables 20 and 21, respectively. Wheat has not been planted on the site to date. Because lime was required, a KSU recommendation without lime was added to the study.

Results

This has been a very interesting study. The yields for 1997 grain sorghum are presented in Table 22. Remember that the check plot has not had any fertilizer for 4 years. The highest and lowest yields from laboratory recommendations differed by about 11 bu in 1997. However, when the KSU without lime is removed, the spread is 5.8 bu and that is not a significant difference at the

95% level of confidence. Table 22 also gives the costs for 1997 production. KSU laboratory had the lowest fertilizer cost and the lowest fertilizer cost/bu produced at $0.46. Servi-Tech was close with $0.49/bu, and costs for Missouri and Midwest were higher. Table 23 summarizes the production fertilizer costs and returns above fertilizer costs for 4 years (1994-1997). Crop prices and fertilizer costs were calculated using prices for each individual year. Income/a over fertilizer cost for the 4 years was highest on the Servi-Tech fertilizer treatments at $726.00/a. The lowest among labs was for the KSU recommendation without lime, $653.25/a. The KSU recommendation and the Midwest lab treatment were intermediate. The check plot had the lowest overall returns.

Table 24 shows the result of soil tests after 2 years of fertilization. Lime improved pH in the top 3 inches. KSU recommended almost twice as much as other labs. That resulted in a higher pH but also increased cost and lowered the return per acre. After just 2 years, P soil test values increased considerably in the top 3 inches, especially where the labs recommended more than KSU, usually 5-9 ppm higher. However, we must ask if we can afford to raise P values when they are already 27 ppm in the top 3 inches.

Table 20. Soil test recommendations for soybeans, Bourbon Co., KS.

Laboratory	Lime[1] lbs. ECC	N	P_2O_5	K_2O	S	Zn	B
KSU	6,000	0	20	40	-	-	-
KSU w/o Lime	0	0	20	40	-	-	-
Servi-Tech	4,200	0	35	55	-	-	-
Midwest	3,600	10	70	85	6	2	0.5
UMC	3,700	0	55	85	-	-	-

[1]Lime applied in spring 1994 only.

Table 21. Soil test recommendations for grain sorghum, Bourbon Co., KS.

Laboratory	Lime[1] lbs. ECC	N	P_2O_5	K_2O	S	Zn	B
		------------------------- lbs/A					----------------------
KSU	6,000	110	25	40	-	-	-
KSU w/o Lime	0	110	25	40	-	-	-
Servi-Tech	4,200	115	55	50	-	-	-
Midwest	3,600	110	70	90	5	1.5	0.6
UMC	3,700	100	80	65	-	-	-

[1]Lime applied before soybeans in 1994.

Table 22. Grain sorghum yields and costs of soil test recommendations, Bourbon Co., KS, 1997.

Entry	No Treatment	KSU w/o Lime	KSU	Servi-Tech	Midwest	UMC
Yield, bu/a[1]	53.2	84.9	89.8	95.6	94.7	93.0
Response to fertilizer, bu/a	0	31.7	36.6	42.4	41.5	39.8
Fertilizer cost[2] per acre, $	0	32.65	41.22	46.60	54.18	49.29
Cost/bu response, $	0	1.02	1.13	1.10	1.31	1.24
Fertilizer cost per bu. produced, $	0	0.38	0.46	0.49	0.57	0.53

[1] LSD .05 = 6.0 Corrected to 14% moisture

[2] Fertilizer cost: Lime $20.00/ton ECC, life 7 yrs. N = $0.21/lb., P_2O_5 $0.19/lb., K_2O = $0.12/lb., S = $0.20/lb., B = $0.40 lb., Zn = $0.40/lb.

Table 23. Economic returns ($) from soil test recommendations, Bourbon Co., KS, 1994-97.

Crop	Year	No Treatment	KSU w/o Lime	KSU	Servi-Tech	Midwest	UMC
Soybeans	1994	197.01	197.01	224.73	230.67	201.96	230.67
Grain Sorghum	1995	121.13	190.34	178.81	207.65	204.76	196.11
Soybeans	1996	150.08	204.35	214.40	220.43	236.51	219.09
Grain Sorghum	1997	115.98	185.08	195.76	208.41	206.45	202.74
4 yr. Crop value/a		584.20	776.78	813.70	867.16	849.68	848.61
Income/a above fertilizer cost 4 yrs.		486.30	653.25	672.54	726.00	659.39	683.49

Table 24. Soil test results before 1996 fertilizer applications were made, Bourbon, Co., KS.

Treatment	Sample Depth In.	pH	Lime lbs. ECC	Available P	Exchangeable K
				- - - - ppm - - - - -	
None	0-3	5.4	2,000	21	100
	3-6	5.4	3,000	10	70
KSU w/o Lime	0-3	5.3	2,000	27	110
	3-6	5.4	2,000	12	60
KSU	0-3	6.8	-	32	100
	3-6	5.8	2,000	12	40
Servi-Tech	0-3	6.6	-	32	100
	3-6	5.6	2,000	12	60
Midwest	0-3	6.4	1,000	35	110
	3-6	5.6	2,000	12	60
UMC	0-3	6.5	-	36	110
	3-6	5-6	2,000	11	40

CROP

Corn

Forage Grasses, Alfalfa

Grain Sorghum

Soybeans

Wheat

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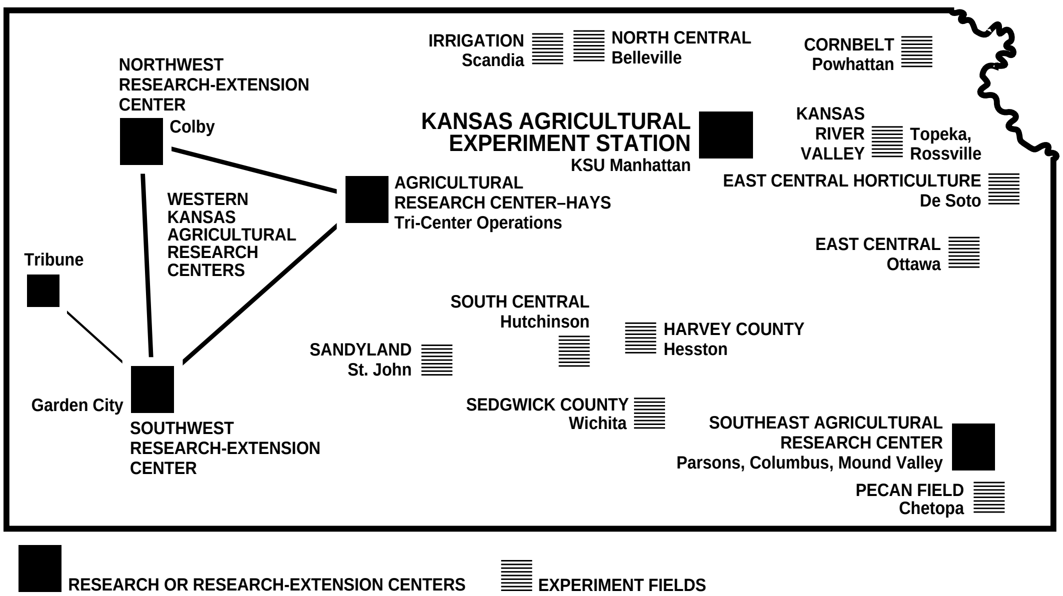

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