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KANSAS FERTILIZER RESEARCH

1998

REPORT OF PROGRESS 829

Kansas State University
Agricultural Experiment Station
and Cooperative Extension Service

INTRODUCTION

The 1998 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.

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

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

Special recognition and thanks are extended to Greg Schwab, Gary Griffith, Kathy Lowe, Ivelisse Albarracin, and the students of the Soil Testing Lab for their help in soil and plant analysis; and the Kansas Agricultural Experiment Station for the support and financial assistance in publishing this progress report. Special note is also taken of the assistance and cooperation of Troy Lynn Eckart of the Extension Agronomy secretarial staff for help in preparation of the manuscript, Mary Knapp of the Weather Data Library for her preparation of the Precipitation Data, Eileen Schofield of the Agricultural Experiment Station for editing the report, and the KSU Printing Services for their efforts in publishing this report.

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

Contribution No. 99-245-S from the Kansas Agricultural Experiment Station.

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Precipitation Data (Inches)

1997	Manhattan	S.W.KS RES-EXT. CTR. Tribune	S.E.KS AG.RES.CTR. Parsons	E.CEN EXP.FLD. Ottawa
August	1.50	4.41	4.39	5.58
September	1.85	1.84	5.49	3.90
October	4.90	4.00	3.17	3.23
November	0.00	0.06	1.94	3.26
December	1.55	1.66	3.93	2.70
Total 1997	26.25	24.72	46.51	45.20
Dept. Normal	-6.63	9.06	8.00	6.93
1998				
January	0.55	0.04	2.52	0.49
February	1.46	0.47	0.00	0.62
March	3.41	1.55	5.19	4.07
April	1.93	0.91	3.43	3.01
May	1.60	2.53	1.96	1.95
June	7.70	0.85	5.41	4.63
July	6.41	6.53	5.09	4.48
August	1.46	1.12	3.42	5.08
September	5.29	0.59	9.02	8.93

1997	N.CEN EXP.FLD. Belleville	KANSAS RV. VALLEY EXP.FLD.	S.CEN. EXP.FLD. Hutchinson	AG.RES. CTR. Hays
August	2.07	4.60	4.09	6.32
September	4.57	1.83	5.74	2.03
October	2.51	2.22	1.43	2.53
November	0.85	0.80	0.29	0.16
December	1.64	3.06	2.46	1.63
Total 1997	23.00	23.63	31.23	25.33
Dept. Normal	-14.56	-11.01	3.92	3.50
1998				
January	0.36	0.87	0.41	0.12
February	2.08	0.75	0.00	1.79
March	2.90	1.34	3.79	1.89
April	4.04	1.08	1.90	3.50
May	0.78	2.60	1.18	2.08
June	2.85	5.01	3.59	1.10
July	4.66	5.10	4.67	6.86
August	1.54	1.21	0.31	2.42
September	3.12	3.73	3.68	1.17

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, C.J. Olsen, and S.R. Duncan

Summary

Research to date on chloride (Cl) shows consistent yield response in Kansas whenever soil Cl are low. 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 1998 in Marion County (three sites).

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. Digestibility (IVDMD) results are not reported, because analyses are not complete.

Results

Grain yields in 1998 ranged from average (Site A) to excellent (Sites B and C). Chloride fertilization tended to increase yields at all sites, although significant yield increases were noted only at Sites A and C (Table 1). The application of 10 lb Cl/a was sufficient and 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, Marion Co., KS, 1998.

		Marion Co. 'A'			Marion Co. 'B'			Marion Co. 'C'		
Cl Rate	Cl Source	Yield	Joint Leaf Cl	Boot Leaf Cl	Yield	Joint Leaf Cl	Boot Leaf Cl	Yield	Joint Leaf Cl	Boot Leaf Cl
lb/a		bu/a	- - - % - - -		bu/a	- - - % - - -		bu/a	- - - % - - -	
0	--	21	.30	.15	53	.12	.10	49	.35	.20
10	KCl	26	.47	.26	58	.23	.26	52	.45	.27
20	KCl	31	.50	.29	56	.35	.30	57	.52	.29
10	$MgCl_2$	30	.42	.22	61	.25	.19	53	.45	.27
20	$MgCl_2$	28	.56	.27	57	.37	.31	51	.50	.29
10	NaCl	30	.40	.24	60	.22	.27	52	.51	.28
20	NaCl	33	.52	.30	61	.32	.40	53	.53	.31
10	SR NaCl	28	.39	.25	62	.23	.25	52	.50	.27
20	SR NaCl	29	.58	.30	62	.39	.36	56	.53	.30
LSD (0.10)		4	.06	.04	NS	.08	.05	5	.07	.03
Mean Values:										
Cl	10	29	.42	.24	60	.23	.24	52	.48	.27
Rate	20	30	.54	.29	59	.36	.35	54	.52	.30
LSD (0.10)		NS	.03	.02	NS	.05	.03	NS	.03	.01
Cl	KCl	28	.48	.27	57	.29	.28	55	.48	.28
Source	$MgCl_2$	29	.49	.25	59	.31	.25	52	.47	.28
	NaCl	32	.46	.27	60	.27	.33	53	.52	.29
	SR NaCl	28	.48	.27	62	.31	.31	54	.51	.29
LSD (0.10)		3	NS	NS	NS	NS	.04	NS	NS	NS
Soil Test Cl 0-24", lb/a		14			31			16		

EVALUATION OF CHLORIDE FERTILIZATION/WHEAT CULTIVAR INTERACTIONS

R.E. Lamond, V.L. Martin, D.D. Roberson, C.J. Olsen, T.M. Maxwell, 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 conducted since 1996 indicates that some wheat cultivars seem to respond consistently to Cl fertilization, whereas others do not, even when soil test Cl levels are low. Yield increases are most consistent when soil Cl levels are <20 lb/a (0-24 in.) and when plant Cl concentrations are <0.10%. Over the past three years, chloride fertilization significantly increased (P<0.10) wheat yields of one or more cultivars at five of six sites. In 1998, 13 of 16 cultivars responded to Cl fertilization at both sites. Ogallala is a consistent nonresponder.

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 Stafford counties in 1998 to evaluate Cl fertilization/wheat cultivar interactions. Sixteen commonly grown winter wheat cultivars were seeded in early October. Chloride as KCl 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 and thousand kernel weights (TKW) were determined. Grain yields were corrected to 13% moisture.

Results

Effects of Cl fertilization and cultivar on wheat grain yield, test weight, TKW, and leaf Cl concentrations are summarized in Tables 2 and 3. Chloride fertilization significantly increased plant Cl concentrations at both sites for all 16 cultivars. Significant differences in plant Cl concentrations were noted between cultivars both in the absence or presence of Cl fertilization, suggesting that cultivars take up Cl differently.

Chloride fertilization significantly increased yields of 13 of 16 cultivars in Stafford Co. (Table 2). This site had low soil test Cl (<10 lb/a) and plant Cl concentrations (<0.10%). The addition of Cl at this site also increased grain test weights and TKW's of most cultivars. Chloride fertilization significantly increased yields of 13 of 16 wheat cultivars in Saline Co. (Table 3). This site also had low soil test Cl (<10 lb/a). The cultivars 'Ogallala' and 'Custer' did not respond to Cl at either site. These cultivars have been consistent nonresponders. 'Cimarron' continued to be very responsive to Cl; the application of Cl increased yields of this cultivar by 13 bu/a in Stafford Co. and 17 bu/a in Saline Co. Averaged over all cultivars, Cl increased wheat yields by 7 bu/a at both sites in 1998.

The cultivars 'Cimarron', 'Windstar', and 'Triumph 64' all showed classic leaf spotting without Cl. When Cl was applied, the leaf spotting was not apparent.

Results to date suggest that when Cl soil test levels are low (<20 lb/a, 0-24 in.), most wheat cultivars are likely to respond to Cl fertilization. This work will be continued in 1999, with several new cultivars to be evaluated.

Table 2. Effects of chloride fertilization/wheat cultivars, Sandyland Experiment Field, St. John, KS, 1998.

Cultivar		Grain Yield			Test Wt			TKW			Leaf Cl		
		+Cl	-Cl	Mean	+Cl	-Cl	Mean	+Cl	-Cl	Mean	+Cl	-Cl	Mean
			bu/a			lb/bu			g.			%	
Windstar		70	63	67	57	54	56	28	24	26	.27	.06	.17
Coronado		91	79	85	60	58	59	32	29	31	.30	.06	.18
Custer		78	78	78	60	59	60	32	31	32	.35	.07	.21
Cimarron		84	71	78	61	58	60	30	26	28	.37	.05	.21
2163		77	71	74	55	55	55	25	24	25	.38	.06	.22
2180		89	78	84	58	54	56	27	25	26	.32	.06	.19
Ogallala		70	72	71	61	58	60	24	21	23	.31	.06	.19
Triumph 64		75	63	69	62	61	62	34	29	32	.35	.06	.21
Tam 107		83	69	76	56	56	56	32	26	29	.32	.05	.19
Tam 200		77	64	71	61	57	59	23	19	21	.36	.05	.20
2137		80	73	77	57	57	57	31	29	30	.35	.06	.20
7853		81	77	79	61	59	60	34	32	33	.29	.05	.17
Champ		76	76	76	59	60	60	30	27	29	.31	.05	.18
Mankato		82	78	80	61	56	59	32	28	30	.33	.06	.20
Jagger		89	81	85	59	58	59	29	26	28	.40	.06	.23
Karl 92		83	78	81	60	58	59	30	29	30	.35	.06	.20
Mean		80	73		59	57		30	26		.33	.06	
LSD (0.10)	Between Columns	3			1			1			.02		
	Between Rows			7			2			2			NS
Cultivar x Cl			NS			NS			NS				

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

Table 3. Effects of chloride fertilization/wheat cultivars, Saline Co., KS, 1998.

		Grain Yield			Test Wt			TKW			Leaf Cl		
Cultivar		+Cl	-Cl	Mean	+Cl	-Cl	Mean	+Cl	-Cl	Mean	+Cl	-Cl	Mean
			bu/a			lb/bu			g.			%	
Windstar		88	83	86	51	51	51	30	28	29	.40	.11	.25
Coronado		90	85	88	60	60	60	29	31	30	.38	.12	.25
Custer		100	103	102	62	61	62	31	31	31	.43	.14	.29
Cimarron		80	63	71	61	59	60	29	29	29	.46	.15	.30
2163		98	95	97	58	57	58	26	25	26	.48	.12	.30
2180		88	82	85	62	60	61	29	29	29	.51	.13	.32
Ogallala		76	75	75	60	60	60	22	22	22	.34	.12	.23
Triumph 64		68	61	65	65	62	63	33	30	32	.48	.17	.33
Tam 107		98	94	96	58	55	57	30	28	29	.43	.17	.30
Tam 200		69	61	65	61	61	61	21	22	22	.43	.13	.28
2137		113	106	110	61	60	61	31	31	31	.43	.15	.29
7853		96	88	92	64	63	64	34	34	34	.42	.15	.29
Champ		88	86	87	60	60	60	28	27	28	.47	.12	.30
Mankato		75	63	69	60	60	60	28	27	28	.50	.14	.32
Jagger		105	87	96	60	58	59	27	26	27	.44	.14	.29
Karl 92		114	95	104	63	62	63	31	30	31	.40	.14	.27
Mean		90	83		61	59		29	28		.44	.14	
LSD (0.10)	Between Columns	3			1			NS			.01		
	Between Rows			8			2			1			.04
Cultivar x Cl			NS			NS			NS			NS	

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

EFFECTS OF NITROGEN RATES AND SOURCES ON WHEAT

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

Summary

Concerns exist about the efficiency of urea-containing N fertilizers when surface broadcast. Previous work in Kansas has shown that N sources perform similarly when topdressed on wheat from November through early March. This research was initiated in 1998 to evaluate an experimental N fertilizer (UCAN-21) as a topdress material on wheat. Results indicate that UCAN-21 produced significantly higher wheat yields than urea-ammonium nitrate solution (UAN) at one of three sites. Wheat yields were significantly increased by N fertilization up to 90 lb/a.

Introduction

Urea-containing fertilizers are subject to N loss through volatilization when surface broadcast without incorporation. Usually, the potential for volatilization loss is minimal when these fertilizers are topdressed on wheat from November through early March. When topdressing is delayed, volatilization potential increases.

The objective of this research was to compare an experimental N fertilizer, UCAN-21, and UAN as topdress fertilizers for wheat.

Procedures

Studies were initiated at three sties in Marion Co. in 1998. Nitrogen rates (30, 60, 90 lb/a) were topdressed in March as either UCAN-21 or UAN. A no-N treatment was included.

Leaf tissue samples were taken at boot stage for N analysis. Grain yields were determined, and grain samples were retained for protein analysis.

Results

Grain yields were good to excellent in 1998. Visual responses to applied N were apparent within a few weeks after topdressing. Nitrogen fertilization increased wheat grain yields up to 90 lb/a (Table 4). The excellent response to N was due to relatively low residual soil N levels because of excellent yields in 1997. Nitrogen also consistently increased leaf N at all sites and significantly increased grain protein at two of three sites.

Nitrogen sources performed similarly at two of three sites, but UCAN-21 produced significantly higher yields than UAN at one site (Table 4). This work will be continued in 1999.

Table 4. Effects of nitrogen rates and sources on wheat, Marion Co., KS, 1998.

		Marion Co. A				Marion Co. B				Marion Co. C			
N Rate	N Source	Yield	Test Wt.	Leaf N	Grain Protein	Yield	Test Wt.	Leaf N	Grain Protein	Yield	Test Wt.	Leaf N	Grain Protein
lb/a		bu/a	lb/bu	%	%	bu/a	lb/bu	%	%	bu/a	lb/bu	%	%
0	--	30	60	1.30	9.6	44	60	1.41	9.1	27	57	1.52	8.9
30	UAN	42	60	1.47	9.8	63	63	1.60	9.8	50	62	1.77	9.6
60	UAN	53	62	1.53	9.7	70	61	1.85	10.3	53	62	1.93	10.1
90	UAN	57	62	1.67	9.7	78	60	1.92	11.5	56	60	2.10	11.1
30	UCAN-21	44	63	1.40	9.8	63	63	1.55	9.5	48	61	1.65	9.2
60	UCAN-21	49	62	1.45	9.7	76	61	1.88	10.5	59	61	1.94	9.9
90	UCAN-21	59	61	1.70	10.0	81	60	2.12	11.5	64	61	2.22	11.4
LSD (0.10)		6	2	0.11	0.2	9	2	0.21	0.5	6	4	0.17	0.5
Mean Values:													
N	30	43	61	1.43	9.8	63	63	1.57	9.6	49	62	1.71	9.4
Rate	60	51	62	1.49	9.7	73	61	1.86	10.4	56	62	1.94	10.2
	90	58	61	1.68	9.9	80	60	2.02	11.5	60	60	2.16	11.2
LSD (0.10)		5	NS	0.08	NS	7	1	0.16	0.4	4	1	0.12	0.3
N	UAN	50	61	1.56	9.7	70	61	1.79	10.5	53	61	1.94	10.3
Source	UCAN-21	51	62	1.52	9.8	73	61	1.85	10.5	57	61	1.94	10.2
LSD (0.10)		NS	NS	NS	NS	NS	NS	NS	NS	3	NS	NS	NS
0-24" Soil NO_3-, lb/a				8			21				33		

EVALUATION OF PREVIOUS CROP, SEEDING RATE, AND NITROGEN RATE FOR OPTIMUM WHEAT PRODUCTION

D.A. Whitney, D.L. Fjell, S.A. Staggenborg, and J.P. Shroyer

Summary

Previous crop, seeding rate, and nitrogen (N) rate all had significant effects on wheat yields in this study. Wheat grain yield following soybean, averaged across seeding and N rates, was 10 bu/a greater than the wheat yield following sorghum (57 vs 47 bu/a). At the lowest seeding rate (60 lb/a) and with no N fertilizer applied, wheat grain yield was 27 bu/a following sorghum and 53 bu/a following soybean. However, at the highest seeding rate and at 80 or 120 lb/a of N, wheat yields following sorghum were not significantly lower than wheat yields following soybeans, suggesting that previous crop effects can be minimized with good management. This study will be repeated in 1999.

Introduction

A considerable acreage of wheat is being planted following fall harvest of a row crop in central and eastern Kansas, partly in response to greater flexibility in crop selection allowed by the current farm legislation. This cropping practice does not allow much time for seedbed preparation before planting, raising questions about optimum seeding rate and nitrogen (N) fertilization. This research was initiated to address effects of previous crop, seeding rate, and N rate on yield of wheat planted following fall harvest of row crops.

Procedures

A site at the North Agronomy Farm was planted to blocks of soybean and grain sorghum in the spring of 1997 to establish the previous crop treatments. The site is on a Reading silt loam soil with good P and K fertility levels. Following fall harvest of sorghum and soybean crops, wheat was seeded using a no-till double-disk opener plot drill with 10 in. row spacing. The variety 2137 was seeded on October 20 at 60, 90, or 120 lb/a in a split-split plot designed study with previous crop as main plots and seeding rates as subplots. On each seeding rate subplot three N rates (40, 80, and 120 lb/a) were applied randomly on October 22 using ammonium nitrate as the N source. One set of subplots received no N. Whole plant samples were taken at late boot to early head emergence for determination of N and P concentrations. Grain yields were determined, and a portion of the grain was retained for moisture and protein determinations.

Results

A response in grain yield was obtained to all three variables (Table 5). With the lowest seeding rate and no application of N, yield was much less for wheat following sorghum compared to wheat following soybean, suggesting less residual N after grain sorghum. However, grain protein (Table 5) and plant N concentrations (Table 6) were similar for these two treatments. Grain yield and plant N increases in response to N application generally were much greater in magnitude following sorghum than soybean. However, at the highest seeding rate and at 80 or 120 lb/a of N, yields were similar following the two previous crops.

Table 5. Effects of previous crop, nitrogen rate, and seeding rate (60, 90, 120 lb/a) on wheat grain yield and grain protein at the North Agronomy Farm, Manhattan, KS.

Previous	N	Grain Yield			Grain N		
Crop	Rate	60	90	120	60	90	120
	lb/a	- - - - - - - bu/a - - - - - - -			- - - - - - - - % - - - - - - - -		
Sorghum	0	27	41	35	2.01	1.86	1.87
	40	41	52	50	2.00	2.02	2.00
	80	46	53	57	2.13	2.12	2.06
	120	48	56	58	2.09	2.06	2.09
Soybean	0	53	48	56	1.86	1.78	1.93
	40	50	60	62	2.07	1.92	2.02
	80	58	55	67	2.11	2.10	2.06
	120	57	59	57	2.14	2.08	2.11
LSD .05			13			.13	

Table 6. Effects of previous crop, nitrogen rate, and seeding rate (60, 90, 120 lb/a) on nitrogen and phosphorus concentrations in boot/early heading whole plant samples at the North Agronomy Farm, Manhattan, KS.

Previous	N	Plant N			Plant P		
Crop	Rate	60	90	120	60	90	120
	lb/a	- - - - - - - % - - - - - - -			- - - - - - - - % - - - - - - - -		
Sorghum	0	1.45	1.18	1.20	.22	.21	.21
	40	1.49	1.49	1.36	.20	.18	.19
	80	1.66	1.67	1.54	.17	.18	.17
	120	1.70	1.54	1.56	.16	.17	.16
Soybean	0	1.48	1.42	1.39	.19	.17	.18
	40	1.64	1.52	1.67	.19	.17	.18
	80	1.73	1.58	1.70	.17	.17	.18
	120	1.76	1.76	1.77	.18	.17	.18
LSD .05			.30			.02	

EVALUATION OF POLYMER-COATED UREA AS A STARTER NITROGEN SOURCE FOR WHEAT

D.A. Whitney and W.B. Gordon

Summary

An excellent response to N fertilization was found, with the lowest N rate (60 lb/a) being adequate. The N source, urea vs. PCU (polymer-coated urea), had no effect on yield or other parameters measured. The PCU placed with the seed at 15, 30, and 60 lb/a of N did not cause germination damage. Work with PCU will be continued in 1999.

Introduction

Flexibility in cropping allowed by the current Farm Bill has encouraged farmers in eastern and central Kansas to plant more wheat after fall harvest of row crops than in the past. Much of this wheat is planted with little prior tillage and little time for fertilizer application. Putting N on with the drill at planting in direct seed contact can be effective, but N rates need to be limited to prevent germination damage. Urea is not recommended for direct seed contact application at any rate because of potential germination damage. Pursell Technologies Inc. makes a polymer-coated urea (POLYON AG) with a differential release rate. The reactive layer coating (RLC) membrane, which encapsulates the urea granule, controls urea release rate by its applied thickness. This slow dissolution rate could be used to reduce potential wheat germination damage and allow a higher N rate in direct seed contact. This research was initiated to investigate the use of PCU as a seed-placed and broadcast N source for wheat.

Procedures

A field study was initiated at the North Central Experiment Field near Belleville. The site was in corn in 1997, and the corn stalks were disked twice prior to wheat planting with a no-till coulter plot drill with 10 in. row spacing. Wheat (variety 2137) was planted on October 17 at 75 lb/a of seed. Urea and PCU44 were used in various combinations of starter with the seed plus broadcast to give a total N rate of either 60 or 120 lb/a. A plot with no N application was included to assess N responsiveness of the site. Individual plots were 5 ft by 20 ft long with four replications. Plant samples for dry matter yield were taken at boot to early head emergence by harvesting 2 feet of row from each plot. Plant samples were dried at 70^{o}C, weighed, ground, and analyzed for N and P concentrations. Grain yields were determined at maturity using a plot combine. A sample of the grain was retained for determinations of moisture, kernel weight, and N content.

Results

Results from this research are summarized in Table 7. An excellent grain yield response to N fertilization was found, with the check (no N) treatment yielding 19 bu/a less than the lowest treatment with N application. No stand counts were made, but visual observation of the plots and yields suggest that PCU44 at 30 and 60 lb/a of N placed with the seed was not injurious to germination and growth. The average yield of all treatments with 120 lb/a of N was only 3 bushels greater than the average yield of those with 60 lb/a of N, indicating that 60 lb/a of N was adequate for optimum yield. No significant treatment effect was noted for other parameters measured.

Table 7. Effects of nitrogen rate, source and placement on wheat yield, and plant concentrations and uptakes of nitrogen and phosphorus at North Central Expt. Field, Belleville, KS.

N with Seed		Broadcast N		Grain	Grain		Boot Stage			Uptake	
Rate	Source	Rate	Source	Yield	N	Kernel wt	DM	N	P	N	P
				bu/a	%	g/1000 seed	lb/a	- - % - -		- - lb/a - -	
check				51	2.29	27.7	5490	1.87	.34	103	18.6
0	--	60	PCU44*	72	2.35	29.0	4510	1.89	.34	86	15.5
0	--	60	Urea	72	2.34	27.3	5520	2.06	.37	115	20.6
15	PCU44	45	Urea	75	2.39	26.5	4120	2.00	.33	82	13.7
30	PCU44	30	Urea	76	2.34	28.6	4340	1.99	.37	87	16.0
60	PCU44	0	Urea	70	2.50	28.2	4690	2.12	.36	101	17.6
3	Urea	57	Urea	80	2.36	26.6	5750	2.23	.36	128	20.9
6	Urea	54	Urea	73	2.33	27.4	5440	2.02	.34	112	19.7
15	Urea	45	Urea	73	2.37	28.0	4530	2.04	.33	93	15.3
15	18-46-0	45	Urea	77	2.37	27.6	4580	1.98	.35	92	16.0
0	--	120	PCU44	78	2.32	26.8	5220	1.84	.34	98	18.0
0	--	120	Urea	74	2.40	26.8	5580	2.19	.36	122	20.6
30	PCU44	90	Urea	77	2.40	26.9	5140	2.32	.38	119	19.5
60	PCU44	60	Urea	79	2.46	26.2	4970	2.09	.35	104	17.7
3	Urea	117	Urea	78	2.32	28.1	4840	2.12	.35	103	17.1
6	Urea	114	Urea	77	2.39	26.8	4370	2.22	.36	97	15.9
LSD (.05)				6	NS	NS	NS	NS	NS	NS	NS

* PCU44 is POLYON AG polymer-coated urea (44% N) from Pursell Technologies Inc.

EVALUATION OF THE USE OF BIO-FORGE™ AND STIMULATE™ FOR WHEAT PRODUCTION

D.A. Whitney and W.B. Gordon

Summary

Bio-Forge™ and Stimulate™ applied 2 weeks prior to heading to well-fertilized and healthy growing wheat had no effects on grain yield or other growth and nutrient measurements taken.

Introduction

Stoller Enterprises, Inc. approached us with interest in evaluation of Bio-Forge™ with or without Stimulate™ as a foliar application to wheat. Bio-Forge™ is reported by the manufacturer to prolong plant greenness, resulting in improved grain yield and grain quality. Stimulate™ is marketed as a yield enhancer to be used with foliar fertilizer or other foliar-applied materials. Our evaluation of these two products was to determine their effect on wheat yields when they were applied 2 weeks prior to heading.

Procedures

The study was initiated at the North Central Experiment Field on an existing stand of wheat, variety 2137. A backpack CO_2 pressured sprayer was used to apply Bio-Forge™ in 20 gal/a of water at rates of 1, 2, and 3 pt/a without and with 5 oz/a of Stimulate™ at Feeke's growth stage 8 (approximately 2 weeks prior to heading). A no-application check treatment also was included as well as a foliar application of 20 lb/a N as UAN. Whole plant samples were taken 3 weeks after treatment application by harvesting 2 feet of one row from each plot for determinations of dry matter production and N and P concentrations. Chlorophyll meter readings were taken prior to treatment application and at roughly 10 and 20 days after application to evaluate the company claim of extended plant greenness. At maturity, grain yields were determined using a plot combine. A portion of the grain was retained for determining grain moisture, test weight, and 1000 kernel weight.

Results

Excellent grain yields in excess of 70 bu/a were obtained at the location, but no significant treatment effect occurred (Table 8). No visual differences were observed in greenness or in chlorophyll meter measurements. At this location, Bio-Forge™ and Stimulate™ had no effect on any parameter measured.

Table 8. Effects of Bio-Forge[T] and Stimulate[T] on wheat yield and plant composition, Belleville, KS.

Treatment*		Grain	Grain		Chlorophyll Meter			Boot Stage		
Bio-Forge	Stimulate	Yield	N	Kernel Wt.	5/1	5/11	5/18	DM	N	P
pt/a	oz/a	bu/a	%	g/1000 seed	- - SPADS - -			lb/a	- - % - -	
0	0	75	2.48	24.7	42	44	48	10,550	2.02	.24
1	0	73	2.43	25.6	43	46	49	9,940	2.01	.23
2	0	72	2.48	25.4	43	45	49	9,830	1.92	.22
3	0	73	2.56	24.1	43	43	50	10,530	2.03	.24
1	5	70	2.55	24.0	43	44	48	9,200	1.94	.25
2	5	71	2.62	23.8	43	45	49	9,810	1.92	.22
3	5	72	2.52	25.2	44	45	47	9,410	1.98	.22
0	0**	71	2.56	24.3	44	45	48	10,300	1.92	.22
LSD (.05)		NS	NS	NS	NS	NS	NS	NS	NS	NS

* Applied foliarly 14 days prior to heading (Feeke 8.0) on May 1.
** 20 N/a at Feeke 8.0

GRASS FERTILIZATION STUDIES
KANSAS STATE UNIVERSITY - DEPARTMENT OF AGRONOMY

BROMEGRASS FERTILIZATION STUDIES

R.E. Lamond, G.L. Keeler, J. Holthaus, H.C. George, C.J. Olsen, 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 1998 in Douglas County (one site), Miami County (four sites), and Jackson County (two 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 1998 results are summarized in Tables 1 and 2. Forage yields were average to excellent at all locations, and yields were increased by N application up to 120 lb/a at all four Miami Co. locations (Table 1). Nitrogen rate effects were less dramatic at the other sites (Table 2). Nitrogen fertilization also significantly increased forage protein levels at all sites. Phosphorus fertilization increased brome forage yields at five of seven locations. The biggest responses to P were observed at the lower P soil test sites. The two sites that did not respond to P fertilization had the highest soil P levels. The addition of S fertilizer produced higher yields at six of seven sites, though not all of the yield increases were statistically significant. At the Douglas Co. site, addition of 20 lb S/a increased forage yields by over 1800 lb/a.

These studies will be continued in 1999.

Table 1. Fertility management on bromegrass, Miami Co., KS, 1998.

			Miami Co “A”			Miami Co “B”			Miami Co “C”			Miami Co “D”		
N	P	S	Yield	Prot.	S	Yield	Prot.	S	Yield	Prot.	S	Yield	Prot.	S
-----lb/a-----			lb/a	----- % -----		lb/a	----- % -----		lb/a	------ % -----		lb/a	----- % -----	
0	0	0	3090	7.5	.14	3300	6.8	.15	2060	7.1	.17	2640	7.8	.17
40	0	0	5170	7.6	.12	5040	7.0	.12	4600	8.4	.14	4920	8.7	.16
80	0	0	5710	9.2	.14	5510	8.0	.12	4590	9.3	.15	4060	10.7	.18
120	0	0	6610	9.9	.14	6730	9.0	.14	5580	9.1	.14	5130	11.9	.18
40	30	0	5570	8.0	.13	5140	6.2	.12	5710	7.5	.14	4700	7.5	.14
80	30	0	6330	8.5	.13	6520	7.5	.13	6080	8.3	.14	5530	9.2	.15
120	30	0	6760	9.4	.13	7290	8.3	.13	6670	9.3	.13	6010	10.3	.15
80	30	20	6770	9.9	.15	6950	8.4	.14	6480	8.1	.15	5900	9.1	.19
	LSD	(0.10)	600	1.0	.02	950	1.0	NS	930	1.4	.02	510	1.2	.02
Mean Values													8.1	.17
N		40	5370	7.8	.13	5090	6.6	.12	5150	7.9	.14	4810	9.9	.15
rate		80	6020	8.8	.13	6010	7.7	.13	5340	8.8	.14	4800	11.1	.16
		120	6690	9.7	.14	7010	8.6	.14	6120	9.2	.14	5570	0.7	NS
	LSD	(0.10)	450	0.8	NS	700	0.7	NS	700	1.0	NS	370		
													10.4	.17
P_2O_5		0	5830	8.9	.13	5760	8.0	.13	4920	8.9	.15	4710	9.0	.15
rate		30	6220	8.6	.13	6320	7.3	.13	6150	8.3	.14	5420	0.6	.01
	LSD	(0.10)	370	NS	NS	540	0.6	NS	530	NS	NS	310		
Soil Test P (ppm)				4			7			3			3	

Table 2. Fertility management on bromegrass, Jackson and Douglas Cos., KS, 1998.

			Jackson Co “A”			Jackson Co “B”			Douglas Co		
N	P	S	Yield	Prot.	S	Yield	Prot.	S	Yield	Prot.	S
-----lb/a-----			lb/a	-----%-----		lb/a	-----%-----		lb/a	-----%-----	
0	0	0	4020	9.6	.14	2220	11.8	.17	2790	8.0	.18
40	0	0	6650	11.0	.15	6420	12.1	.18	5560	9.0	.16
80	0	0	6790	12.6	.16	6130	12.9	.16	5840	9.8	.17
120	0	0	7380	14.7	.17	6450	14.9	.19	4790	11.1	.17
40	30	0	6830	11.8	.14	6750	13.0	.17	6130	8.2	.15
80	30	0	6950	12.3	.15	6630	11.5	.16	5900	9.0	.14
120	30	0	7040	15.3	.18	7320	15.4	.19	5770	10.7	.16
80	30	20	6870	12.7	.20	7040	14.0	.21	7770	8.7	.15
	LSD	(0.10)	950	2.3	.03	870	1.6	.02	890	0.7	.02
Mean Values											
N		40	6240	11.4	.14	6580	12.6	.17	5840	8.6	.15
rate		80	6870	12.4	.16	6380	12.2	.16	5620	9.4	.16
		120	7210	15.0	.18	6880	15.1	.19	5280	10.9	.16
	LSD	(0.10)	690	1.6	.02	NS	1.2	.01	NS	0.5	NS
P_2O_5		0	6940	12.8	.16	6330	13.3	.17	5390	10.0	.17
rate		30	6910	13.2	.16	6900	13.3	.17	5960	9.3	.15
	LSD	(0.10)	NS	NS	NS	NS	NS	NS	560	0.4	.01
Soil Test P (ppm)				16			12			6	

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. Dry matter yields and crude protein concentrations increased with N fertilization. Dry matter yield increased further with the addition of P to the fertilizer treatment. Forage P concentration also responded positively to P fertilization. In the first year, 1997, delaying harvest from early June to early July resulted in significantly more dry matter harvested, but forage crude protein and P concentration were significantly reduced. In 1998, the late harvest resulted in dry matter yields that were no greater than those from the early harvest; however, crude protein and P concentrations were reduced significantly. This work will be continued in 1999.

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 resulted in poor production and reduced stands of bromegrass. Harvest often is delayed past optimum time in anticipation of increased yields but adversely affects hay quality and the bromegrass stand. 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 of 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 was topdressed at 30 lbs/a alone and at 0, 15, 30 and 45 lbs/a P_2O_5 with 80 lbs/a N as urea. These treatments have remained constant throughout the study. Severe doughty conditions resulted in no forage harvest in 1996. Soil tests were taken in December of 1996 from each treatment and repeated in September of 1997 and 1998. Fertilizer treatments were repeated in February, 1997 and 1998. A 14 ft by 34 in sample 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 and May 29 or June 30, 1998. The same halves will be harvested in the same sequence approximately 30 days apart each year of this study. The hay was cut at a 4 in. stubble height, and after the July 2 harvest in 1997 and June 30 harvest in 1998, all previously uncut border area was cut and removed from the site. Bromegrass was in bloom on the first cutting dates and at hard dough on the late harvest. A sub-sample from each plot harvest was weighed and then dried in a dehydrator to determine dry matter. The yield results are approximately 96% dry matter. The subsample was retained after weighing for determination of N and P concentrations by the K-State Soil Testing Lab.

Results

Soil test results are shown in Table 3. An increase in available P did not occur until the test in September 1997 (Table 1), and then only on the plots that had received two applications of 30 or 45 lbs/a of P. After a

very dry summer, soil tests P levels were back near those of the initial test.

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. 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 remained infested with prairie threeawn. Infestation levels were determined by visual evaluation.

Table 4 summarizes the results of the 1997 and 1998 harvests. The dramatic forage increase created by the addition of only 15 lbs/a of P_2O_5 shows that application of N alone when low soil P levels exist is not cost effective. As expected on low-P testing soils, P_2O_5 application resulted in increased N utilization. An application of 80 lb/a N ($18/a) more than tripled (+349%) dry matter yields vs no fertilizer applied and increased returns by $34/a. The average forage increases of 658 lbs/a dry matter in 1997 and 508 lbs/a dry matter in 1998 (worth approximately $18.00 and $14.00, respectively, at $55/ton) produced by applying 30 vs 15 lbs/a P_2O_5 (an additional $4-5/a) were also significantly cost effective. Although an average of 28% increase in forage occurred for the late harvest compared to the first harvest in 1997, no significant dry matter yield differences between early and late harvests were noted in 1998. This may have been due to the hot, dry weather in June, 1998, following a dry May. Average 24% and 14% decreases in crude protein and P concentrations, respectively, existed for all treatments. The forage P levels of all samples (less than 0.2%) 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 3. Soil test results from fertilizer P_2O_5 applied to a bromegrass hay meadow, Butler Co., KS, 1996-1998.

P_2O_5 Applied, lbs/a	Available P, ppm		
March 1996, February 1997, & February 1998	December 1996	September 1997	September 1998
0	4	5	4
15	3	6	4
30	3	12	7
45	7	22	10

Table 4. 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., KS, 1997-1998

		Dry Matter Yield		Crude Protein		Phosphorus	
Fertilizer N - P - K	Cutting Date	1998	2-Year Average	1998	2-Year Average	1998	2-Year Average
lb/a		- - - - - lb/a - - - - -		- - - - % - - - -		- - - - % - - - -	
0-0-0	May 29	430	346	6.4	6.0	0.106	0.093
	June 30	413	861	5.9	6.1	0.104	0.096
80-0-0	May 29	1621	1315	8.7	9.6	0.095	0.094
	June 30	1318	1854	6.8	7.7	0.079	0.080
0-30-0	May 29	670	657	6.6	6.5	0.158	0.148
	June 30	529	951	5.5	5.5	0.149	0.141
80-15-0	May 29	2947	2783	8.2	8.9	0.111	0.112
	June 30	2584	3109	5.5	6.2	0.084	0.092
80-30-0	May 29	3346	3250	8.0	8.7	0.127	0.124
	June 30	3200	3807	5.3	5.6	0.106	0.095
80-45-0	May 29	3470	3410	8.0	8.7	0.146	0.145
	June 30	3466	3760	5.6	5.9	0.123	0.112
$LSD_{(P=0.05)}$		560		0.9		0.020	
0-0-0		421	603	6.1	6.0	0.105	0.094
80-0-0		1470	1585	7.7	8.6	0.087	0.087
0-30-0		600	805	6.1	6.0	0.154	0.145
80-15-0		2766	2946	6.9	7.6	0.097	0.102
80-30-0		3273	3529	6.6	7.1	0.116	0.109
80-45-0		3468	3585	6.8	7.3	0.135	0.129
$LSD_{(P=0.05)}$		397		0.8		0.017	
	May 29	2081	1960	7.7	8.1	0.124	0.119
	June 30	1918	2390	5.8	6.2	0.108	0.103
$LSD_{(P=0.05)}$		NS		0.4		0.010	

EFFECTS OF NITROGEN AND PHOSPHORUS FERTILIZATION ON A NATIVE GRASS HAY MEADOW

S.R. Duncan, J.C. Baker, and B.N. Barber

Summary

Previous studies have reported that fertilization of native grass hay meadows will increase hay yield. In this 3-year study, dry matter yield of native grass hay increased with applications of nitrogen (N) and/or N + phosphorus (P). Potassium (K) application did not affect hay production. Forage crude protein content improved with greater applications of N when the hay meadow was burned prior to fertilizer application. When P was applied to the meadow, P (2 of 3 years) and calcium (Ca) content of the forage tended to increase. Depending on fertilizer and hay prices, application of fertilizer may be a cost-effective management tool for native hay producers.

Introduction

Some native grass hay meadows in the western Flint Hills region are poor in vigor and have suffered declining yields because of continuous poor harvest management. With ownership and attitude changes, new landowners and operators are interested in improving the vigor and productivity of these hay meadows. Soil test results have indicated low to very low levels of P and profile-N on many of these sites. Although native grasses developed and flourished on these low fertility soils, N is the primary growth factor limiting forage yield. Prior research has shown a positive dry matter yield response to fertilization, but the net economic returns to the operator evidently have not justified the practice of fertilizing native hay meadows. Other studies have also reported an increase of broadleaf plants (forbs) and undesirable cool-season grasses when native rangeland sites were fertilized. The purpose of this study was to determine the role fertilizer application may play in the recovery of poor-vigor hay meadows to a productive state.

Procedures

This study was established on a native hay meadow near Cambridge, in Cowley County, in the spring of 1995. The meadow is an upland site on a Tabler silty-clay loam soil, consisting of mixed species of perennial, warm-season grasses and forbs that are dominant in the Flint Hills region. Initial soil test results from a 4 in. depth were: pH of 5.9, available P of 1 ppm, available K of 120 ppm and profile N of 1 ppm. The meadow had a history of being burned annually in late April to initiate growth of desirable grass species. During the extremely dry spring of 1996, a burn ban was in place in Cowley County, so the meadow was not burned. Seven treatments, including an unfertilized check, were applied by hand when the grass reached a height of 4 in. - 27 April, 3 May and 30 April in 1995, 1996, and 1997, respectively. Urea, triple superphosphate, and muriate of potash were the nutrient sources for the study. Nitrogen as urea was applied at 20 or 40 lbs N/a, either alone or in combination with P at 20 lbs P_2O_5/a. Phosphorus was applied alone in one treatment at 20 lbs P_2O_5/a. Potash at 20 lbs K_2O/a was combined with 40 lbs N and 20 lbs P_2O_5/a. A 34 in. by 15 ft area was harvested with a sickle-bar mower at a 4-in. height on 5 July, 11 July, and 3 July, 1995, 1996, and 1997, respectively. Forbs and grasses from each plot were weighed separately in the field. A subsample from the grass portion and the entire forb sample of each plot were dried to determine percent dry matter. Forage was analyzed for crude protein, P, and calcium (Ca) content.

Results

Any combination of N + P fertilizer used in this study resulted in significantly increased dry matter yields vs unfertilized grass (Table 5). When 40 lbs/a N were applied, dry matter yields increased over those of the untreated check in 2 of 3 years.

The 20-0-0 treatment also increased yields but was inconsistent. Applications of P without N did not affect hay yield. Only in 1997 did the additional 20 units of N in the 40-20-0 and 40-20-20 treatments increase dry matter yield vs the 20-20-0 treatment. Growing-season precipitation in 1996 was below normal, which led to a potential carryover of mineralized N from 1996 to 1997. Precipitation during the early 1997 growing season was above the 30-year average. Combined with the potential carryover N plus fertilizer N, this resulted in a greater response from the higher N rates. Lack of a controlled burn in the spring of 1996 may have counteracted the low rainfall by leaving the 1995 regrowth for harvest in 1996, resulting in potentially inflated dry matter yields. Dry matter yield of forbs did not increase significantly with N or N + P application, possibly because of the short duration of the study and the prescribed burn conducted in 2 of 3 years. Addition of K to the fertilizer formula did not increase dry matter yields or enhance forage quality.

Forage crude protein increased significantly with the addition of only 20 lbs N/a in 1995 and 1997 (Table 6). In 1996, when no spring burn occurred and the dead regrowth from 1995 was harvested with the new grass, crude protein levels were dramatically lowered. Phosphorus alone or in combination with N across all rates did not affect crude protein content. Phosphorus application slightly increased forage P content in 2 of 3 years (Table 7).

Depending on fertilizer and application costs and price received for hay, fertilization of native hay meadows may be cost effective. In this study, dry matter yields needed to be increased at least 500 lbs/a to cover fertilizer material and application costs. On this low-P testing site, applying 40 lbs N/a was a breakeven practice. The addition of 20 lbs P/a to 20 or 40 lbs N/a increased yields at least 500 lbs/a and, therefore, net returns. However, in only 1 of 3 years (1997) would the 40-20-0 treatment have been more profitable than the 20-20-0 treatment. Kansas hay producers may profit from applications of fertilizer to native hay meadows on low P soils. Applying low levels of N + P in a 1:1 ratio should be adequate to increase yields enough to cover fertilizer material and application costs, plus increase return over costs of production. In the year following a dry growing season, producers may increase net profits by increasing the N application rates.

Table 5. Effects of nitrogen and phosphorus fertilization on dry matter yields from a native hay meadow, Cowley Co., KS, 1995-1997.

Fertilizer	Total Dry Matter Produced			
N - P - K	1995	1996	1997	3-Year Average
lbs/a	- - - - - - - - - - - - - - - lbs dry matter/a - - - - - - - - - - - -			
0-0-0	1741	1283	896	1307
20-0-0	1819	1564	1562	1648
40-0-0	2203	1562	1930	1898
0-20-0	1693	1429	1111	1411
20-20-0	2259	2054	1991	2101
40-20-0	2497	2071	3012	2527
40-20-20	2220	1991	2888	2366
$LSD_{(0.10)}$	281	342	654	

Table 6. Effects of nitrogen and phosphorus fertilization on forage crude protein content from a native hay meadow, Cowley Co., KS, 1995-1997.

Fertilizer	Forage Crude Protein			
N - P - K	1995	1996	1997	3-Year Average
lbs/a	- - - - - - - - - - - - - - - - - - % - - - - - - - - - - - - - - - - - -			
0-0-0	6.2	4.9	6.0	5.7
20-0-0	6.8	5.1	6.8	6.2
40-0-0	6.8	5.5	8.0	6.8
0-20-0	6.0	4.9	6.5	5.8
20-20-0	6.7	5.2	6.6	6.2
40-20-0	6.8	5.4	7.3	6.5
40-20-20	6.7	5.6	7.3	6.5
$LSD_{(0.10)}$	0.5	0.6	0.7	

Table 7. Effects of nitrogen and phosphorus fertilization on forage phosphorus content from a native hay meadow, Cowley Co., KS, 1995-1997.

Fertilizer	Forage Phosphorus Content			
N - P - K	1995	1996	1997	3-Year Average
lbs/a	- - - - - - - - - - - - - - - - % - - - - - - - - - - - - - - - -			
0-0-0	0.10	0.09	0.09	0.09
20-0-0	0.08	0.09	0.07	0.08
40-0-0	0.08	0.08	0.11	0.09
0-20-0	0.10	0.11	0.11	0.11
20-20-0	0.10	0.11	0.11	0.11
40-20-0	0.10	0.10	0.13	0.11
40-20-20	0.09	0.10	0.09	0.09
$LSD_{(0.10)}$	NS	0.01	0.03	

SOIL FERTILITY RESEARCH
SOUTHWEST RESEARCH - EXTENSION CENTER

LONG-TERM FERTILIZATION OF IRRIGATED CORN AND GRAIN SORGHUM

A.J. Schlegel

Summary

Long-term research shows that phosphorus (P) and nitrogen (N) fertilizers must be applied for optimum grain yields of irrigated corn and grain sorghum in western Kansas. In this study, N and P fertilization increased corn yields more than 100 bu/a. Application of 160 lb N/a tended to be sufficient to maximize corn yields. Phosphorus increased corn yields by 75 bu/a when applied with at least 120 lb N/a. Application of 40 lb P_2O_5/a was adequate for corn, and higher rates were not necessary. Grain sorghum yields were increased over 40 bu/a by N and about 20 bu/a by P fertilization. Application of 80 lb N/a was sufficient to maximize yields in most years. Potassium fertilization had no effect on sorghum yield.

Introduction

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

Procedures

Initial fertilizer treatments in 1961 to corn and grain sorghum in adjacent fields were N rates of 40, 80, 120, 160, and 200 lb N/a without P and K; with 40 lb P_2O_5/a and zero K; and with 40 lb P_2O_5/a and 40 lb K_2O/a, and a no-N check. In 1992, the treatments for the corn study were changed with the K variable being replaced by a higher rate of P (80 lb P_2O_5/a). All fertilizers were broadcast by hand in the spring and incorporated prior to planting. The soil is a Ulysses silt loam. The corn hybrids were Pioneer 3379 (1992-94), Pioneer 3225 (1995-97), and Pioneer 3395IR (1998) planted at 32,000 seeds/a in late April or early May. Sorghum (Mycogen TE Y-75 from 1992-1996, Pioneer 8414 in 1997, and Pioneer 8505 in 1998) was planted in late May or early June. Both studies were furrow irrigated to minimize water stress. The center two rows of all plots were machine harvested after physiological maturity. Grain yields were adjusted to 15.5% moisture for corn and 12.5% for sorghum.

Results

Nitrogen and P fertilization increased corn yields averaged across the 7-year period by over 100 bu/a (Table 1). In 1995, hail during the growing season reduced overall yields about 40%, but yields still were increased up to 80 bu/a by N and P fertilization. The apparent N fertilizer requirement was about 160 lb/a. Application of 40 lb P_2O_5/a increased yields more than 70 bu/a when applied with at least 120 lb N/a. No significant yield difference occurred between applications of 40 and 80 lb P_2O_5/a, averaged across all N rates. However, at 160 and 200 lb N/a, corn yields were 4 bu/a greater with 80 than with 40 lb P_2O_5/a.

Grain sorghum yields were increased 43 bu/a by application of 80 N/a, averaged across the last 6 years (Table 2).

Phosphorus increased sorghum yields by about 20 bu/a, but K had no effect on sorghum yields.

Table 1. Effects of nitrogen and phosphorus fertilizers on irrigated corn, Tribune, KS, 1992-1998.

		Grain Yield						
Nitrogen	P_2O_5	1992	1993	1994	1995	1996	1997	1998
- - - - lb/a - - - -		- - - - - - - - - -	- - - -	- - - -	bu/a	- - - -	- - - -	- - - - - - - - - -
0	0	73	43	47	22	58	66	49
0	40	88	50	43	27	64	79	55
0	80	80	52	48	26	73	83	55
40	0	90	62	66	34	87	86	76
40	40	128	103	104	68	111	111	107
40	80	128	104	105	65	106	114	95
80	0	91	68	66	34	95	130	95
80	40	157	138	129	94	164	153	155
80	80	140	144	127	93	159	155	149
120	0	98	71	70	39	97	105	92
120	40	162	151	147	00	185	173	180
120	80	157	153	154	111	183	162	179
160	0	115	88	8	44	103	108	101
160	40	169	175	162	103	185	169	186
160	80	178	174	167	100	195	187	185
200	0	111	82	80	62	110	110	130
200	40	187	169	171	106	180	185	188
200	80	165	181	174	109	190	193	197
<u>ANOVA</u>								
Nitrogen		0.001	0.001	0.001	0.001	0.001	0.001	0.001
Linear		0.001	0.001	0.001	0.001	0.001	0.001	0.001
Quadratic		0.001	0.001	0.001	0.001	0.001	0.001	0.001
P_2O_5		0.001	0.001	0.001	0.001	0.001	0.001	0.001
Linear		0.001	0.001	0.001	0.001	0.001	0.001	0.001
Quadratic		0.001	0.001	0.001	0.001	0.001	0.001	0.001
N x P		0.013	0.001	0.001	0.001	0.001	0.001	0.001
<u>MEANS</u>								
Nitrogen, lb/a	0	80	48	46	25	65	76	53
	40	116	90	92	56	102	104	93
	80	129	116	107	74	139	146	133
	120	139	125	124	83	155	147	150
	160	154	146	136	82	161	155	157
	200	154	144	142	92	160	163	172
LSD.0.05		14	7	13	7	10	12	11
P_2O_5, lb/a	0	96	69	68	39	92	101	91
	40	149	131	126	83	148	145	145
	80	141	135	129	84	151	149	143
LSD 0.05		10	5	9	5	7	9	7

Table 2. Effect of nitrogen, phosphorus, and potassium fertilizers on irrigated sorghum, Tribune, KS, 1992-1998.

N	P_2O_5	K_2O	Grain Yield 1992	1993	1994*	1996	1997	1998
- - - - - - - lb/a - - - - - - -			- - - - - - - - - - - - - - - - - bu/a - - - - - - - - - - - - - - - - -					
0	0	0	27	46	64	74	81	77
0	40	0	28	42	82	77	75	77
0	40	40	35	37	78	79	83	76
40	0	0	46	69	76	74	104	91
40	40	0	72	97	113	100	114	118
40	40	40	72	92	112	101	121	114
80	0	0	68	91	96	73	100	111
80	40	0	85	105	123	103	121	125
80	40	40	85	118	131	103	130	130
120	0	0	56	77	91	79	91	102
120	40	0	87	120	131	94	124	125
120	40	40	90	117	133	99	128	128
160	0	0	62	93	105	85	118	118
160	40	0	92	122	137	92	116	131
160	40	40	88	123	125	91	119	124
200	0	0	80	107	114	86	107	121
200	40	0	91	127	133	109	126	133
200	40	40	103	123	130	95	115	130
ANOVA								
Nitrogen			0.001	0.001	0.001	0.003	0.001	0.001
Linear			0.001	0.001	0.001	0.002	0.001	0.001
Quadratic			0.001	0.001	0.001	0.116	0.001	0.001
P-K			0.001	0.001	0.001	0.001	0.001	0.001
Zero P vs P			0.001	0.001	0.001	0.001	0.001	0.001
P vs P-K			0.431	0.888	0.734	0.727	0.436	0.649
N x P-K			0.420	0.006	0.797	0.185	0.045	0.186
MEANS								
Nitrogen								
0 lb/a			30	42	75	77	80	76
40			64	86	100	92	113	108
80			80	104	117	93	117	122
120			78	105	118	91	114	118
160			81	113	122	89	118	124
200			91	119	126	97	116	128
LSD .05			10	10	14	9	10	8
P_2O_5 K_2O								
0-0 lb/a			56	81	91	79	100	103
40-0			76	102	120	96	113	118
40-40			79	102	118	95	116	117
LSD.05			7	7	10	7	7	6

SOIL FERTILITY RESEARCH
KSU AGRICULTURAL RESEARCH CENTER - HAYS

EFFECTS OF STOCKOSORB AGRO ON WHEAT AND TRITICALE IN CENTRAL KANSAS

C.A. Thompson

Summary

Stockosorb AGRO is a potassium-based, high molecular weight, dry polyacrylamide (cross-linked) crystal produced by Stockhausen, Inc. in Germany. When water comes in contact with the crystal, it forms a hydrated gel, absorbing many times its original weight in water. Use of Stockosorb AGRO for agricultural purposes is relatively new; therefore, little information is available. In this study, application methods included broadcast and incorporation, subsurface (6-in. deep) broadcast, and furrow banding with the seed. Throughout the remainder of this report the product will be referred to as Stockosorb. Furrow banding Stockosorb with the seed at planting resulted in more consistent yield increases and higher net return than any other application method. When Stockosorb was placed in a ½ inch band with the seed, this was equivalent to 24 times the amount broadcast. On some sites, Stockosorb in combination with a starter fertilizer gave better results than separate applications. When summarized over several sites, results showed that applying 1 lb/a Stockosorb in the furrow with the seed was sufficient. This is good news for the producer who is trying to lower costs and increase profits. On some of the test sites, wheat yields were reduced when high Stockosorb rates were banded with the seed. Possibly, the crystals absorbed what little moisture was present at the expense of the tender young plants. Low Stockosorb rates were difficult to distribute evenly in the row. Blending the Stockosorb crystals with starter fertilizer may be risky because of the possibility of settling out. Mounting one of the accurate pesticide-metering devices (like Gandy) on the drill would provide more even application.

Introduction

Availability of soil nutrients often declines under droughty conditions or when they are leached below the root zone of the growing crop. Any material or procedure that extends the time or amount of nutrient uptake could have a positive effect on plant growth and grain yield. Because of their high absorption capacity, cross-linked polyacrylamides, like Stockosorb, have been used in the diaper industry for years and only recently have been considered in agriculture. Cross-linked polyacrylamides should not be confused with linear polyacrylamides that have been used for decades in paper manufacturing, food processing, and wastewater treatment.

Procedures

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 with the seed. A water wagon was used twice to flood irrigate selected plots with 2 inches of water. Water was retained on those plots by perimeter berms constructed soon after crop emergence.

Test sites were established on silt loam and silty clay loam soils. The varieties Ike, Jagger, or 2137 were used in the wheat studies, and Jenkins winter triticale was used in the hay study. A 12-inch row hoe-type grain drill was used to plant the small grain studies. Treatments were replicated four times. Wheat was seeded at 60 lb/a and triticale at 75 lb/a. Fifty pounds of 18-46-0 was applied as starter fertilizer. Ammonium nitrate (34-0-0) was the nitrogen (N) fertilizer source. Six rows from the center of each plot

were harvested with a Massey MF-8 plot combine equipped with a 72-inch header. Data were analyzed with SAS using ANOVA or GLM.

Results

Stockosorb x Starter Fertilizer; On-Station

The effects of banding 1, 2, and 3 lb/a of Stockosorb with the wheat seed applied with and without starter fertilizer under dryland and irrigated management are shown in Tables 1 and 2. The largest yield increase and economic return occurred under dryland conditions. Because droughty conditions are more likely to occur under dryland cropping, the moisture/nutrient holding capacity of the gel would be expected to positively affect crop performance. Stockosorb had no significant effect on test weight, plant height, or general rating. In general, the combined effect of Stockosorb and starter fertilizer on yield and profit was higher than the effect of either of the materials applied alone. Banding 2 or 3 lb/a of Stockosorb provided no significant yield advantage over the 1 lb/a rate.

Stockosorb x Starter Fertilizer; Off-Station Dryland

A Stockosorb rate study with and without starter fertilizer was established on off-station farmers' fields in six counties. The results are shown in Table 3. Grain yields were increased significantly at three of the six sites. When averaged over the six sites, a small but significant yield increase occurred with 1 lb/a Stockosorb. Yield increases above the 1 lb/a rate were not significant. This is good news for the wheat grower who is trying to lower input costs.

Stockosorb x Nitrogen Fertilizer

Effects of Stockosorb and N fertilizer banded with the wheat seed at planting under dryland and irrigated conditions are reported in Tables 4 and 5. The primary treatment effects resulted from irrigation and N. Although a significant yield increase occurred with Stockosorb, it did not translate into significant increases in the net return. The general rating increased with Stockosorb, but it did not affect test weight and plant height.

Stockosorb x Crop Rotation Study

Stockosorb applied in the fall of 1995 had no residual effect on 1998 grain yields (Table 6). Even when prorated over 3 years, the net return was negative. An obvious conclusion is that subsurface broadcasting high rates of Stockosorb is risky for achieving a significant net return. The use of Stockosorb did not cause any significant lowering of yields, test weight, plant height, or general rating.

Stockosorb x Application Method on Winter Triticale

Banded Stockosorb significantly increased triticale grain yield (Table 7) and gave a higher net return than broadcast treatments applied at comparable rates (1 lb/a banded = 24 lb/a broadcast). No yield or economic advantage resulted from using rates higher than 1 lb/a. None of the treatments affected test weight, plant height, general rating or lodging.

Stockosorb significantly increased forage yields (Table 8). Starter fertilizer was applied on all treatments. The two methods of application did not affect yield. The lowest rate of Stockosorb produced nearly as much forage as higher rates. Because of the low rates used, the banding method resulted in a significantly higher net return than broadcast. Treatments had no effect on percentage of dry matter or plant height.

General

In the microenvironment created by banding, the gel-like substance formed as the Stockosorb crystals absorb soil moisture from rainfall or irrigation likely will include water-soluble nutrients. Thus, both water and soil nutrients are available for uptake by plant roots that grow into the gel. Increased crop production and higher net return may occur under proper management.

The cost effectiveness of using Stockosorb for small grain production will depend on the price of the product, yield increase, wheat price at harvest, and cost of

application. For the first year or two, applying Stockosorb in strip applications on one or more fields is recommended. If results are positive, expanded use is warranted.

Table 1. Winter wheat results for 1998 as affected by Stockosorb applied with and without starter fertilizer placed in a band with the seed at planting under dryland and irrigated conditions on an Armo loam, KSU Agricultural Research Center-Hays, KS.

Dryland/ Irrigated	Stockosorb Rate w/Seed	Starter Fertilizer w/Seed[1]	Yield	Net $ per Ac from Stockosorb[2]	Test Weight	Plant Height	General Rating[3]
	lb/a		bu/a		lb/bu	inch	
Dryland	0	No	15.6	0.00	59.4	24.8	4.0
Dryland	2	No	22.4	10.82	59.8	26.2	5.2
Dryland	0	Yes	20.1	6.71	59.1	25.5	4.2
Dryland	2	Yes	25.5	14.72	59.4	26.8	6.0
Irrigated	0	No	30.7	0.00	59.0	28.5	6.0
Irrigated	2	No	35.1	4.03	59.7	30.2	6.5
Irrigated	0	Yes	33.5	1.83	59.4	29.0	6.2
Irrigated	2	Yes	38.1	7.55	59.6	28.8	6.5
LSD (P<.05)							
Dryland vs Irrigated			1.8	4.89	NS	0.7	0.4
Stockosorb Rate			1.8	NS	NS	NS	NS
Starter Fertilizer			1.8	4.89	0.3	0.7	0.4
Dry/Irr X Stockosorb			NS	NS	NS	NS	NS
Dry/Irr X Starter			NS	NS	NS	NS	0.6
Stockosorb X Starter			NS	NS	NS	NS	NS
Dry/Irr X Stockosorb X Starter			NS	NS	NS	NS	NS
P Values							
Dryland vs Irrigated			<.01	<.01	0.90	<.01	<.01
Stockosorb Rate			<.01	0.10	0.49	0.86	0.14
Starter Fertilizer			<.01	<.01	<.01	<.01	<.01
Dry/Irr X Stockosorb			0.59	0.58	0.10	0.13	0.37
Dry/Irr X Starter			0.35	0.35	0.77	0.39	0.01
Stockosorb X Starter			0.75	0.91	0.33	0.13	0.76
Dry/Irr X Stockosorb X Starter			0.64	0.64	0.43	0.24	0.37

[1] Starter fertilizer at 50 lb/a of 18-46-0.

[2] Wheat @ $2.75/bu; Stockosorb @ $2.40/lb; starter fertilizer @ $7.00/a; banding cost @ $1.00/a.

[3] 1=poorest, 10=best (visual observation of wheat quality).

Table 2. Winter wheat results for 1998 as affected by Stockosorb applied with and without starter fertilizer placed in a band with the seed at planting under dryland conditions on an Armo loam, KSU Agricultural Research Center-Hays, KS.

Stockosorb Rate w/Seed	Starter Fertilizer w/Seed[1]	Yield	Net $ Return per Ac from Stockosorb[2]	Test Weight	Plant Height	General Rating[3]
lb/a		bu/a		lb/bu	inch	
0	No	15.6	0.00	59.4	24.8	4.0
1	No	19.0	6.20	59.3	25.5	4.2
2	No	20.1	6.71	59.1	25.5	4.2
3	No	20.4	5.01	59.0	26.0	5.0
0	Yes	22.4	0.00	59.8	26.2	5.2
1	Yes	26.3	8.42	59.7	26.8	6.0
2	Yes	25.5	3.90	59.4	26.8	6.0
3	Yes	27.4	6.45	59.6	27.2	6.0
LSD (P<.05)						
Stockosorb Rate		2.4	NS	NS	NS	NS
Starter Fertilizer		1.7	4.67	0.2	0.7	0.5
Stockosorb X Starter		NS	NS	NS	NS	NS
P Values						
Stockosorb Rate		<.01	0.14	0.10	0.13	0.08
Starter Fertilizer		<.01	<.01	<.01	<.01	<.01
Stockosorb X Starter		0.86	0.86	0.78	0.99	0.56

[1] Starter fertilizer at 50 lb/a of 18-46-0.

[2] Wheat @ $2.75/bu; Stockosorb @ $2.40/lb; starter fertilizer @ $7.00/a; banding cost @ $1.00/a.

[3] 1=poorest, 10=best (visual observation of wheat quality).

Table 3. Six-site summary of winter wheat yields for 1998 as affected by Stockosorb applied with and without starter fertilizer placed in a band with the seed at planting under dryland conditions in six counties near the KSU Agricultural Research Center-Hays, KS.

Stockosorb Rate lb/a w/Seed	Starter Fertilizer w/Seed[1]	Yield, bu/a Barton County	Ellis County	Graham County	Rush County	Russell County	Trego County	Six-Site Average
0	No	25.4	18.4	53.3	15.1	26.1	24.1	27.1
1	No	27.6	16.6	60.0	13.8	26.0	31.0	29.2
2	No	30.1	18.4	59.9	13.9	23.0	27.5	28.8
3	No	36.0	18.3	61.5	12.6	22.7	27.4	29.6
6	No	28.9	18.3	61.0	13.0	26.1	32.4	30.0
12	No	27.5	19.0	57.8	15.2	23.7	29.8	28.8
0	Yes	36.2	24.2	58.8	14.6	29.2	29.7	32.1
1	Yes	35.9	25.8	59.2	20.0	27.2	37.4	34.3
2	Yes	38.8	24.0	62.3	16.2	27.7	22.6	33.8
3	Yes	38.0	24.8	59.5	18.7	27.3	35.9	34.0
6	Yes	36.8	26.4	61.8	16.9	25.3	34.3	33.6
12	Yes	43.2	27.0	62.3	16.3	28.2	33.2	35.0
LSD (P<.05)								
Stockosorb Rate		2.7	NS	3.4	NS	NS	3.7	1.2
Starter Fertilizer		1.6	1.2	NS	1.9	1.8	2.1	0.7
Stockosorb X Starter		3.9	NS	NS	NS	NS	NS	NS
P Values								
Stockosorb Rate		<.01	0.39	0.04	0.15	0.73	<.01	<.01
Starter Fertilizer		<.01	<.01	0.08	<.01	<.01	<.01	<.01
Stockosorb X Starter		<.01	0.39	0.20	0.30	0.28	0.41	0.46

[1] Starter fertilizer at 50 lb/a of 18-46-0.

Table 4. Winter wheat results for 1998 as affected by Stockosorb applied with and without nitrogen fertilizer placed in a band with the seed at planting under dryland and irrigated conditions on a Harney silt loam, KSU Agricultural Research Center-Hays, KS.

Dryland/ Irrigated	Stockosorb Rate w/Seed	N Rate, N/a w/Seed[1]	Yield	Net $ Return per Ac from Stockosorb[2]	Test Weight	Plant Height	General Rating[3]
	lb/a	lb/a	bu/a		lb/bu	inch	
Dryland	0	0	18.8	0.00	61.0	26.0	4.0
Dryland	2	0	20.3	-1.72	61.1	27.0	4.8
Dryland	0	20	19.8	-4.43	60.6	27.0	5.0
Dryland	2	20	21.5	-4.41	60.6	26.8	5.2
Irrigated	0	0	34.6	0.00	61.2	27.8	6.2
Irrigated	2	0	36.5	-0.58	61.0	28.0	6.8
Irrigated	0	20	41.2	11.14	60.9	28.5	7.2
Irrigated	2	20	43.1	11.64	60.6	29.2	7.5
LSD (P<.05)							
Dryland vs Irrigated			1.7	4.64	NS	0.5	0.3
Nitrogen Rate			1.7	NS	0.02	0.5	0.3
Stockosorb Rate			1.7	NS	NS	NS	0.3
Dry/Irr X N Rate			2.4	6.56	NS	NS	NS
Dry/Irr X Stockosorb			NS	NS	0.2	NS	NS
N Rate X Stockosorb			NS	NS	NS	NS	NS
Dry/Irr X N Rate X Stockosorb			NS	NS	NS	NS	NS
P Values							
Dryland vs Irrigated			<.01	<.01	0.28	<.01	<.01
Nitrogen Rate			<.01	0.08	<.01	<.01	<.01
Stockosorb Rate			<.01	0.84	0.45	0.06	<.01
Dry/Irr X N Rate			0.04	<.01	0.35	0.18	0.65
Dry/Irr X Sockosorb			0.85	0.86	0.03	0.78	0.65
N Rate X Stockosorb			0.93	0.76	0.55	0.41	0.19
Dry/Irr X N Rate X Stockosorb			0.94	0.94	0.67	0.06	0.65

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

[2] Wheat @ $2.75/bu; Stockosorb @ $2.40/lb; N fertilizer @ $6.00/a; banding cost @

[3] 1=poorest, 10=best (visual observation of wheat quality).

Table 5. Winter wheat results for 1998 as affected by Stockosorb applied with and without nitrogen fertilizer placed in a band with the seed at planting under dryland conditions on a Harney silt loam, KSU Agricultural Research Center-Hays, KS.

Stockosorb Rate w/Seed	N Rate w/Seed[1]	Yield	Net $ Return per Ac from Stockosorb[2]	Test Weight	Plant Height	General Rating[3]
lb/a	lb N/a	bu/a		lb/bu	inch	
0	0	18.8	0.00	61.0	26.0	4.0
1	0	20.5	1.25	61.2	26.0	4.8
2	0	20.3	-1.72	61.1	27.0	4.8
3	0	20.2	-4.51	61.0	26.2	4.8
0	20	19.8	0.00	60.6	27.0	5.0
1	20	21.0	1.03	60.6	27.0	5.5
2	20	21.5	0.02	60.6	26.8	5.2
3	20	20.2	-5.89	60.4	26.8	5.2
LSD (P<.05)						
Stockosorb Rate		1.1	3.12	NS	NS	0.4
Nitrogen Rate		NS	2.20	0.2	0.5	0.3
Stockosorb X N Rate		NS	NS	NS	NS	NS
P Values						
Stockosorb Rate		0.03	<.01	0.28	0.66	0.04
Nitrogen Rate		0.09	<.01	<.01	0.04	<.01
Stockosorb X N Rate		0.73	0.78	0.88	0.29	0.61

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

[2] Wheat @ $2.75/bu; Stockosorb @ $2.40/lb; N fertilizer @ $6.00/a; banding costs @ $1.00/a.

[3] 1=poorest, 10=best (visual observation of wheat quality).

Table 6. Winter wheat results for 1998 on two crop rotations as affected by Stockosorb subsurface applied in the fall of 1995 on a Crete silty clay loam soil, KSU Agricultural Research Center-Hays, KS.

Stockosorb Rate Subsurface	Yield	Net $ Return per Ac from Stockosorb[1]	Test Weight	Plant Height	General Rating[2]
lb/a	bu/a		lb/bu	inch	
		Wheat-Wheat-Wheat			
0	30.3	0.00	59.4	30	7.7
25	30.9	-20.58	60.8	27	7.3
		Wheat-Sorghum-Fallow			
0	37.6	0.00	61.1	31	7.7
25	37.0	-23.79	61.4	31	7.7
LSD (P<.05)					
Crop Rotation	3.5	9.51	0.2	0.7	NS
Stockosorb Rate	NS	9.51	0.2	0.7	NS
Rotation X Stockosorb	NS	NS	0.4	0.9	NS
P-Values					
Crop Rotation	<.01	<.01	<.01	<.01	0.36
Stockosorb Rate	0.97	<.01	<.01	<.01	0.36
Rotation X Stockosorb	0.69	0.69	<.01	<.01	0.36

[1] Wheat @ $2.75/bu; Stockosorb @ $0.80/lb and subsurface @ $2.50/a over 3 years.

[2] 1=poorest, 10=best (visual observation of wheat quality).

Table 7. Winter triticale grain results for 1998 as affected by Stockosorb applied preplant broadcast and incorporated and banded with the seed at planting, on an Armo loam soil, Fort Hays State University farm, Hays, KS.

Stockosorb Rate	Method of Application	Grain Yield	Net $ Return per Ac from Stockosorb[1]	Test Weight	Plant Height	General Rating[2]	Lodging
lb/a		lb/a		lb/bu	inch		%
0		1567	0.00	50.8	46.0	5.5	67.5
24	Broadcast	1488	-64.54	51.0	45.5	5.5	75.0
48	Broadcast	1475	-122.80	51.0	45.8	5.2	85.0
72	Broadcast	1680	-170.14	51.0	44.0	5.2	83.8
0		1525	0.00	50.8	45.0	5.0	83.8
1	Banded	1680	4.37	50.9	46.0	5.8	80.0
2	Banded	1713	3.61	51.0	46.5	5.8	76.2
3	Banded	1656	-1.68	51.1	46.8	5.5	85.0
LSD (P<.05)							
Stockosorb Rate		75	3.75	NS	NS	NS	NS
Placement		53	2.65	NS	NS	NS	NS
Stockosorb Rate X Placement		106	5.31	NS	NS	NS	NS
P-Values							
Stockosorb Rate		0.02	<.01	0.91	0.75	0.63	0.87
Placement		<.01	<.01	0.98	0.16	0.56	0.67
Stockosorb Rate X Placement		<.01	<.01	0.98	0.12	0.38	0.74

[1] Triticale @ $0.05/lb, Stockosorb @ $2.40/lb, broadcast @ $3.00/a, banding @ $1.00/a.
[2] 1=poorest, 10=best (visual observation of triticale quality).

Table 8. Winter triticale forage results for 1998 as affected by Stockosorb applied preplant broadcast and incorporated and banded with the seed at planting, on an Armo loam soil, Fort Hays State University farm, Hays, KS.

Stockosorb Rate	Method of Application	Forage Yield, ODW	Net $ Return per Ac from Stockosorb[1]	Dry Matter	Plant Height
lb/a		lb/a		%	inch
0		10842	0.00	24.8	46.2
24	Broadcast	11611	-32.97	23.1	45.2
48	Broadcast	11170	-111.22	25.2	46.8
72	Broadcast	11956	-145.25	24.6	45.0
0		10456	0.00	22.6	45.8
1	Banded	11875	23.00	25.6	45.5
2	Banded	11321	13.22	23.8	44.8
3	Banded	12255	37.18	23.4	46.2
LSD (P<.05)					
Stockosorb Rate		472	18.33	NS	NS
Placement		NS	12.96	NS	NS
Stockosorb Rate X Placement		NS	25.92	NS	NS
P-Values					
Stockosorb Rate		<.01	<.01	0.95	0.93
Placement		0.61	<.01	0.58	0.71
Stockosorb Rate X Placement		0.42	<.01	0.45	0.39

[1] Triticale @ $60/ton @ 15% moisture, Stockosorb @ $2.40/lb, broadcast @ $3.00/a, banding @ $1.00/a.

EFFECTS OF STOCKOSORB ON GRAIN SORGHUM IN CENTRAL KANSAS

C.A. Thompson

Summary

Stockosorb AGRO is a cross-linked white crystalline polyacrylamide produced by Stockhausen, Inc. The crystal is capable of absorbing many times its weight in water, resulting in a hydrated gel. Plant roots grow into the gel and absorb water and possibly water-soluble nutrients. Increased crop production may occur under proper management. Studies to date indicate that the banding placement method is more cost effective than broadcast and incorporated or subsurface (6-inches deep) application. One lb/a applied in a ½ inch band is equivalent to 24-lb/a broadcast or subsurface applied and is sufficient to increase yield. Accurate distribution of the dry crystalline form in the seed furrow is difficult with conventional grain drills even with fertilizer boxes. The recommended rate is low, and particle size and weight are greatly different than those of most dry fertilizers. Thus, separation in the seed box over time is likely. However, on row crop planters, pesticide boxes are capable of metering out small quantities of material and, therefore, can be very effective in accurately distributing the cross-linked polymer in the seed furrow. A finely sieved form of Stockosorb AGRO, called Stockosorb F (a powder), was combined with liquid fertilizer. The blend remained a liquid and did not gel before entering the soil. This blending procedure worked with 10-34-0 and 28-0-0. Significant grain and economic responses were achieved with this blended material. Whether results will be the same with other liquid fertilizers is unknown. There is a definite trend showing that banding Stockosorb AGRO or Stockosorb F with fertilizers will result in yields higher than the sum of their separate effects. This possible synergistic action needs to be studied more carefully.

Introduction

Research has documented that low fertilizer rates when placed with the seed can greatly enhance crop production. However, nitrogen (N) fertilizers are subject to leaching. In addition, mild to severe droughts can leave fertilizers in dry soil where nutrient uptake is limited.

Cross-linked polyacrylamides, like crystal Stockosorb materials, will absorb many times their original weight in liquid. Thus, the cross-linked polyacrylamides have performed well in the diaper industry. Cross-linked polymers should not be confused with linear polymers, which have few hydrated properties. There may be places for both in the agricultural arena, but this study addresses only the effectiveness of the cross-linked polymer Stockosorb.

Can these cross-linked polyacrylamides absorb and hold enough water in the soil to make a difference in crop production? Can these polymers not only absorb water but also water-soluble nutrients that plant roots can use to enhance crop production? And lastly, can the hydrated gel reduce nutrient leaching under irrigation and high rainfall? The goal of this work is to achieve yes or no answers to these questions. This may take several years.

Procedures

Dry Stockosorb AGRO, when applied alone, was blended with sand for banding with the seed at planting with a cone/spinner mechanism mounted on the planter. Blending with the sand was necessary to ensure uniform distribution in the seed row. When dry fertilizer was blended with Stockosorb AGRO, no sand was added.

A powder form of Stockosorb AGRO (achieved by sieving) called Stockosorb F was mixed with two liquid fertilizers, 10-34-0 and 28-0-0. A small amount of water was added to this mixture to achieve a 20 gpa

application. The blended material was metered out through an orifice using a regular nozzle body mounted behind the opener on the planter. The angle of the nozzle body containing the orifice was very critical. The nozzle body needed to be angled back enough so that the liquid did not cause a gradual mud buildup around the seed opening. When mud buildup did occur, plugging of the seed tube resulted. I suggest a 30 to 45 degree angle of the liquid fertilizer tube shooting back of the seed opening.

Irrigation was achieved by using a water wagon to flood irrigate selected bermed plots with 2 inches of water. The berms were constructed on the perimeter of the plots soon after crop emergence.

Test sites were established on silt loam and silty clay loam soils. A 12-inch row hoe-type grain drill was used to plant the grain sorghum studies. Treatments were replicated four times. Seeding rate was 80,000 seeds/a in 12-inch row spacing (superthick sorghum). Ammonium nitrate (34-0-0) was the dry N source, and 28-0-0 and 10-34-0 were the liquid fertilizer sources. Six rows from the center of each plot were harvested with a Massey MF-8 plot combine equipped with a 72-inch header. A Dickey-John was used to measure test weight. Plant height and general rating notes were taken at harvest. Data were analyzed with SAS using ANOVA or GLM.

In the fall of 1995, broadcast Stockosorb AGRO was applied by hand on each plot area. Stockosorb AGRO also was applied 6-inches below the soil surface with a 20-foot sweep unit using a fan to uniformly distribute the crystals. A 200 h.p. tractor was required to apply the subsurface treatments. High Stockosorb AGRO rates, regardless of application method, were applied one time (1995). Carryover of the material was assumed to occur for the next several growing seasons. Throughout the remainder of this report, Stockosorb refers to Stockosorb AGRO.

Results

Placement of Stockosorb with and without dry N fertilizer is shown in Tables 9 and 10. The effect of irrigation was significant on increasing yields and net return. Although a sorghum yield increase occurred with Stockosorb, this did not translate into significant dollar returns. It is important to use as low a Stockosorb rate as possible to effectively raise yield levels and achieve a positive net return. Banded N fertilizer had a significant positive effect on grain yield, return per acre, and general rating.

An off-station study where six rates of Stockosorb were placed with and without N fertilizer is reported in Table 11. Four of the six sorghum sites (medium to low fertility) responded significantly to banded Stockosorb. As expected, all sites responded to banded N using ammonium nitrate. Although the Stockosorb X N interaction was not significant, a trend favoring the placement of Stockosorb with N fertilizer was observed. Results indicate that using more than 2 lb/a is not necessary.

For the first time, this investigator made an effort to mix Stockosorb with liquid fertilizer so that the combined products could be applied as a liquid in a band in the seed furrow. The new powder form, Stockosorb F, does not form a gel when mixed with liquid fertilizer alone or with a small amount of water added. However, when Stockosorb F is combined with water first, a rapid gel is formed. Therefore, it is important to add the Stockosorb F to the liquid fertilizer first and then add the water if needed. The results of this blending process on sorghum production are reported in Table 12. Liquid fertilizer significantly increased yields over the control. Additional yield increases were obtained when Stockosorb F or AGRO were added to the liquid fertilizer. When the products were combined, exceeding the 2 lb/a Stockosorb rate was not necessary. The liquid fertilizer in this blend apparently is absorbed into the soil around the banded mixture. This leaves the Stockosorb F in a state ready to receive water (rain or irrigation) and form a gel possibly also containing water-soluble nutrients. This microenvironment band was much easier to achieve with Stockosorb F and liquid fertilizer than with Stockosorb

AGRO blended or added separately with dry or liquid fertilizers. Because liquid fertilizers are used widely on most crops, this blending ability could be a marketing advantage for Stockosorb F. More studies need to be conducted to verify the effectiveness of Stockosorb F on grain crops.

A study comparing Stockosorb crystal sizes is shown in Tables 13 and 14. Stockosorb AGRO was sieved to achieve the particle sizes desired. Visual sorghum ratings showed a significant difference with rates but not particle size. Although definite yield trends favored Stockosorb usage, they were not significant. Also no significant yield differences occurred among the three Stockosorb particle sizes. Stockosorb had no significant effect on test weight or plant height.

Subsurface broadcast Stockosorb (Table 15) had no significant positive effects on grain yields or other agronomic factors of sorghum grown in two crop rotations. Because of the high initial dollar investment when 25 lb/a were used, yield differences would have to be substantially greater than those achieved in the last 3 years.

A study comparing two placement methods and six Stockosorb rates is reported in Table 16. The residual affect of Stockosorb was still apparent but not cost effective. Although a significant yield increase occurred with Stockosorb usage, this did not translate into higher returns per acre. Placement method had no effect. Stockosorb did not affect test weight, plant height, lodging, or general rating.

Table 9. Grain sorghum results for 1998 as affected by Stockosorb applied with and without nitrogen fertilizer placed in a band with the seed at planting under dryland and irrigated conditions on a Harney silt loam, KSU Agricultural Research Center-Hays, KS.

Dryland/ Irrigated	Stockosorb Rate w/Seed	N Rate w/Seed[1]	Yield	Net $ Return per Ac from Stockosorb[2]	Test Weight	Plant Height	General Rating[3]
	lb/a	lb N/a	bu/a		lb/bu	inch	
Dryland	0	0	51.7	0.00	59.2	38.8	4.0
Dryland	2	0	54.5	-1.80	59.3	40.2	4.8
Dryland	0	20	59.9	5.26	59.3	38.8	5.5
Dryland	2	20	63.2	5.21	59.4	39.5	5.8
Irrigated	0	0	71.8	0.00	59.2	44.5	7.0
Irrigated	2	0	74.1	-2.51	59.1	44.5	7.0
Irrigated	0	20	81.4	7.40	59.1	44.2	7.8
Irrigated	2	20	86.9	10.65	59.4	43.2	8.0
LSD							
Dryland vs Irrigated			2.9	4.32	NS	0.5	0.4
Stockosorb Rate			2.9	NS	NS	NS	NS
Nitrogen Rate			2.9	4.32	NS	0.5	0.4
Dry/Irr X Stockosorb			NS	NS	NS	NS	NS
Dry/Irr X N Rate			NS	NS	NS	NS	NS
Stockosorb X N Rate			NS	NS	NS	NS	NS
Dry/Irr X Stockosorb X N Rate			NS	NS	NS	NS	NS
P Values							
Dryland vs Irrigated			<.01	<.01	0.39	<.01	<.01
Stockosorb Rate			0.02	0.89	0.56	0.23	0.09
Nitrogen Rate			<.01	<.01	0.56	0.04	<.01
Dry/Irr X Stockosorb			0.76	0.76	0.89	0.01	0.30
Dry/Irr X N rate			0.33	0.33	0.89	0.47	0.30
Stockosorb X N Rate			0.51	0.38	0.45	0.10	0.72
Dry/Irr X Stockosorb X N Rate			0.63	0.63	0.69	0.81	0.30

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

[2] Sorghum @ $1.50/bu; Stockosorb @ $2.50/lb; N fertilizer @ $6.00/a; banding cost @ $1.00/a.

[3] 1=poorest, 10=best (visual observation of grain sorghum quality).

Table 10. Continuous grain sorghum results for 1998 as affected by Stockosorb applied with and without nitrogen fertilizer placed in a band with the seed at planting under dryland conditions on a Harney silt loam, KSU Agricultural Research Center-Hays, KS.

Stockosorb Rate w/Seed	N Rate w/Seed[1]	Yield	Net $ Return per Ac from Stockosorb[2]	Test Weight	Plant Height	General Rating[3]
lb/a	lb N/a	bu/a		lb/bu	inch	
0	0	51.7	0.00	59.2	38.8	4.0
1	0	54.2	0.45	59.2	39.5	4.0
2	0	54.5	-1.80	59.3	40.2	4.8
3	0	54.9	-3.74	59.3	40.0	5.0
0	20	59.9	0.00	59.3	38.8	5.5
1	20	62.2	0.91	59.4	39.2	5.8
2	20	63.2	-0.05	59.4	39.5	5.8
3	20	63.3	-2.36	59.4	39.2	5.8
LSD (P<.05)						
Stockosorb Rate		NS	NS	NS	NS	0.5
Nitrogen Rate		2.1	3.13	NS	NS	0.3
Stockosorb X N Rate		NS	NS	NS	NS	NS
P Values						
Stockosorb Rate		0.11	0.36	0.82	0.19	0.04
Nitrogen Rate		<.01	<.01	0.17	0.25	<.01
Stockosorb X N Rate		0.99	0.98	0.95	0.85	0.14

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

[2] Sorghum @ $1.50/bu; Stockosorb @ $2.50/lb; N fertilizer @ $6.00/a; banding cost @ $1.00/a.

[3] 1=poorest, 10=best (visual observation of grain sorghum quality).

Table 11. Six-site summary of dryland grain sorghum yields for 1998 as affected by Stockosorb applied with and without nitrogen fertilizer placed in a band with the seed at planting in six counties near the KSU Agricultural Research Center-Hays, KS.

Stockosorb Rate, lb/a w/Seed	Nitrogen Fertilizer w/Seed[1]	Yield, bu/a Ellis County	Ness County	Osborne County	Rooks County	Rush County	Trego County	Six-Site Average
0	No	40.6	90.4	41.7	55.6	37.4	67.1	55.5
1	No	43.2	94.8	43.6	57.7	39.9	69.2	58.1
2	No	45.4	94.5	46.6	59.4	43.2	68.4	59.6
3	No	44.5	96.9	46.4	57.1	44.8	72.0	60.3
6	No	45.7	98.6	48.6	57.6	44.7	71.2	61.1
12	No	42.2	98.8	39.3	59.8	47.0	71.4	59.7
0	Yes	63.5	108.0	50.1	57.5	54.4	82.9	69.4
1	Yes	69.2	111.4	52.7	62.3	59.4	86.4	73.6
2	Yes	71.7	114.1	57.0	62.9	57.7	88.0	75.2
3	Yes	71.3	114.7	58.3	62.4	57.5	87.1	75.2
6	Yes	72.0	115.5	47.6	60.4	59.4	87.6	73.8
12	Yes	73.7	123.1	41.9	63.4	56.6	87.1	74.3
LSD (P<.05)								
Stockosorb Rate		3.9	3.5	3.9	NS	4.2	NS	2.0
Nitrogen Fertilizer		2.2	2.0	2.3	3.1	2.4	6.6	1.2
Stockosorb X Nitrogen		NS	NS	5.5	NS	NS	NS	NS
P Values								
Stockosorb Rate		0.01	<.01	<.01	0.47	0.05	0.74	<.01
Nitrogen Fertilizer		<.01	<.01	<.01	0.02	<.01	<.01	<.01
Stockosorb X Nitrogen		0.40	0.23	0.01	0.99	0.26	0.99	0.72

[1] Nitrogen fertilizer at 30 lb N/a using ammonium nitrate (34-0-0).

Table 12. Six-site summary of 1998 dryland grain sorghum yields as affected by liquid and dry Stockosorb applied with and without liquid fertilizer placed in a band with the seed at planting in six counties near the KSU Agricultural Research Center-Hays, KS.

Treatments Banded in Furrow with the Seed	Yield, bu/a Ellis Count	 Ness Count	 Osborne County	 Rooks Count	 Rush Count	 Trego County	 Six-Site Average
Control	44.4	62.9	46.9	52.2	49.7	55.3	51.9
Stockosorb AGRO @ 1 lb/a	48.5	66.8	49.6	54.0	51.3	56.6	54.4
Stockosorb AGRO @ 2 lb/a	51.1	64.9	52.9	56.4	54.8	58.3	56.4
Stockosorb AGRO @ 3 lb/a	55.2	70.8	55.4	58.0	56.9	61.5	59.6
Liquid Fertilizer[1]	63.5	102.4	64.3	62.9	66.0	84.9	74.0
Stockosorb F @ 1 lb/a blended with liq	69.0	108.8	68.3	67.9	68.5	89.2	78.6
Stockosorb F @ 2 lb/a blended with liq	72.0	116.1	69.3	70.8	72.0	92.7	82.1
Stockosorb F @ 3 lb/a blended with liq	73.2	116.6	73.8	75.0	75.6	94.4	84.7
Stockosorb AGRO @ 1 lb/a + liq fert	64.1	107.8	66.6	60.5	64.7	87.2	75.1
Stockosorb AGRO @ 2 lb/a + liq fert	72.0	115.0	64.8	63.6	66.2	90.0	78.6
Stockosorb AGRO @ 3 lb/a + liq fert	74.0	115.4	69.0	65.6	68.7	91.4	80.7
LSD (P<.05)	5.0	6.7	9.1	6.0	6.6	8.2	2.8
P Values	<.01	<.01	<.01	<.01	<.01	<.01	<.01

[1] 30+30+0 liquid fertilizer using 10-34-0 and 28-0-0 metered through a ground-driven John Blue pump.

Table 13. Continuous grain sorghum results for 1998 as affected by Stockosorb size placed in a band with the seed at planting under dryland and irrigated conditions on a Harney silt loam soil, KSU Agricultural Research Center-Hays, KS.

Dryland/ Irrigated	Stockosorb Particle Size	Stockosorb Rate	Yield	Test Weight	Plant Height	General Rating[3]
		lb/a	bu/a	lb/bu	inch	
Dryland	None	0	61.3	59.8	39.8	4.0
Dryland	Fine[1]	2	64.8	59.5	39.0	6.0
Dryland	Large[2]	2	60.2	59.8	38.5	5.0
Dryland	Combination	2	63.2	59.6	39.5	5.5
Irrigated	None	0	79.0	59.8	43.2	7.0
Irrigated	Fine	2	81.3	59.8	42.5	7.8
Irrigated	Large	2	84.7	59.4	42.8	8.2
Irrigated	Combination	2	81.2	59.6	43.0	7.2
LSD (P<.05)						
Dryland vs Irrigated			6.7	NS	1.1	0.6
Stockosorb Size			NS	Ns	NS	NS
Stockosorb Rate			NS	NS	NS	0.7
Dry/Irr X Size			NS	NS	NS	NS
Dry/Irr X Rate			NS	NS	NS	NS
P Values						
Dryland vs Irrigated			<.01	0.80	<.01	<.01
Stockosorb Size			0.97	0.79	0.59	0.34
Stockosorb Rate			0.42	0.17	0.17	<.01
Dry/Irr X Size			0.56	0.12	0.79	0.06
Dry/Irr X Rate			0.74	0.40	0.78	0.17

[1] Stockosorb material passed through a round-hole, 2-mm screen.

[2] Stockosorb material did not pass through a round-hole, 2-mm screen.

[3] 1=poorest, 10=best (visual observation of grain sorghum quality).

Table 14. Continuous grain sorghum results for 1998 as affected by Stockosorb size and rate placed in a band with the seed at planting under dryland conditions on a Harney silt loam, KSU Agricultural Research Center-Hays, KS.

Stockosorb Particle Size	Stockosorb Rate	Yield	Test Weight	Plant Height	General Rating
	lb/a	bu/a	lb/bu	inch	
Control	0	61.3	59.7	39.8	4.0
Fine[1]	1	65.2	59.8	39.2	6.0
Large[2]	1	64.2	59.6	39.8	5.5
Combination	1	67.9	59.5	38.8	6.2
Fine	2	64.8	59.5	39.0	6.0
Large	2	60.2	59.8	38.2	5.0
Combination	2	63.2	59.6	39.5	5.5
Fine	3	63.6	59.6	38.2	5.8
Large	3	62.2	59.5	38.5	5.5
Combination	3	64.6	59.5	39.2	5.5
LSD (P<.05)					
Stockosorb Size		NS	NS	NS	NS
Stockosorb Rate		NS	NS	NS	0.5
Size X Rate		NS	NS	NS	NS
P Values					
Stockosorb Size		0.72	0.57	0.37	0.09
Stockosorb Rate		0.60	0.26	0.06	<.01
Size X Rate		0.99	0.26	0.66	0.50

[1] Stockosorb material passed through a round-hole, 2-mm screen.
[2] Stockosorb material did not pass through a round-hole, 2-mm screen.

Table 15. Grain sorghum results for 1998 on two crop rotations as affected by Stockosorb subsurface applied in the fall of 1995 on a Crete silty clay loam soil, KSU Agricultural Research Center-Hays, KS.

Stockosorb Rate Subsurface	Yield	Net $ return per Ac from Stockosorb[1]	Test Weight	Plant Height	General Rating[2]
lb/a	bu/a		lb/bu	inch	
		Sorghum-Sorghum-Sorghum			
0	55.2	0.00	58.6	45.0	6.0
25	51.2	-27.89	58.4	44.0	5.0
		Sorghum-Fallow-Wheat			
0	62.3	0.00	58.5	44.7	7.0
25	65.9	-16.46	57.8	45.0	7.7
LSD (P<.05)					
Crop Rotation	3.5	5.28	NS	NS	0.04
Stockosorb Rate	NS	5.28	NS	NS	NS
Rotation X Stockosorb	5.0	7.48	NS	NS	0.06
P-Values					
Crop Rotation	<.01	<.01	0.39	0.76	<.01
Stockosorb Rate	0.89	<.01	0.23	0.76	0.36
Rotation X Stockosorb	0.04	0.04	0.49	0.55	<.01

[1] Sorghum @ $1.50/bu; Stockosorb @ $0.83/lb and subsurface @ $2.50/a over 3 years.

[2] 1=poorest, 10=best (visual observation of grain sorghum quality).

Table 16. Continuous dryland grain sorghum results for 1998 as affected by six Stockosorb rates applied broadcast and subsurface in the fall of 1995 on a Harney silt loam soil, KSU Agricultural Research Center-Hays, KS.

Method of Application	Stockosorb	Yield	Net $ Return per Ac from Stockosorb[1]	Test Weight	Plant Height	Lodging	General Rating
	lb/a	lb/a		lb/bu	inch	%	
	0	66.9	0.00	60.4	41.0	6.2	5.6
Broadcast	10	72.8	-0.57	60.6	40.6	5.0	6.1
Broadcast	25	74.2	-10.89	60.4	40.8	12.5	6.2
Broadcast	50	76.4	-28.51	60.4	40.8	6.9	6.2
Broadcast	100	74.0	-73.83	60.4	39.8	8.1	5.2
Broadcast	1000	71.6	-827.37	60.4	40.2	23.1	5.8
	0	66.8	0.00	60.6	40.5	1.2	5.6
Subsurface	10	71.4	-4.02	60.4	40.4	6.2	5.9
Subsurface	25	73.3	-13.61	60.4	40.9	5.6	6.1
Subsurface	50	72.7	-35.39	60.4	40.0	11.9	5.6
Subsurface	100	79.6	-66.67	60.5	40.8	5.6	6.5
Subsurface	1000	77.6	-819.80	60.4	40.5	17.8	5.9
LSD (P<.05)							
Stockosorb Placement		NS	NS	NS	NS	NS	NS
Stockosorb Rate		5.1	7.62	NS	NS	NS	NS
Placement X Rate		NS	NS	NS	NS	NS	0.8
P-Values							
Stockosorb Placement		0.52	0.94	0.54	0.93	0.50	0.69
Stockosorb Rate		0.01	<.01	0.48	0.68	0.09	0.43
Placement X Rate		0.31	0.32	0.87	0.32	0.91	0.02

[1] Broadcast: broadcast & incorporated prior to planting.
Subsurface: broadcast evenly 6 inches below soil surface w/sweeps & fan.
Sorghum @ $1.50/bu; Stockosorb @ $0.83/lb; broadcast @ $1.00/a; subsurface @ $2.50/a; cost prorated over 3 years.

EFFECTS OF AMISORB ON WINTER WHEAT

C.A. Thompson

Summary

AmiSorb was evaluated on six off-station sites, and positive responses occurred on four. These sites were located within a 60-mile radius of the KSU Agricultural Research Center-Hays. The cost effectiveness of using AmiSorb for small grain production will depend on the price of the product, yield increase, wheat price at harvest, and cost of application. In one study located at three different sites (two responded), four recommended wheat varieties (Ike, Jagger, Vista, and 2137) did not differ in their response to liquid AmiSorb foliar-applied in the spring. If this is repeatable, then the choice of which variety to plant may not be important. This will be good news for the wheat producer. In a three-site study (two responded), dry AmiSorb topdressed in the spring was slightly superior to foliar-applied liquid AmiSorb. However, when AmiSorb was banded at planting time, the liquid form was superior. This may have been due to more uniform distribution in the row.

Introduction

AmiSorb is a long-chain polymer of the amino acid, aspartic acid. The chemical nature of the compound is a synthetic thermal protein. AmiSorb is produced by Donlar Agricultural Products, Bedford Park, Illinois.

AmiSorb has a high density of negative charges, which produces a high cation exchange capacity (the ability to adsorb and hold plant nutrients). A large shell of water also surrounds the molecule.

The large size of the AmiSorb molecule prevents its uptake by the plant root. Nutrient uptake by plants is enhanced by concentration of nutrients at the root surface by the AmiSorb molecules.

AmiSorb is nontoxic and biodegradable and is available in both liquid and dry forms. Application of AmiSorb with fertilizer is recommended for greatest efficacy.

Pilot studies of various crops in several states under controlled conditions have shown positive results. The objectives of the studies reported here were to (1) determine if any yield differences occurred among four wheat varieties when AmiSorb was foliar applied at 1 and 2 qt/a in the spring and (2) compare dry and liquid forms of AmiSorb banded in the furrow at planting time and topdressed in the spring.

Procedures

Six off-station sites were established on silt loam or silty clay loam soils. A 12-inch row hoe-type grain drill was used to plant all the small grain studies. Treatments were replicated four times in a randomized complete block design. Wheat was seeded at 60 lb/a. The banded dry AmiSorb was applied with a cone/spinner device mounted on the drill. The banded liquid AmiSorb was applied with a ground-driven John Blue pump mounted on the drill. The wheat varieties were prepackaged and metered out through a cone/spinner device. Foliar applications in the spring were applied with a hand sprayer with a three-nozzle boom. Six rows from the center of each plot were harvested with a Massey MF-8 plot combine equipped with a 72-inch header. Data were analyzed statistically with SAS using ANOVA.

Results

The effects of liquid and dry AmiSorb banded with the seed at planting and topdressed or foliar applied in the spring are reported in Table 17. Wheat at two of three sites responded favorably to AmiSorb application. When banded, the liquid form resulted in significantly higher yields than did the dry form. This may be due in part to a more uniform furrow application of the liquid. In the spring, the dry form was significantly better than the liquid form. Part of the liquid

nitrogen applied with the foliar AmiSorb may have been volatilized before being taken into the plant.

Four wheat varieties were compared with liquid AmiSorb foliar-applied in the spring (Table 18). Yields increased at two of three sites. No interaction occurred between varieties and applied AmiSorb. This strongly suggests that the variety of wheat doesn't make any difference. The wheat producer should like this outcome, because it will give him more flexibility in his choice of variety to plant. There was a trend favoring the 2 qt over the 1 qt rate. This merits more attention to see if it is consistent. The stage of plant growth at the time of application in the spring may be critical to obtain consistent yield responses each year.

Table 17. Yields of 1998 dryland winter wheat as affected by liquid and dry AmiSorb, near Hays, KS.

Treatment	Graham County	Rush County	Trego County	3-Site Average
	------------ bu/a ------------			
Liquid AmiSorb + UAN Spring Topdressed				
0 qt/a	65.1	17.1	30.2	37.4
1 qt/a	67.8	17.5	31.4	38.9
2 qt/a	65.8	19.0	31.5	38.8
Dry AmiSorb + Am Nitrate Spring Topdressed				
0 lb/a	64.8	17.2	29.8	37.3
1 lb/a	70.0	18.8	31.0	39.9
2 lb/a	71.4	21.1	36.1	42.8
Liquid AmiSorb + UAN Banded with Seed				
0 qt/a	65.4	17.6	30.8	37.9
1 qt/a	74.8	17.0	34.6	42.2
Dry AmiSorb + Am Nitrate Banded with Seed				
0 lb/a	65.0	15.9	29.9	36.9
1 lb/a	69.2	15.2	32.7	39.0
LSD (P<.05)	2.4	2.2	NS	2.3
P-Value	<.01	<.01	0.17	<0.1

Table 18. Yields of four 1998 winter wheat varieties as affected by spring applied liquid, Amisorb, near Hays, KS.

Variety and Amisorb Rate	Barton County	Ellis County	Russell County	3-Site Average
	- - - - - - - - - - - -	- bu/a -	- - - - - - - - - - - -	
Ike				
0 qt/a	39.1	37.4	25.1	33.8
1 qt/a	41.6	33.8	30.1	35.2
2 qt/a	42.9	35.3	31.2	36.5
Jagger				
0 qt/a	42.0	37.3	27.6	35.6
1 qt/a	45.0	32.1	33.8	37.0
2 qt/a	46.2	36.2	36.4	39.6
Vista				
0 qt/a	48.6	34.4	27.2	36.7
1 qt/a	49.3	35.2	28.4	37.6
2 qt/a	50.2	31.6	30.0	37.2
2137				
0 qt/a	38.0	33.6	25.0	33.9
1 qt/a	41.3	34.4	25.8	33.8
2 qt/a	43.8	34.7	29.8	36.1
LSD (P<.05)				
Variety	2.5	NS	2.9	1.6
AmiSorb Rate	2.1	NS	2.5	1.4
Variety X AmiSorb Rate	NS	NS	NS	NS
P-Value				
Variety	<.01	0.60	<.01	<.01
AmiSorb Rate	<.01	0.37	<.01	<.01
Variety X AmiSorb Rate	0.90	0.38	0.54	0.59

SOIL FERTILITY RESEARCH
KANSAS RIVER VALLEY EXPERIMENT FIELD

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

L.D. Maddux

Summary

A study was initiated in 1996 to evaluate effects of nitrogen (N) application time and rate on irrigated soybeans. Soybean yields for the 0 N control plot were 71.8 bu/a in 1996, 65.7 bu/a in 1997, and 61.7 bu/a in 1998. Fertigation at the R3 growth stage resulted in slight yield increases of 2.0 and 3.0 bu/a in 1996 and 1998, but these were not statistically significant at the 5% probability level. Fertigation at R5 resulted in no significant yield difference. No significant difference in yield was observed in 1997 with any treatment.

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. In 1996 and 1997, UAN was applied as a fertigation treatment at R1, R3 (beginning pod), and R5 (beginning seed). In 1998, the treatments were changed to apply UAN as fertigation treatments at R3, R5, and R3 + R5. However, because of wet weather during the R5 growth stage, the R5 fertigation treatments were not applied. 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. Grain yields were determined by machine harvesting.

Results

No significant differences in soybean yields because of N application time or N rate occurred in any of the 3 years as shown in Table 1. However, in 1996, we observed a slight trend (2.0 bu/a) to increased yields with fertigation treatments at R1 and R3 growth stages. This same trend was apparent at the 30 lb N/a rate in 1998. No significant differences or trends occurred in the 1997 data. The trends observed in 1996 and 1998 support previous work at Kansas State University indicating that irrigated soybeans with high yield potential can benefit from a small amount of N (20 - 40 lbs/a) applied at the R3 growth stage.

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

N Application Time	N Rate	Yield		
		1996	1997	1998
	lbs/a	----------bu/a-----------		
None	0	71.8	65.7	61.7
UAN, Fertigation, R1	30	73.9	60.6	
UAN, Fertigation, R1	60	73.5	61.8	
UAN, Fertigation, R3	30	72.4	63..3	64.7
UAN, Fertigation, R3	60	75.1	67.1	62.1
UAN, Fertigation, R5	30	74.0	65.6	
UAN, Fertigation, R5	60	69.3	60.5	
LSD(.05)		NS	NS	NS
N Application Time:				
UAN, Fertigation, R1		73.7	61.2	
UAN, Fertigation, R3		73.8	65.2	64.7
UAN, Fertigation, R5		71.6	63.1	
LSD(.05)		NS	NS	
N RATE:				
	30	72.9	63.1	64.7
	60	71.5	63.6	62.1
LSD(.O5)		NS	NS	NS

MACRONUTRIENT FERTILITY AND THE EFFECT OF STARTER FERTILIZER ON AN IRRIGATED CORN/SOYBEAN ROTATION

L.D. Maddux

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 occurred 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 occurred.

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 (1997 & 1998). 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 of preplant 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 in 1997. 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 through 1997.

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, 1996, and 1997; 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. A Gleaner E plot combine was used for harvesting grain.

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.

In 1997, corn yields of 194 bu/a were obtained for both the 120 and 160 lbs N/a treatments (Table 3). Corn yield obtained with starter fertilizer only (12 lbs N/a) was only 92 bu/a. No significant yield differences were observed with the previous P treatments, probably because of the almost 41 lbs P_2O_5/a

applied in the starter to all plots. No corn yield response to K fertilization was observed. However, 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 higher yield with the 120-60-0 treatment vs the 120-60-150 treatment.

Previously applied N of 160 lbs/a resulted in an average soybean yield increase of 3.1 bu/a (Table 2). 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. However, in 1998, no significant yield responses to previously applied N, P, or K were observed.

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, KS[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 corn and soybean yields in a corn-soybean cropping sequence, 1997 & 1998, Topeka, KS[1].

Fertilizer Applied			Yield	
N	P_2O_5[2]	K_2O	Corn, 1997	Soybean, 1998
-------------lbs/a-------------			bu/a	bu/a
0	0	0	93	63.2
0	0	150	95	63.0
0	30	0	101	63.6
0	30	150	87	63.7
0	60	0	86	60.8
0	60	150	89	62.8
120	0	0	200	65.0
120	0	150	181	62.8
120	30	0	189	60.2
120	30	150	208	69.0
120	60	0	195	63.7
120	60	150	190	63.0
160	0	0	203	63.9
160	0	150	177	63.8
160	30	0	184	60.3
160	30	150	205	63.0
160	60	0	191	63.1
160	60	150	204	66.5
80	30	150	187	66.3
240	30	150	206	65.8
LSD(.05)			27	4.8
NITROGEN MEANS:				
0			92	62.9
40			194	64.0
160			194	63.5
LSD(.05)			19	NS
PHOSPHORUS MEANS[2]:				
	0		158	63.6
	30		162	63.3
	60		159	63.3
LSD(.05)			NS	NS
POTASSIUM MEANS:				
		0	160	62.7
		150	159	64.2
LSD(.05)			NS	NS

[1] Fertilizer applied to corn in 1983, 1985, 1987, 1989, 1991, 1993, and 1995 and to soybeans for 11 years prior to 1983. N & K treatments applied to corn in 1997

[2] P treatments not applied in 1997. Starter fertilizer of 10 gal/a of 10-34-0 was applied to all treatments in 1997 & 1998.

SOIL FERTILITY RESEARCH
SOUTHEAST AGRICULTURAL RESEARCH CENTER

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

D.W. Sweeney

Summary

In 1997, the fifteenth cropping year of a grain sorghum-soybean rotation, tillage and N management systems affected grain sorghum yields. The greatest yields resulted from conventional tillage and anhydrous ammonia. In 1998, soybean yields were not affected by tillage or the residual from N management systems used for the 1997 grain sorghum crop.

Introduction

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

Procedures

A split-plot design with four replications was initiated in 1983, with tillage systems as whole plots and N treatments as subplots. The three tillage systems were conventional, reduced, and no tillage. The conventional system consisted of chiseling, disking, and field cultivation. The reduced-tillage system consisted of disking and field cultivation. Glyphosate (Roundup) was applied each year at 1.5 qt/a to the no-till areas. The four N treatments for the odd-year grain sorghum crops from 1983 to 1997 were a) no N (check), b) anhydrous ammonia knifed to a depth of 6 in., c) broadcast urea-ammonium nitrate (UAN - 28% N) solution, and d) broadcast solid urea. The N rate was 125 lb/a. Harvests were collected from each subplot for both grain sorghum (odd years) and soybean (even years) crops, even though N fertilization was applied only to grain sorghum.

Results

In 1997, grain sorghum yields were affected by tillage in the order of conventional>reduced>no tillage (Table 1). Without N, yields averaged only about 5 bu/a, but all N sources resulted in grain sorghum yields exceeding 60 bu/a. Anhydrous ammonia resulted in greater yield than did urea application. UAN application resulted in yield that was intermediate between those with the other two N sources. In 1998, soybean yields were not affected by tillage or the residual from N fertilization treatments (data not shown).

Table 1. Effects of tillage and nitrogen fertilization on yield of grain sorghum grown in rotation with soybean, Southeast Agricultural Research Center, Parsons, KS.

Treatment	Yield 1997	Yield Avg. 1983-1997
	-------------------- bu/a	--------------------
Tillage		
Conventional	75.3	70.1
Reduced	57.7	67.6
No Tillage	38.7	52.7
LSD $_{(0.05)}$	9.1	
N Fertilization		
Check	4.8	38.4
Anhydrous NH_3	88.3	76.0
UAN Broadcast	64.0	67.4
Urea Broadcast	72.0	71.8
LSD $_{(0.05)}$	17.2	
T x N Interaction	NS	

YIELD RESPONSE OF SHORT-SEASON CORN TO NITROGEN FERTILIZATION AND TILLAGE[1]

D.W. Sweeney and D.J. Jardine

Summary

In 1998, at 30 lb N/a, knife application and ridge tillage resulted in greater short-season corn yield. However, as N rates were increased, yield tended to be greater with broadcast applications but with less difference between tillage systems

Introduction

Corn grown on the upland soils in southeastern Kansas often is stressed by lack of moisture in July and August. However, short-season hybrids reach reproductive stages earlier than full-season hybrids and may partially avoid the periods with high probabilities of low rainfall during mid-summer. Because short-season hybrids were developed in northern climates, research is lacking concerning nitrogen (N) management in conservation tillage systems in southeastern Kansas.

Procedures

The experiment was established in 1996 at a remote site in Crawford County in southeastern Kansas. The experiment was a split plot arrangement of a randomized complete block with four replications, with tillage systems as whole plots and N fertilizer management as subplots. Tillage systems were ridge and no tillage. The N fertilizer management subplot treatments were arranged as a 3x5 factorial including urea-ammonium nitrate (UAN) solution placement method (broadcast, dribble, and knife) and N rate (0, 30, 60, 90, and 120 lb/a). Tillage systems were established in 1995, and N fertilizer treatments were initiated in spring 1996 and continued in 1997. Short-season corn was planted on April 11, 1996; April 23, 1997; and April 17, 1998.

Results

In 1998, the effect of N rate on short-season corn yield interacted with N placement and also with tillage system. At 30 lb N/a, knife application resulted in greater yield than either broadcast or dribble applications (Table 2). However, with 90 lb N/a, greater yield was obtained when the fertilizer was broadcast. At 30 lb N/a, greater yield was obtained in the ridge tillage system than with no tillage (Table 3). With ridge tillage, short-season corn yield was not increased by N rates greater than 60 lb/a. However, with no tillage, 120 lb N/a resulted in greater yields than did N rates of 60 lb/a or less.

[1] Research partially supported by the Kansas Fertilizer Research Fund.

Table 2. Effects of nitrogen rate and placement on yield of short-season corn in 1998, Southeast Agricultural Research Center, Parsons, KS.

N	Yield		
Rate	Broadcast	Dribble	Knife
lb/a	-- bu/a ---------------------------------------		
0	24.5	26.3	30.5
30	45.9	45.8	63.5
60	67.0	69.5	71.3
90	82.1	73.0	68.1
120	77.7	77.1	72.0

$LSD_{(0.05)}$ = 11.5 bu/a

Table 3. Effects of nitrogen rate and tillage on yield of short-season corn in 1998, Southeast Agricultural Research Center, Parsons, KS.

	Yield	
N	Tillage	
Rate	No Tillage	Ridge
lb/a	-------------------------- bu/a ------------------------	
0	24.1	30.1
30	45.3	58.2
60	67.0	71.6
90	71.5	77.3
120	79.3	71.9

$LSD_{(0.05)}$ = 9.5 bu/a

EFFECT OF PREVIOUS RESIDUE MANAGEMENT SYSTEMS ON SUBSEQUENT GRAIN SORGHUM PRODUCTION

D.W. Sweeney

Summary

Across years, the residual effect from long-term burning of wheat straw reduced the yield of the following four grain sorghum crops by more than 6 bu/a, whereas previous nitrogen (N) management for wheat did not have a lasting effect on subsequent grain sorghum. Fertilizing the grain sorghum with 100 lb N/a resulted in 4-year average yields nearly 30 bu/a greater than those of sorghum without N. Within each year, this difference became more pronounced as the time increased since soybean, a legume, had been grown.

Introduction

Double-cropping of soybean after wheat or other small grains is practiced by many producers in southeastern Kansas. Options for dealing with the straw prior to planting the double-cropped soybean include tillage to incorporate it, burning, and no tillage. When these practices are continued long term and then the system is changed, it is uncertain if they will have residual effects on other row crops. Thus, the objective of this study is to determine whether long-term residue and N management systems used for a long-term, wheat — double-cropped soybean rotation will affect subsequent grain sorghum production.

Procedures

Three management systems for wheat straw residue with double-cropped soybean were established in 1983 and continued through 1993: no tillage, disk only, and burn then disk. Additionally, the residue management whole plots were split into two N fertility levels: low — 83 lb N/a and high — 129 lb N/a. Following this long-term, continuous wheat — double-cropped soybean rotation, grain sorghum was grown from 1994 through 1997. Whole and split plots were the residuals of the residue and N management systems used for the wheat — double-cropped soybean rotation. Additionally, these plots were split again to apply either no additional N or 100 lb N/a. Thus, the experiment was a split-split plot including 12 treatments with three replications.

Results

Where double-cropped soybean had been grown after burning the residue in previous years, the average yield of the following four grain sorghum crops was more than 6 bu/a less than where the wheat straw either had been disked or left unincorporated with no tillage (Table 4). Although the previous residue management did not interact with year, the differences in grain sorghum yield appeared more pronounced in the latter years (data not shown). Nitrogen management for the wheat in the previous rotation had no significant effect on the following grain sorghum yield (Table 4). Fertilizing with 100 lb N/a increased average grain sorghum yield by nearly 30 bu/a. A year by N fertilization interaction showed a greater response to N application as the number of years increased since soybean had been grown (data not shown).

Table 4. Effects of previous residue and nitrogen management of wheat — double-cropped soybean and nitrogen fertilization on subsequent grain sorghum, Southeast Agricultural Research Center, Parsons, KS.

Treatment	Average Grain Sorghum Yield (1994-1997)
	------------ bu/a ----------
Previous Residue Management	
Burn then Disk	66.6
Disk Only	74.0
No Tillage	72.9
LSD $_{(0.10)}$	5.0
Previous N Management	
Low — 83 lb N/a	69.8
High — 129 lb N/a	72.6
LSD $_{(0.05)}$	NS
N Fertilization (lb/a)	
0	57.4
100	85.0
LSD $_{(0.05)}$	3.4
Interactions	Year x N Fertilization

EFFECTS OF PREVIOUS CROPPING SYSTEMS AND FERTILIZER NITROGEN ON GRAIN YIELD OF SUBSEQUENT CROPS

K.W. Kelley

Summary

Where no fertilizer N was applied, both corn and grain sorghum yields were influenced significantly by previous wheat double-crop and summer-fallow treatments. Grain yields were highest following sweet clover and the summer-fallow (herbicide) treatment and lowest following double-cropped grain sorghum and double-cropped soybean. However, when fertilizer nitrogen (125 lb N/a) was applied, corn and grain sorghum yields were similar among previous cropping systems, except where corn followed double-cropped grain sorghum. Previous wheat cropping system did not have a significant effect on soybean grain yield. Fertilizer N increased soybean grain yield only slightly (3 bu/a). In the second year of the crop rotation, wheat grain yields were similar following corn, grain sorghum, and soybean where fertilizer N (28% UAN) was knifed below crop residues. Previous wheat double-cropping systems had no significant effect on wheat yields.

Introduction

In southeastern Kansas, producers typically plant double-cropped soybean following wheat, although other crops, such as grain sorghum or sunflowers, sometimes are planted. However, other wheat cropping options can include planting a legume crop, such as sweet clover, in wheat in early spring to improve soil quality or summer-fallowing after wheat harvest, which likely will include mechanical tillage or the use of herbicides to control weeds during the summer. This research seeks to determine the influence of previous wheat double-crop and wheat summer-fallow systems on grain yields of subsequent spring crops (corn, grain sorghum, and soybean) and possible residual double-crop rotation effects on wheat yield in the second year of the crop rotation.

Procedures

In 1996, six cropping systems were established at the Parsons Unit, which included three crops (soybean, grain sorghum, and sunflower) planted no-till after wheat harvest; two wheat summer-fallow treatments (disk tillage versus herbicide only); and one legume crop (white sweet clover) interseeded in wheat in early spring. Roundup herbicide was used to control weeds in the summer-fallow treatment. Double-cropped grain sorghum and sunflowers each received 75 lb/a of fertilizer nitrogen (N) as broadcast ammonium nitrate. In 1997, corn, grain sorghum, and soybeans were planted with conventional tillage in each of the six previous wheat cropping system. A fertilizer nitrogen variable (no N versus 125 lb N/a) also was included for each spring crop. Fertilizer N (28% urea-ammonium nitrate, UAN) was applied preplant at a depth of 4 to 6 in. with a coulter-knife applicator. In the fall, wheat was planted with conventional disk tillage following corn, grain sorghum, and soybean harvests. Fertilizer N (UAN) was applied preplant with the coulter-knife applicator at the 125 lb N/a rate. Phosphorus and potassium fertilizers were broadcast applied and incorporated with tillage prior to the planting of spring crops and wheat in the fall.

Results

Where no fertilizer N was applied, both corn and grain sorghum yields were influenced significantly by previous wheat double-crop and summer-fallow treatments (Table 5). Grain yields were highest following sweet clover and the summer-fallow (herbicide) treatment and lowest following double-cropped grain sorghum and double-cropped soybean. However, when fertilizer N (125 lb N/a) was applied, corn and grain sorghum yields were similar among previous cropping systems, except where corn

followed double-cropped grain sorghum. Plant N analyses (data not shown) indicated that grain yields were influenced largely by differences in plant and soil N availability following the previous wheat cropping systems. Soil samples taken in early spring prior to corn planting showed that residual soil nitrate-N levels were relatively low (less than 20 lbs/a) for all previous wheat cropping systems. However, because grain yield and plant N were highest following sweet clover and for the chemical fallow treatment, results suggest that significant amounts of residual soil N or mineralized plant N were present in the organic fraction of the soil, which became available for plant uptake later in the growing season. Results also indicate that when corn or grain sorghum followed wheat and double-cropped grain sorghum, the fertilizer N requirement was higher than for the other wheat cropping systems because significant amounts of both fertilizer N and soil N likely were immobilized in the decomposing plant residues and unavailable for plant uptake.

Previous wheat cropping system did not have a significant effect on soybean grain yield. Fertilizer N increased soybean grain yield only slightly (3 bu/a).

In 1998, where no fertilizer N was applied, wheat grain yield also was influenced significantly by previous corn, grain sorghum, and soybean crops (Table 6). Grain yields were highest following soybean and lowest following grain sorghum, suggesting that any residual soil N likely was being immobilized to a greater extent following grain sorghum compared to soybeans and corn. However, when fertilizer N (125 lb N/a) was knifed below crop residues, wheat yields were similar among previous crops, indicating that fertilizer N efficiency was significantly increased by placement. Some research studies have shown that previous crop residues can result in early stunting of seedling growth because of an allelopathic effect; however, this effect was not observed in 1997.

Wheat yields were not affected significantly by any of the previous wheat double-crop systems that preceded the full-season summer crops (corn, grain sorghum, and soybean). This study will be continued for three complete cropping cycles to further evaluate residual rotation effects on subsequent crop yields.

Table 5. Effects of previous wheat cropping systems and fertilizer nitrogen on grain yields of subsequent corn, sorghum, and soybean crops, Southeast Agricultural Research Center, Parsons, KS, 1997.

Previous Wheat	Corn Yield		Sorghum Yield		Soybean Yield	
Cropping System	No N	125 N	No N	125 N	No N	125 N
	------ bu/a ------		------ bu/a ------		------ bu/a ------	
Wh-Chemical fallow	118.8	168.3	120.4	134.2	50.6	52.8
Wh-Tillage fallow	95.5	157.9	104.4	132.3	48.3	50.7
Wh-Sweet clover	147.2	166.2	116.7	138.0	50.2	53.3
Wh-Grain sorghum	72.8	147.8	75.5	132.3	46.7	50.2
Wh-Soybean	86.8	165.6	87.3	141.1	47.4	50.1
Wh-Sunflower	97.0	160.5	101.9	137.5	48.7	51.6
Avg*	101.9[b]	161.1[a]	101.0[b]	135.9[a]	48.7[b]	51.4[a]

LSD (0.05):
Comparing subplot N treatments within same previous crop:
corn = 13.0 bu/a; sorghum = 10.3 bu/a; soybean = NS.
Comparing subplot N treatments for different previous crop:
corn = 14.2 bu/a; sorghum = 10.9 bu/a; soybean = NS.
* Fertilizer N means of same previous crop followed by a different letter are significant at the 5% level of probability;
NS = not significant at the 5% level of probability.
Fertilizer N (28% UAN) applied at a depth of 4 to 6 in. with a coulter-knife applicator.

Table 6. Effects of previous cropping systems and fertilizer nitrogen on grain yield of winter wheat, Southeast Agricultural Research Center, Parsons, KS, 1998.

	Wheat Yield following					
Previous Wheat	Corn		Grain Sorghum		Soybean	
Cropping System	No N	125 N	No N	125 N	No N	125 N
	bu/a					
Wh-Chemical fallow	14.6	61.5	9.1	60.1	25.9	59.5
Wh-Tillage fallow	17.6	58.6	10.1	56.9	20.4	62.0
Wh-Sweet clover	16.9	59.6	10.3	60.1	24.1	59.8
Wh-Grain sorghum	16.6	58.6	11.0	59.3	22.9	59.6
Wh-Soybean	17.6	61.5	9.5	58.3	26.5	60.6
Wh-Sunflower	17.8	61.2	10.0	59.7	26.1	59.9
Avg	16.8	60.2	10.0	59.1	24.3	60.2

LSD (0.05):
Comparing previous crop (corn, grain sorghum, soybean) means for same or different fertilizer N rate = 2.0 bu/a
Comparison of previous double-cropping systems (main plot) = NS
Fertilizer N (28% UAN) applied at a depth of 4 to 6 in. with a coulter-knife applicator.
NS = not significant at the 5% level of probability.

SOIL FERTILITY RESEARCH
NORTH CENTRAL AND IRRIGATION EXPERIMENT FIELDS

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

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

Summary

When averaged over nitrogen (N) rates, 1982-1995 yields were 23 bu/a greater in sorghum rotated with soybeans than in continuous sorghum. When no N was applied, rotated sorghum yielded 32 bu/a greater than continuous sorghum. In the continuous system, grain sorghum yield continued to increase with increasing N rate up to 90 lb/a. In the soybean rotation, sorghum yields increased with increasing N rate only up to 60 lb/a. When averaged over N rate, no-tillage grain sorghum rotated with soybeans reached mid-bloom 7 days sooner than continuous grain sorghum. Two knife-applied N sources (anhydrous ammonia and 285 UAN) were evaluated during 1992-1989. No grain sorghum yield differences resulted from N source. The 17-year soybean yield average was 36 bu/a. Soybean yields were not affected by N applied to the previous grain sorghum crop. In 1996, four additional N rates (120, 150, 180, and 210 lb/a) were added to the experiment. When averaged over the period 1996-1998, yields were greater in the rotated system than in the continuous sorghum at all levels of N. Yields in the continuous system continued to increase with increasing N rate up to 90 lb/a. Yields in the rotated system were maximized with application of 60 lb/a N.

Introduction

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

Procedures

This study was established in 1980 at the North Central Kansas Experiment Field, located near Belleville, on a Crete silt loam soil. Data are reported starting in 1982. Treatments included cropping system (continuous grain sorghum and grain sorghum rotated with soybeans) and N rates (0, 30, 60, and 90 lb/a). In 1982-1989, the two N sources anhydrous ammonia and urea-ammonium nitrate solution (28% UAN) were evaluated. Both N sources were knife applied in the middle of rows from the previous year's crop. After 1989, only anhydrous ammonia was used. In each year, N was applied 7-14 days prior to planting. Grain sorghum was planted at the rate of 60,000 seed/a, and soybeans were planted at the rate of 10 seed/foot in 30 inch rows. Soybean yields were not affected by N applied to the previous sorghum crop and, therefore, are averaged over all N rates. In 1996, four additional N rates (120, 150, 180, and 210 lb/a) were added to the experiment in order to further define N response.

Results

In the continuous grain sorghum system, grain yields (1982-1995) continued to

increase with increasing N rate up to 90 lb/a (Table 1). Sorghum yields in the rotated system were maximized with an application of 60 lb/a N. When no N was applied, rotated sorghum yielded 32 bu/a greater than continuous sorghum. When four additional N rates were added, sorghum yields were greater in the soybean rotation than in the continuous system at all levels of N (Table 2). Addition of N alone did not make up yield losses in a continuous production system. Over the 17-year period (1982 - 1998), soybean yields averaged 36 bu/a and were not affected by N applied to the previous sorghum crop (Table 3). When averaged over cropping system and N rate from 1982-1989, yields were 60 and 59, bu/a for anhydrous ammonia and UAN, respectively. When averaged over N rates, the number of days from emergence to mid-bloom was 7 days shorter in the rotated system than in the continuous system (Table 1).

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

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

Table 2. Effects of cropping system and nitrogen rate on grain sorghum yields, Belleville, KS, 1996-1998.

N Rate	Cropping System	Yield 1996	1997	1998	Avg.
lb/a		- - - - - - -	- - - - - -	bu/a - - - - - -	- - - - - - -
0	Continuous	92	51	55	66
	Rotated	120	88	87	98
30	Continuous	110	71	75	85
	Rotated	137	108	115	120
60	Continuous	131	110	118	120
	Rotated	164	128	142	145
90	Continuous	143	121	126	130
	Rotated	163	141	144	149
120	Continuous	148	122	128	133
	Rotated	162	144	145	150
150	Continuous	148	120	127	132
	Rotated	162	143	145	150
180	Continuous	148	121	128	132
	Rotated	162	144	145	150
210	Continuous	148	122	128	133
	Rotated	162	145	145	151
System Means					
	Continuous	134	105	111	117
	Rotated	154	130	134	139
N Rate Means					
0		106	70	71	82
30		124	90	95	103
60		148	119	130	132
90		153	131	135	140
120		155	133	137	142
150		155	132	136	141
180		155	133	137	142
210		155	134	137	142
LSD(0.05)		8	6	6	

Table 3. Yield of soybeans grown in rotation with grain sorghum, Belleville, KS,1982-1998.

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

EFFECTS OF PLACEMENT, RATE, AND SOURCE OF STARTER FERTILIZER CONTAINING POTASSIUM ON CORN AND SOYBEAN PRODUCTION

W.B. Gordon

Summary

Field studies were conducted at the Irrigation Experiment Field, located near Scandia, on a Crete silt loam soil. Starter fertilizer (7-21-7) included two sources of potassium (K): sulfate of potassium (SOP) and potassium chloride KCL). The test also included two placement methods (in-furrow with the seed and 2 inches to the side and 2 inches below the seed at planting) and five application rates (50, 75, 100, 150, 200 lb/a of 7-21-7). A no-starter check plot also was included in the experiment. Sulfur rates were balanced so that all plots received the same amount, regardless of K source. Experiments were conducted with both corn and soybeans. For the corn experiment, nitrogen (N) as urea-ammonium nitrate solution (28% UAN) was applied immediately after planting so that all plots received 200 lb/a N. Soybeans received no additional N. When liquid 7-21-7 starter fertilizer containing KCL was placed in-furrow, grain yield, plant stand, and early-season dry matter were reduced in both the corn and soybean experiments. In the corn experiment, starter fertilizer containing KCL applied at the 100 lb/a rate reduced yield by 12 bu/a compared to the same rate applied 2 x 2. Corn yield was reduced 40 bu/a when starter fertilizer containing KCL was applied in-furrow at the 200 lb/a rate. When starter fertilizer containing SOP was placed in-furrow, a yield reduction was seen only at the 200 lb/a rate. When starter fertilizer containing KCL as the K source was placed in-furrow with soybean seed, yields and plant populations were reduced regardless of rate. Yields and populations of soybean declined when in-furrow rates of 7-21-7 starter fertilizer containing SOP exceeded 100 lb/a.

Procedures

This irrigated ridge-tilled field experiment was conducted at the Irrigation Experiment Field, near Scandia, on a Crete silt loam soil. Analysis by the KSU Soil Testing Lab showed that in the corn experimental area, initial soil pH was 6.4; organic matter content was 2.4%; and Bray-1 P and exchangeable K in the top 6 inches of soil were 43 and 380 ppm, respectively. In the soybean area, soil pH was 6.5; organic matter content was 2.2%; Bray-1 P was 45 ppm, and exchangeable K was 350 ppm in the top 6 inches of soil. The experimental design was a randomized complete block with three factors. Both the corn and soybean tests included starter fertilizer (7-21-7) made with two potassium (K) sources applied either in-furrow or 2 x 2 at five different rates. A no-starter check also was included. The two sources of K were sulfate of potassium (SOP) and potassium chloride (KCL). A liquid 7-21-7 fertilizer was made using ammonium polyphosphate (10-34-0) and either SOP or KCL and was applied at 50, 75, 100, 150, and 200 lb/a. Sulfur was balanced so that all plots received the same amount. Nitrogen as 28% UAN also was balanced on all corn plots to give a total of 200 lb/a. The soybean experiment received no additional N. The corn hybrid Dekalb 632 was planted on 22 April at the rate of 31,000 seed/a. The soybean variety Dekalb CX370RR was planted on 12 May at the rate of 200,000 seed/a in 30-inch rows. Both the corn and soybeans were grown in a ridge-tillage production system. Stand counts were taken 3 weeks after emergence. Whole plant samples (20 plants/plot) were taken at the V-6 stage. The center two rows of each four row plot were harvested for yield determination.

Results

Corn grain yields were affected by a starter fertilizer x placement x rate interaction (Table 4). When SOP was used as the K source in the 7-21-7 starter fertilizer and

placed in-furrow with the seed, grain yields were not different than those with fertilizer placed 2 x 2, except at the 200 lb/a rate. When 200 lb/a of 7-21-7 starter fertilizer was applied in-furrow, yields were 14 bu/a less than when the same rate was applied 2 x 2. Plant population and whole-plant dry weight at the V-6 stage were reduced by an in-furrow application of 200 lb/a 7-21-7 containing SOP. When KCL was used as the K source for 7-21-7 starter fertilizer placed in-furrow, yields were reduced at all application rates compared to the 2 x 2 placement. A 50 lb/a in-furrow application of 7-21-7 containing KCL reduced grain yield by 12 bu/a and plant population by 3,198 plants/a. At the 200 lb/a rate, yields were reduced by 40 bu/a with in-furrow application of starter fertilizer containing KCL.

When starter fertilizer containing KCL was placed in-furrow with the soybean seed, yield and plant population were reduced regardless of rate (Table 5). At the 50 lb/a rate of 7-21-7 containing KCL, yields were 9 bu/a less when fertilizer was placed in-furrow as compared to 2 x 2. At the 200 lb/a rate of 7-21-7 placed in-furrow, yields were reduced by 21 bu/a. Yields and population of soybean declined when in-furrow rates of 7-21-7 starter fertilizer containing SOP exceeded 100lb/a.

In both corn and soybean experiments, in-furrow applications of starter fertilizer containing SOP resulted in less salt injury than those containing KCL. Even at low application rates, in-furrow applications of fertilizer containing KCL reduced plant population and yield.

Table 4. Effects of placement, rate, and potassium source of 7-21-7 starter fertilizer on grain yield, population, and V-6 stage whole plant dry matter uptake of corn, Scandia, KS, 1998.

Source	Placement	Rate of 7-21-7	Yield, 1998	Yield, 1997	Population, 1998	V6 Dry Wt, 1998
		lb/a	- - - bu/a - - -		plants/a	lb/a
		0*	165	185	31405	166
SOP**	In-furrow	50	180	222	31399	305
		75	192	225	31401	325
		100	195	226	31320	322
		150	191	227	30612	320
		200	182	221	27423	228
	2 x 2	50	181	217	31410	320
		75	190	224	31422	369
		100	196	227	31397	370
		150	198	232	31425	380
		200	196	232	31415	378
KCL***	In-furrow	50	170	200	28200	180
		75	168	195	25469	165
		100	165	191	24875	159
		150	164	189	23567	160
		200	158	184	21496	149
	2 x 2	50	182	220	31398	328
		75	188	226	31408	331
		100	195	226	31379	348
		150	198	228	31415	356
		200	198	227	31377	347
CV%			2.0	2.3	1.5	4.0
LSD (0.05)****			8	9	485	22

*No-starter check plot was not included in statistical analysis.
**7-21-7 Starter fertilizer made using sulfate of potassium (SOP) as the K source.
***7-21-7 Starter fertilizer made using potassium chloride (KCL) as the K source.
**** Three-way interaction LSD (placement x rate x K source.

Table 5. Effects of placement, rate, and potassium source of 7-21-7 starter fertilizer on yield, population, and V-6 stage whole plant dry matter of soybeans, Scandia, KS, 1998.

Source	Placement	Rate of 7-21-7	Yield, 1998	Yield, 1997	Population 1998	V-6 Dry Wt., 1998
		lb/a	- - - - bu/a - - - -		plant/a	lb/a
		0*	55	61	195543	220
SOP**	In-furrow	50	59	72	196056	310
		75	60	72	195840	315
		100	58	69	191987	289
		150	50	54	150897	268
		200	45	52	148642	240
	2 x 2	50	58	73	198631	315
		75	58	74	198386	320
		100	57	73	197980	326
		150	57	74	198164	330
		200	56	72	197690	327
KCL***	In-furrow	50	51	56	167854	227
		75	45	51	158975	215
		100	42	51	146896	200
		150	41	51	126785	188
		200	37	51	122189	162
	2 x 2	50	60	67	197896	322
		75	61	73	198325	341
		100	59	73	197964	327
		150	59	73	197836	322
		200	58	72	198253	324
CV%			4.8	5.1	4.0	4.1
LSD (0.05)****			7.0	8.0	9580	25

*No-starter check plot was not included in statistical analysis.
**7-21-7 Starter fertilizer made using sulfate of potassium (SOP) as the K source.
***7-21-7 Starter fertilizer made using potassium chloride (KCL) as the K source.
****Three-way interaction LSD (placement x rate x K source.

RESPONSES OF CORN 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 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 hybrids to starter fertilizer containing a complete complement of nutrients. This study evaluated the response of four corn hybrids (Pioneer 3563, Pioneer 3346, Dekalb 591, and Dekalb 646) to starter fertilizer combinations containing nitrogen (N), phosphorus (P), potassium (K), sulfur (S), and zinc (Zn). The experiment was conducted on a Carr sandy loam soil located in the Republican River Valley near Scandia, KS. 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 24 and 15 bu/a, respectively, compared to the no-starter check. The addition of 10 lb/a S to the starter fertilizer mix resulted in additional yield increases for Pioneer 3346 and Dekalb 591. Additions of K and Zn to the starter fertilizer mix did not result in any additional yield benefit.

Procedures

The ridge-tilled, furrow-irrigated corn study was conducted on a farmer's 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 in the surface 6 inches of soil. The site had been in ridge-tillage for 4 years prior to the establishment of this study. Corn hybrids used were: Pioneer 3563, Pioneer 3346, Dekalb 591, and Dekalb 646. The liquid starter fertilizer treatments used in both experiments are given in Table 6. Starter fertilizer was applied 2 inches to the side and 2 inches below the seed at planting. Corn was planted on 23 April at the rate of 30,000 seed/a. Immediately after planting, N was balanced on all plots to give a total of 200 lb/a. The N source used in the experiment 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

Starter fertilizer containing N and P improved V-6 stage dry matter production of all hybrids tested (Table 7). Additional response was achieved with the inclusion of S. Additions of K and Zn did not result in any further yield increase.

Two hybrids (Pioneer 3563 and Dekalb 646) did not show any yield response to starter fertilizer (Table 8). 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 24 and 15 bu/a, respectively. Inclusion of S in the starter fertilizer mix resulted in an additional 12 bu/a yield increase for Pioneer 3346 and an additional 11 bu/a for Dekalb 591.

Starter fertilizer improved early-season growth in all hybrids included in the experiment. However, this 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 not low in available nutrients, particularly when corn is planted in a high-residue production system.

Table 6. Starter fertilizer treatments on corn, Scandia, KS, 1998.

Treatment	N	P_2O_5	K_2O	S	ZN
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 7. Mean effects of starter fertilizer combinations on V-6 stage whole plant dry weight of corn hybrids, Scandia, KS, 1998.

Hybrid					V-6 Whole Plant Dry Weight
					lb/a
Pioneer 3563					340
Pioneer 3346					332
Dekalb 591					317
Dekalb 646					352
LSD (0.05)					19
Starter Combination					
N	P2O5	K2O	S	Zn	
----------------lb/a-----------------					
0	0	0	0	0	150
30	30	0	0	0	340
30	30	20	0	0	365
30	30	0	10	0	398
30	30	0	0	1	362
30	30	20	10	1	395
LSD(0.05)					22

Table 8. Effects of starter fertilizer combinations on grain yield of corn hybrids, Scandia, KS.

Hybrid	Starter Fertilizer					Yield, 1998	Yield, 1996-1998
	lb/a					bu/a	
Pioneer 3563	N	P_2O_5	K_2O	S	Zn		
	0	0	0	0	0	162	188
	30	30	0	0	0	165	190
	30	30	20	0	0	164	191
	30	30	0	10	0	164	189
	30	30	0	0	1	165	192
	30	30	20	10	1	163	190
Pioneer 3346	0	0	0	0	0	152	149
	30	30	0	0	0	176	185
	30	30	20	0	0	172	182
	30	30	0	10	0	188	199
	30	30	0	0	0	175	185
	30	30	20	10	0	190	199
Dekalb 591	0	0	0	0	0	155	152
	30	30	0	0	0	170	190
	30	30	20	0	0	171	190
	30	30	0	10	0	181	202
	30	30	0	0	1	174	191
	30	30	20	10	1	183	203
Dekalb 646	0	0	0	0	0	162	184
	30	30	0	0	0	165	184
	30	30	20	0	0	164	183
	30	30	0	10	0	165	184
	30	30	0	0	1	163	186
	30	30	20	10	1	166	184
LSD(0.05)						7	8

SOIL FERTILITY RESEARCH
SOUTH CENTRAL EXPERIMENT FIELD

EFFECTS OF AUSTRIAN WINTER PEA WINTER COVER CROP AND NITROGEN RATES ON GRAIN SORGHUM YIELD IN A WINTER WHEAT-COVER CROP-GRAIN SORGHUM CROPPING SYSTEM

W.F. Heer and R.R. Janke

Summary

The 1996 grain sorghum was the first grain crop harvested in the cropping system. The true effects of the winter pea cover crop most likely were not expressed in this first cycle. Limited growth of the cover crop because of weather conditions produced limited amounts of organic nitrogen (N). Therefore, the effects of the cover crop when compared to fertilizer N were less and varied. The rotation is being continued, and the wheat crop was planted for 1998 harvest. The data for the wheat harvest are incomplete at the time of this report and, therefore, are not included. The second cycle of the cover crop was planted in September of 1998.

Introduction

Renewed interest exists in the use of winter cover crops as a means of soil and water conservation, a substitute for commercial fertilizer, and a way to maintain/improve soil quality. One of the winter cover crops that may be a good candidate for the above is winter pea. Winter peas are established in the fall, over-winter, can produce sufficient spring foliage, and are returned to the soil prior to planting of a summer annual (grain sorghum). This plant is a legume, and has potential for adding nitrogen (N) to the soil system. With this in mind, research projects were established at the South Central Experiment Field to evaluate winter peas, sweet clover, and hairy vetch for their ability to supply N to the succeeding grain sorghum crop in comparison to commercial fertilizer N. Only data from the winter wheat-winter pea-grain sorghum cropping system are reported here.

Procedures

The research was conducted at the K.S.U. South Central Experiment Field, Hutchinson. The soil in the experimental area was an Ost loam. The site had been cropped uniformly to wheat prior to starting the cover crop cropping system. The research used a randomized block design and was replicated four times. Cover crop treatments consisted of fall planted winter peas with scheduled termination dates in April and May and no cover crop (fallow). The winter peas were planted on September 14, 1995 at a rate of 35 lb/a in 10-inch rows with a double-disk opener grain drill. Actual dates of termination (DOT) were May 16, 1996 (DOT1) and June 4, 1996 (DOT2). Prior to termination of the cover crop, aboveground biomass samples were taken from a 1 sq m area. These samples were used to determine forage yield (winter pea and other), and forage N and phosphorus (P) content for the winter pea portion. Fertilizer treatments consisted of four fertilizer N levels (0, 30, 60, and 90 lb N/a) both with and without the cover crop . Nitrogen treatments were broadcast applied as NH_4NO_3 (34-0-0) prior to planting of grain sorghum on June 17, 1996. Phosphate was applied at a rate of 40 lbs P_2O_5 in the row at planting. Grain sorghum plots were harvested on November 25 (reps 1 and 2) and December 8, 1996 (reps 3 and 4) to determine grain yield, moisture, test weight, and N and P contents.

Results

Winter pea cover crop and grain sorghum results are summarized in Tables 1 and 2, respectively. Soil conditions at planting of the winter peas were excellent with good moisture. However, the mid-

September planting date was later than desired because of above normal rainfall in late August and early September. After planting, temperatures cooled and limited fall growth of the winter peas.

Fall ground cover ranged from 26 to 36% with no significant differences across treatments (Table 1). The winter months were cool and dry. Thus, growth of the cover crop was limited, and the first date of termination (DOT1) was delayed from early April to May 16. The date of second termination (DOT2) also was delayed from May to June 4 by wet conditions. Winter pea aboveground biomass at DOT1 was about one-half that at DOT2 (Table 1). However, no significant differences in dry matter (DM) production occurred within DOT's. Differences in the percent N in the DM existed in the treatments for DOT2. These differences were not related to the N treatments but to natural occurrence. No N treatments were applied to the cover crop plots prior to termination.

Nitrogen credited to the cover crop ranged from 9.48 to 30.70 lb N/a. These N levels were considered low and did not carry forward to increased grain yield in the grain sorghum crop. Only the no-N treatments with and without the cover crop and the DOT1 no cover crop and cover crop plus 90 lb/a N treatments had significantly lower grain yields (Table 2). Grain sorghum flag leaf N (%) and whole plant N (%) were decreased in the no-N treatments with or without cover crop. The highest flag leaf and whole plant N occurred in the April cover crop plus 90 lb/a N treatment. Thus, the overall effects of the cover crop and N fertilizer on flag leaf and whole plant N and grain yield were not always significant or consistent.

As with other N rate studies on the South Central Field, the first increment of fertilizer N (30lbN/a) had the greatest effect on flag leaf N, whole plant N, and grain yield. Sorghum yields at DOT1 were not significantly different by treatment. At DOT2, 30 lb/a N as fertilizer was needed to produce a sorghum yield comparable to that with the cover crop and no added N. Highest sorghum yields occurred in the DOT1 no-cover crop plus 30 lb/a N and DOT2 cover crop plus 30 and 60 lb/a N treatments.

Table 1. Effects of termination date and nitrogen fertilizer on winter pea growth in a grain sorghum - winter wheat-cover crop rotation, South Central Experiment Field, Hutchinson KS, 1996.

Termination Date	N Rate[1]	Fall Ground Cover[2]	WP DM N	DM Yield	Winter Pea[3] N	Winter Pea[3] P
	lb/a	%	lb/a		%	
May 16	0	33	9.48	302	3.14	0.26
	30	28	12.43	413	3.01	0.22
	60	30	10.26	342	3.00	0.21
	90	36	22.68	717	3.16	0.23
June 4	0	36	19.71	900	2.19	0.27
	30	34	32.40	1200	2.70	0.32
	60	33	23.98	1110	2.16	0.25
	90	26	30.70	1279	2.40	0.30
LSD (P=0.05)		NS		812	0.49	0.04

[1] Nitrogen applied as 34-0-0 after pea termination prior to planting grain sorghum (see Table 2)
[2] Winter pea cover estimated by 6 inch intersects on one 44-foot line transect per plot.
[3] Winter pea oven dry weight, %N, and %P determined from samples taken just prior to termination.

Table 2. Effects of termination date and nitrogen fertilization on grain sorghum in a rotation with winter wheat and cover crop, South Central Experiment Field, Hutchinson KS, 1996.

Termination		Flag Leaf		Whole Plant		Grain		
Date	N Rate[1]	N	P	N	P	N	P	Yield
	lb/a	- - - - - - - -	- - - - - - - -	- - - - - - - -	%	- - - - - - - -	- - - - - - - -	bu/a
April[2] N/pea	0	2.5	0.38	1.1	0.14	1.6	0.26	86.5
	30	2.7	0.44	1.0	0.13	1.6	0.27	93.9
	60	2.8	0.43	1.1	0.11	1.7	0.27	82.6
	90	2.8	0.44	1.2	0.11	1.7	0.25	90.4
April[2] /pea	0	2.4	0.40	0.9	0.11	1.5	0.29	80.2
	30	2.7	0.39	0.9	0.10	1.6	0.26	85.7
	60	2.7	0.38	1.1	0.10	1.7	0.27	90.0
	90	2.9	0.41	1.2	0.14	1.8	0.23	83.8
May[3] N/pea	0	2.1	0.39	0.9	0.13	1.4	0.30	81.4
	30	2.4	0.39	0.9	0.13	1.5	0.28	88.1
	60	2.6	0.40	1.1	0.12	1.6	0.27	90.7
	90	2.6	0.40	1.1	0.11	1.6	0.26	89.6
May[3] /pea	0	2.3	0.40	0.9	0.11	1.4	0.29	85.0
	30	2.5	0.40	1.1	0.12	1.5	0.31	92.4
	60	2.6	0.38	1.2	0.11	1.6	0.26	92.9
	90	2.7	0.41	1.1	0.13	1.6	0.25	90.5
LSD (P=0.05)		0.2	0.02	0.2	NS	0.1	NS	8.9

[1] Nitrogen applied as 34-0-0 after pea termination prior to planting grain sorghum on 17 June.
[2] Early April termination . Actual termination 16 May because of limited growth.
[3] Early May termination. Actual termination 4 June because of delay in April termination.

SOIL FERTILITY RESEARCH
EAST CENTRAL EXPERIMENT FIELD

BIOAVAILABLE PHOSPHORUS LOSSES IN SURFACE WATER AS AFFECTED BY TILLAGE AND PHOSPHORUS FERTILIZATION[1]

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

Summary

Runoff from cropland can add to the nutrient enrichment and eutrophication of surface water bodies. Research was conducted during 1995-1997 to determine which tillage systems and methods of applying phosphorus (P) fertilizer will result in the least losses of bioavailable P in runoff. The tillage and fertilizer systems evaluated were a chisel-disk-field cultivate system, a ridge-till system, and a no-till system. The fertilizer treatments were a P check; 50 lb/a P_2O_5 surface broadcast; and 50 lb/a P_2O_5 preplant, deep-banded. Runoff from natural rainfall was collected during three grain sorghum fertilization and planting periods, 1995-1997. Runoff amounts, averaged across all runoff events collected over 3 yrs, were highest in the ridge-till and no-till systems. Chisel-disk produced the least runoff. Soil and sediment P losses followed the pattern chisel-disk > ridge-till > no-till. Soluble P losses were highest with no-till followed by ridge-till and chisel-disk. Most bioavailable P losses occurred in the conservation tillage systems when the P fertilizer was broadcast and not incorporated. Least bioavailable P losses occurred when P fertilizer was deep-banded or incorporated by tillage. Grain yield was not affected by the tillage treatments. Preplant, deep-banded P increased grain sorghum yield an average 7 bu/a compared to broadcast P. This yield advantage coupled with reduced bioavailable P losses with deep-banded P should provide an incentive for crop producers to subsurface-band P fertilizer.

Introduction

Phosphorus (P) losses in runoff water from cropland can contribute to the nutrient enrichment in lakes, streams, and rivers. High levels of P in runoff water accelerate eutrophication of fresh water bodies, producing water that has undesirable odor and taste for drinking and recreation. Excess P in surface water is a problem in many USA watersheds. Losses of P from cropland occur mainly in two forms, as particulate and soluble P. In fields with full-width tillage, particulate P losses generally predominate. As a result, soil erosion control practices and use of conservation tillage systems have been the major focuses for reducing P losses. Several recent studies, however, have shown that conservation tillage systems can increase losses of soluble P because of nonincorporation of P fertilizers and release of P from decomposition of crop residues on soil surface. Soluble P is significantly more bioavailable than particulate P and is more readily useable by aquatic plants. Particulate P is sorbed by the sediment and organic soil particles and desorbs slowly and only partially in water. These differences in bioavailability, coupled with no expected reduction in runoff with use of conservation tillage systems because of an abundance of claypan soils in eastern Kansas, might mitigate some or all of the sediment P reduction benefits associated with conservation tillage. Best P management practices for reducing bioavailable P losses on these soil types thus may require subsurface placement of P if conservation tillage systems are used. The deeper placement would put the fertilizer P below the critical surface-water soil interface and mixing zone (approximately the top 1

[1]This research was funded by the Kansas Fertilizer Research Fund.

inch of soil, where most P losses occur). It also might benefit crop yield because of reduced soil contact and tie-up of P and better location for root uptake during dry surface soil conditions.

The objective of this study was to differentiate the effects of various tillage systems and P fertilization practices on crop yield and bioavailable P losses in runoff water under eastern Kansas conditions.

Procedures

The study was conducted at the East Central Kansas Experiment Field, near Ottawa, on a 1.0 to 1.5 % slope, somewhat poorly drained, Woodson silt loam soil (fine, montmorillonitic, thermic, Abruptic Argiaquolls). The tillage systems evaluated were chisel-disk-field cultivate (chisel in the fall or late winter, disk in the early spring, and field cultivate prior to planting); ridge-till (with ridges formed in the fall or late winter); and no-till. Also evaluated as subplots in the tillage systems were three P fertilizer treatments: a P check with no P fertilizer applied; 50 lb/a P_2O_5 surface broadcast, and 50 lb/a P_2O_5 preplant, deep-banded (coulter-knifed) at approximately 4-inch depth on 15-inch centers. This rate of P was for two crops, grain sorghum and the following year's soybean crop. Bray P-1 soil test P at the start of this study was in the medium to high range. Liquid 7-21-7 fertilizer was the source of P for all applications. Surface broadcast P in the chisel-disk-field cultivate system was incorporated by the field cultivation before planting. In the ridge-till and no-till systems, broadcast P was not incorporated except for that covered by the planting operations. Grain sorghum and soybean crops were grown in alternate blocks each year. All P runoff data were collected in the sorghum portion of the crop rotation on the previous year’s soybean stubble. Runoffs from five events in 1995, six events in 1996, and seven events in 1997, spanning the period before and after P fertilizer application and grain sorghum planting, were collected. This period is considered most vulnerable to soil erosion and P losses. Areas of 50 sq ft (5 ft x 10 ft) were delimited with metal frames driven approximately 3 inches deep into the ground in each 10 x 50 ft plot. The runoff from within these frames was directed to a sump and then pumped though a series of dividers (five spitters) to determine the volume and to obtain a composite sample. Sediment and the various forms of P losses in the runoff water were measured in all years. Bioavailable P in the runoff was measured by the FeO strip method. Rainfall amounts and dates when runoff was collected are shown in Table 1. The P fertilizer treatments were applied on 11 July 1995, 21 June 1996, and 7 June 1997.

Table 1. Rainfall amounts and runoff collection dates, Ottawa, KS.

Rainfall	Date
1995	
0.80	7-4-95
1.94	7-20-95
1.68	7-31-95
0.72	8-3-95
1.10	8-15-95
1996	
1.75	5-26-96
2.45	6-06-96
2.02	6-16-96
1.85	7-04-96
1.28	7-08-96
2.04	7-22-96
1997	
1.52	5-18-97
1.40	5-25-97
1.40	5-26-97
1.40	5-30-97
0.97	6-13-97
0.98	6-16-97
1.10	7-13-97

Results

<u>Runoff and Soil Loss</u>

The amount of runoff varied with rainfall events, tillage systems, and years. Generally, most runoff occurred with the largest and most intense rainfall events. However, moisture and infiltration differences between tillage systems preceding the rainfall events also influenced runoff amounts.

Runoff, when averaged across all rainfall events and years and across all fertilizer treatments, was highest in the ridge-till and no-till systems and lowest with chisel-disk (Figure 1). This was because tillage in the chisel-disk system dried and loosened the soil prior to rainfall events, which increased infiltration and reduced runoff. The amounts of rainfall that ran off were 18% for the chisel-disk system, 32% for the ridge-till system, and 30% for the no-till system. These higher runoff percentages for the conservation tillage systems differ from some reports of up to 50 % reductions or more in runoff volume with the use of conservation tillage systems on some better drained soils.

Soil losses in the runoff water (Figure 2) generally paralleled rainfall and runoff amounts, but intensity and timing of individual rainfall events and tillage also influenced losses. Overall, soil losses followed the pattern chisel-disk > ridge-till > no-till, suggesting that full-width loosening of the soil surface and incorporation of crop residue result in greater sediment losses than partial (shaving of the ridge at planting in the ridge-till system) or very limited soil and residue disturbance (coulter at planting in no-till). Averaged across all runoff events and years, soil losses were 0.8 ton/a for the chisel-disk system, 0.6 ton/a for the ridge-till system, and 0.3 ton/a for the no-till system. These are roughly 25 and 60% reductions in soil losses, respectively, for the ridge-till and no-till tillage systems, compared to the chisel-disk system.

Phosphorus Losses

Losses of P in the runoff water also varied with rainfall events, tillage system, fertilizer practices, and years. Total P losses when summed across all runoff events and years (Figure 3) were highest with the chisel-disk and ridge-till systems and lowest for no-till. These differences generally parallel soil losses. Most of the total P losses were particulate (sediment) P losses (Figure 4). However, only a small portion of the particulate P was bioavailable, approximately 5% (Figure 5).

Losses of soluble P (that dissolved in the solution phase of the runoff water and considered to be 100% bioavailable) also varied with tillage systems and P fertilizer treatments. Averaged across all runoff events and across all years, soluble P losses (Figure 6) were highest for no-till, intermediate for ridge-till, and least for chisel-disk. The incorporation of the broadcast P fertilizer in the chisel-disk system greatly reduced soluble P losses. In the ridge-till system, where the fertilizer P was only partially covered by the shaving of the ridge at planting, soluble P losses were moderate compared to no P application . In the no-till system, where the broadcast P remained nearly all exposed on the surface of the soil, soluble P losses increased nearly sixfold compared to no P fertilizer applied. In contrast, deep-banded P (coulter-knifed P) increased soluble P losses only slightly. This is because of it's placement below the critical surface soil-runoff water interface and mixing zone.

Total bioavailable P losses (Figure 7) followed the same general loss patterns as soluble P. This was because nearly all of the bioavailable P that was lost was in the soluble P form. On more highly erosive soils, the contribution of bioavailable P from particulate P would be greater. Most all of the bioavailable P losses each year occurred during the first couple of runoff events after the P fertilizer was applied (data not shown) and then diminished significantly with successive runoff events. This pattern of P loss suggests that broadcast P on tilled soil probably also should be incorporated before runoff occurs; otherwise bioavilable P losses could be similar to those for surface P applications in conservation tillage systems.

Grain Yield

Grain yield was not affected by the different tillage systems (data not shown). However, application and placement of P fertilizer significantly influenced grain sorghum yield (Table 5). Deep-banded P increased grain sorghum yield by an average of 7 bu/a compared to broadcast P and by 11 bu/a compared to the P check. These positive yield effects for deep-banded P should provide an incentive for crop producers to subsurface-band P fertilizer, which will also reduced bioavailable P losses in runoff.

Conclusions

The results of this study suggest that on soils where conservation tillage systems do not significantly reduce runoff volume, fertilizer P needs to be subsurface applied to prevent elevated losses of bioavailable P. Suitable methods for applying P fertilizer would be to preplant, deep-band or 2x2, row-band the P fertilizer with the planter. In tilled systems, where fertilizer P was incorporated before runoff occurred, losses of bioavailable P were only slightly increased compared to no P fertilizer applied.

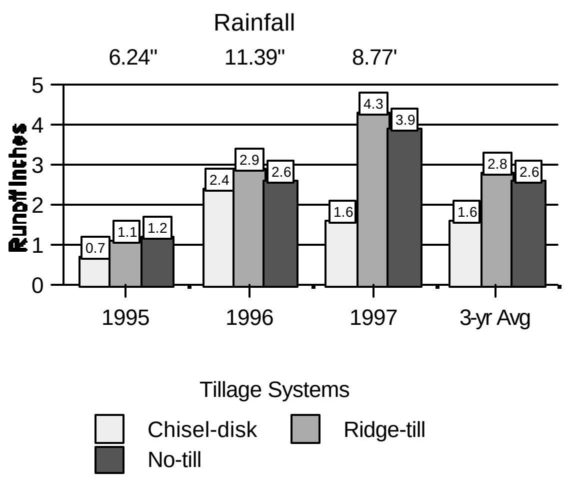

Figure 1. Amount of runoff as influenced by tillage and rainfall in 3 years, Ottawa, KS.

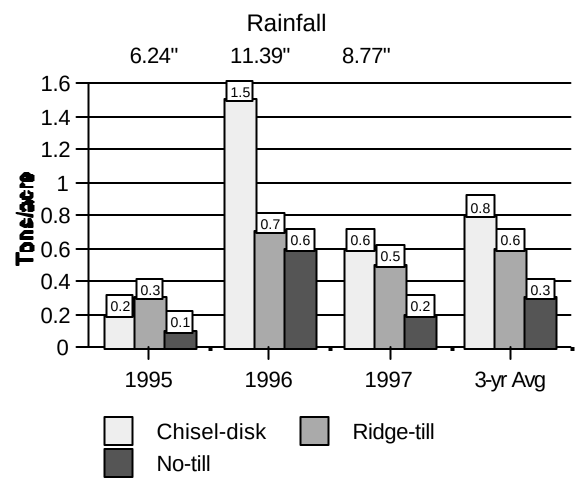

Figure 2. Soil losses as influenced by tillage and rainfall in 3 years, Ottawa, KS.

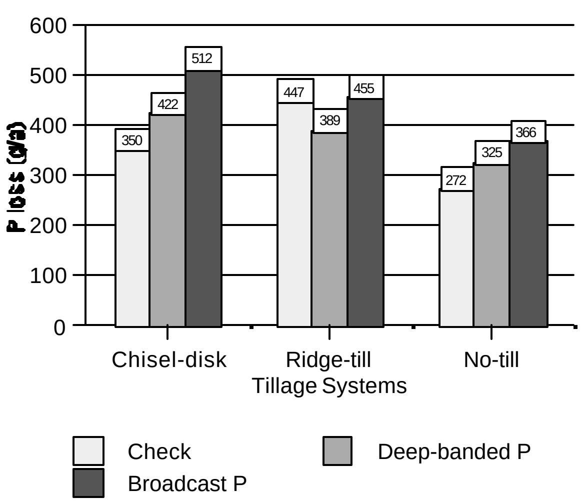

Figure 3. Total P losses (3-yr avg) as influenced by tillage and P rate/placement, Ottawa, KS.

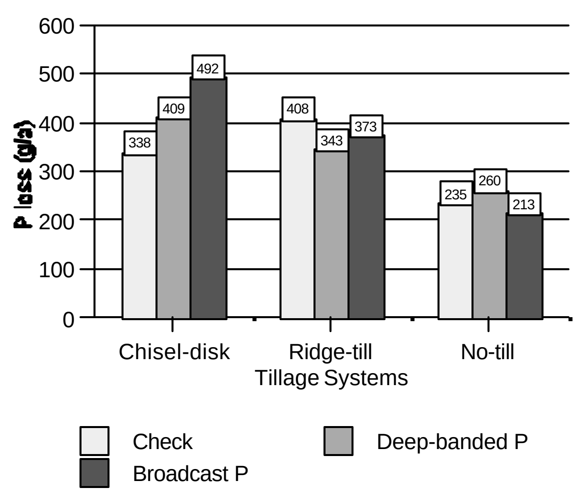

Figure 4. Particulate P losses (3-yr avg) as influenced by tillage and P rate/placement, Ottawa, KS.

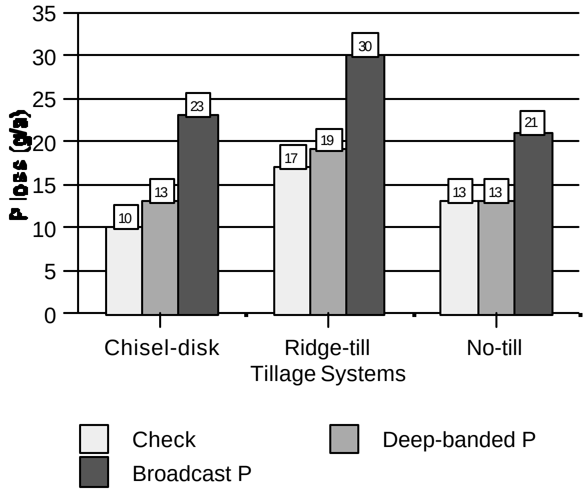

Figure 5. Bioavailable particulate P losses (3-yr avg) as influenced by tillage and P rate/placement, Ottawa, KS.

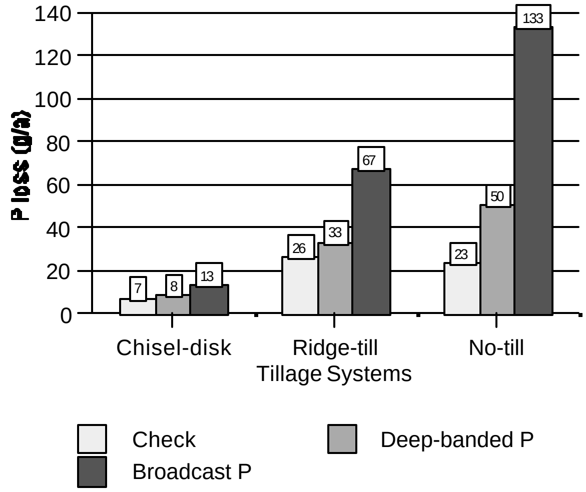

Figure 6. Soluble P losses (3-yr avg) as influenced by tillage and P rate/placement, Ottawa, KS.

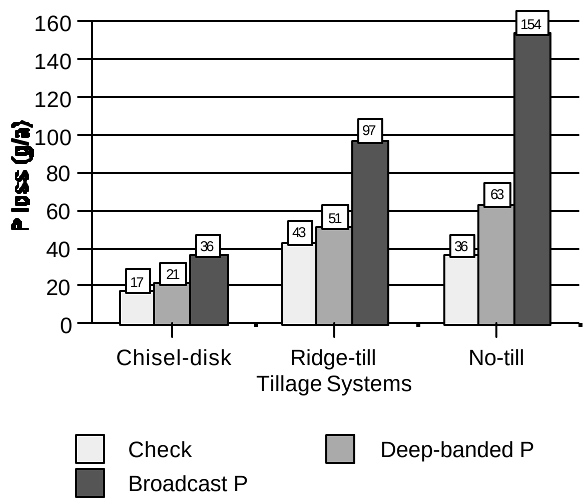

Figure 7. Total bioavailable P losses (3-yr avg) as influenced by tillage and P rate/placement, Ottawa, KS.

Table 2. Phosphorus fertilizer effects on grain sorghum yield, Ottawa, KS.

	Yield			
Phosphorus Treatment	1995[1]	1996	1997	3-Year Avg
		bu/a		
Check-no P	20	91	123	78
50 lb/a P_2O_5 broadcast	22	90	128	80
50 lb/a P_2O_5 preplant, deep banded	28	102	131	87
LSD.05	3	4	3	

[1] Yield for 1995 was significantly reduced because of late planting and a killing early freeze.

SOIL FERTILITY RESEARCH
HARVEY COUNTY EXPERIMENT FIELD

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

M.M. Claassen

Summary

At the end of the first cycle in a vetch-sorghum-wheat rotation, fall residual soil nitrate nitrogen (N) was 4 lb/a higher than in a sorghum-wheat rotation. At the beginning of the second cycle of the rotation, hairy vetch planted in mid-September and terminated on May 14 produced an average dry matter yield of 1.64 ton/a. The corresponding potential N contribution was 94 lb/a for the succeeding sorghum crop. Seasonal environmental factors caused increased variation in treatment effects. Vetch significantly increased sorghum leaf N levels and tended to increase grain yields as well. However, the yield response was not significant. In the absence of fertilizer N, sorghum after vetch yielded about 12 bu/a more than sorghum without a preceding cover crop. The apparent yield enhancement following vetch was equivalent to at least 30 lb/a of fertilizer N. Method of vetch termination did not influence sorghum leaf N level or yield of sorghum. Fertilizer N rate affected leaf N level significantly, but not sorghum yield.

Introduction

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

Procedures

The experiment was established on a Geary silt loam soil with the initial planting of hairy vetch following winter wheat in the fall of 1995. Sorghum was grown in 1996 after vetch had been terminated, and the comparison was made with sorghum in annual rotation with wheat alone. No-till winter wheat without fertilizer was recropped following sorghum. Reduced tillage practices with a disk and field cultivator were used to control weeds and prepare a seedbed. In the second cycle of the rotation, hairy vetch plots were planted on September 16, 1997 at 20 lb/a in 8 in. rows with a grain drill equipped with double-disk openers.

Volunteer wheat was controlled by an April application of Fusilade DX + crop oil concentrate (10 oz/a + 1% v/v). One set of vetch plots was terminated by disking on May 14. Hairy vetch in a second set of plots was terminated at that time with Roundup Ultra + 2,4-D_{LVE} (1 qt + 1.5 pt/a).

Vetch forage yield was determined by harvesting a 1 sq m area from each plot on May 13, 1998. Nitrogen fertilizer treatments were broadcast as ammonium nitrate on June 11, 1998. 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 after a rain delay at approximately 42,000 seeds/a on June 29, 1998. Weeds were controlled with preemergence application of Microtech + AAtrex 90 DF (2.5 qt/a + 0.28 lb/a). Grain sorghum was combine harvested on October 24.

Results

Initial soil nitrate N (0 to 2 ft) averaged 24 lb/a in the sorghum-wheat rotation and 28 lb/a in the vetch-sorghum-wheat system. Because of poor germination, hairy vetch establishment in the fall was limited, with disuniformity in some plots. Average ground cover on November 13, 1997 was 12%. (Table 1). Hairy vetch was beginning to bloom at the time of termination in May. Vetch dry matter yield averaged 1.64 ton/a, with an N content of 2.94%. The average potential amount of N to be mineralized for use by the sorghum crop was 94 lb/a.

Disking to terminate hairy vetch growth did not adversely affect soil moisture at the surface because of subsequent rains, which ultimately delayed planting. Sorghum stands averaged 38,370 plants/a and were relatively uniform across treatments. Fall armyworms caused considerable damage to sorghum leaves. Drouth stress occurred from mid-August through mid-September. At the zero N rate, leaf N at boot to early heading stages was higher in sorghum after vetch than in sorghum without a prior vetch cover crop. This increase was equivalent to that with 30 lb/a of fertilizer N. Method of vetch termination had no effect on leaf N. The overall effect of N rate on leaf N was significant. In sorghum not following vetch, leaf N increased mostly with the first increment (30 lb/a) of fertilizer N, whereas in sorghum after vetch, leaf N increased inconsistently with N rates.

Grain sorghum maturity (days to half bloom) was not affected by any of the treatments. With zero fertilizer N, sorghum after vetch yielded about 12 bu/a more than sorghum without a preceding cover crop. The apparent yield enhancement following vetch was equivalent to at least 30 lb/a of fertilizer N. Nevertheless, when averaged over N rates, the effects of vetch and termination method on sorghum yield were not statistically significant. Yield of sorghum without a prior vetch crop increased by 11 to 14 bu/a with fertilizer N, but most of this occurred with the 30 lb/a rate. Sorghum yields following vetch showed no response to N fertilizer. The overall effect of N rate on yield was not significant.

Table 1. Effects of hairy vetch cover crop, termination method, and N rate on grain sorghum after wheat, Hesston, KS, 1998.

Cover Crop/ Termination	N Rate[1]	Initial Soil NO_3-N[2]	Fall Ground Cover[3]	Vetch Yield[4] Forage	Vetch Yield[4] N	Grain Sorghum Stand	Grain Sorghum Half[5] Bloom	Grain Sorghum Leaf N[6]	Grain Sorghum Grain Yield
	lb/a	lb/a	%	ton/a	lb	1000's/ a	days	%	bu/a
None	0	25	--	--	--	38.8	57	2.45	66.6
	30	25	--	--	--	37.9	56	2.62	77.9
	60	25	--	--	--	37.5	56	2.63	80.3
	90	22	--	--	--	38.4	56	2.67	79.1
Vetch/Disk	0	27	15	1.89	119	39.1	56	2.67	79.6
	30	25	10	1.36	78	38.5	56	2.65	66.6
	60	30	18	1.95	106	38.0	56	2.85	77.9
	90	29	13	1.57	77	37.8	56	2.66	79.8
Vetch/No-till	0	29	10	1.88	110	39.2	56	2.62	77.1
	30	27	14	1.75	107	37.1	56	2.82	72.5
	60	33	10	1.56	85	38.7	56	2.65	81.4
	90	28	13	1.35	77	38.5	56	2.78	70.4
LSD .05		NS	NS	NS	NS	1.3	NS	0.13	NS
Means: Cover Crop/ Termination									
None		24	--	--	--	38.1	56	2.59	76.0
Vetch/Disk		28	14	1.69	95	38.3	56	2.71	76.0
Vetch/No-till		29	12	1.63	95	38.4	56	2.72	75.4
LSD .05		3	NS	NS	NS	NS	NS	0.07	NS
N Rate									
0		27	13	1.88	115	39.0	56	2.58	74.5
30		26	12	1.56	93	37.9	56	2.70	72.3
60		29	14	1.75	96	38.1	56	2.71	80.0
90		26	13	1.46	77	38.2	56	2.70	76.4
LSD .05		NS	NS	NS	NS	0.75	NS	0.08	NS

[1] N applied as 34-0-0 on June 11, 1998.
[2] Mean nitrate nitrogen at 0 - 2' depth on Sept. 16, 1997, 1 day before hairy vetch planting.
[3] Estimated by 6" intersects on one 40' line transect per plot on November 13, 1997.
[4] Oven dry weight and N content on May 13, 1998.
[5] Days from planting (June 29, 1998) to half bloom.
[6] Flag leaf at late boot to early heading.

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

M.M. Claassen

Summary

Wheat in annual wheat-sorghum and wheat-vetch-sorghum rotations were compared at nitrogen (N) fertilizer rates of 0 to 90 lb/a. Prior hairy vetch cover crop as well as N rates significantly affected soil nitrate N concentration at the time of wheat planting. Notably, soil nitrate N levels significantly increased only at N rates of 60 and 90 lb/a and only in the rotation involving vetch. Both hairy vetch and N rate significantly increased wheat yield. When averaged over N rates, wheat following vetch-sorghum produced 9 bu/a more than wheat in the rotation without hairy vetch. The residual vetch benefit was equivalent to 28 lb/a of fertilizer N. Wheat after vetch-sorghum appeared to be nearer a maximum yield at 90 lb/a of N than did wheat without a prior hairy vetch crop.

Introduction

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

Procedures

The experiment was established on a Geary silt loam soil with the initial planting of hairy vetch following winter wheat in the fall of 1996. Sorghum was grown in 1997 with or without the preceding cover crop. Variety 2137 winter wheat was no-till planted in 8-inch rows into sorghum stubble on November 8, 1997 at 90 lb/a with 32 lb/a of P_2O_5 fertilizer banded in the furrow. Fertilizer N was broadcast as 34-0-0 on April 6, 1998 at rates equal to those applied to the prior sorghum crop. Wheat was harvested on June 26.

Results

Hairy vetch terminated April 25 and May 14, 1997, respectively produced 2.66 and 2.99 ton/a of dry matter, yielding 147 and 188 lb/a of N potentially available to the sorghum that followed (Table 2). However, the contribution of vetch to the yield of sorghum was equivalent to only 70 and 89 lb/a of fertilizer N. Prior hairy vetch cover crop as well as N rates significantly affected soil nitrate N (0 to 2 ft) at the time of wheat planting. It averaged only 7 lb/a after sorghum. In comparison, it averaged 21 lb/a after vetch-sorghum because of carryover from the highest fertilizer N rates. Date of vetch termination had no effect on soil N. Also, N rates in sorghum without vetch had no effect on residual soil nitrate N. But rates of 60 and 90 lb/a of N resulted in soil nitrate N levels of 22 and 43 lb/a following sorghum after vetch.

Residual effect of hairy vetch on wheat yield was positive and significant, but vetch termination date did not influence wheat yield significantly. When averaged over N rates, wheat yield following vetch-sorghum averaged 38 bu/a, about 9 bu/a more than for wheat with no prior cover crop. In wheat after sorghum without vetch, each 30 lb/a increment of fertilizer N significantly increased yield. This trend suggested that yields were below maximum at the 90 lb/a rate of fertilizer N. In wheat after vetch-sorghum, yields also increased with increasing fertilizer N, but appeared to be

closer to a maximum at 90 lb/a of N. The yield of wheat after vetch-sorghum at the zero N rate indicated a residual vetch benefit equivalent to 28 lb/a of fertilizer N.

Vetch had no significant residual effect on wheat test weight, whole-plant N content at heading, or grain N level. Fertilizer N significantly increased plant N and grain N, with highest levels occurring at the 90 lb/a rate. Wheat test weight decreased somewhat with N rate.

Table 2. Residual effects of hairy vetch cover crop, termination date, and N rate on no-till wheat after grain sorghum, Hesston, KS, 1998.

Cover Crop/ Terminaion[1]	N Rate[2]	Vetch Yield[3] Forage	Vetch Yield[3] N	Sorghum Yield	Initial Soil NO_3-N[4]	Wheat Yield	Wheat Bushel Wt	Wheat Plant N[5]	Wheat Grain N
	lb/a	ton/a	lb	bu/a	lb/a	bu/a	lb	%	%
None	0	--	--	90.8	6	14.8	59.0	1.04	1.75
	30	--	--	97.3	7	21.8	58.5	1.11	1.62
	60	--	--	101.8	7	35.8	57.9	1.35	1.65
	90	--	--	107.0	9	44.0	58.1	1.52	1.78
Vetch-April 25	0	2.75	145	103.3	7	22.4	59.2	1.10	1.73
	30	2.85	157	108.3	9	29.3	58.7	1.12	1.62
	60	2.45	148	101.8	26	46.7	57.7	1.50	1.72
	90	2.58	138	105.4	45	48.8	57.5	1.69	1.89
Vetch-May 14	0	3.11	215	106.4	7	24.5	59.2	1.08	1.72
	30	3.08	155	110.5	16	34.9	58.6	1.25	1.64
	60	3.28	210	111.4	17	43.6	58.1	1.48	1.71
	90	2.47	173	107.0	40	51.1	57.1	1.77	1.86
LSD .05		0.53	68	8.8	13	5.5	0.50	0.25	0.10
Means: Cover Crop/ Termination									
None		--	--	99.2	7	29.1	58.4	1.25	1.70
Vetch-April 25		2.66	147	104.7	22	36.8	58.3	1.35	1.74
Vetch-May 14		2.99	188	108.8	20	38.5	58.2	1.40	1.73
LSD .05		0.27	34	4.4	6	2.8	NS	NS	NS
N Rate									
0		2.93	180	100.2	7	20.6	59.1	1.07	1.73
30		2.97	156	105.4	11	28.7	58.6	1.16	1.62
60		2.87	179	105.0	17	42.1	57.9	1.44	1.69
90		2.53	155	106.4	32	48.0	57.6	1.66	1.84
LSD .05		NS	NS	NS	7	3.2	0.3	0.14	0.06

[1] Hairy vetch planted in mid-September, 1996, and terminated the following spring.
[2] N applied as 34-0-0 June 23, 1997 for sorghum and April 6, 1998 for wheat.
[3] Oven dry weight and N content just prior to termination.
[4] Mean nitrate nitrogen at 0 - 2' depth in mid-November, 1997.
[5] Whole-plant N concentration at heading.

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

NITROGEN MANAGEMENT FOR NO-TILL CORN PRODUCTION

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

Summary

Surface-applied urea-containing fertilizers have potential for volatilization and immobilization losses of nitrogen (N), particularly when residue levels are high. Results in 1998 indicate that ammonium nitrate and AgrotaiN (urea with a urease inhibitor) often produced higher leaf N concentrations and grain yields and protein than urea. The poor performance of urea likely was due to volatilization losses of N following fertilizer application.

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 sites were established in 1998. Nitrogen rates (varied depending on whether the corn was dryland or irrigated) and N sources (urea, AgrotaiN, and ammonium nitrate) were evaluated. AgrotaiN is urea with a urease inhibitor and is available commercially. "Super Urea", which also has AgrotaiN in it, was evaluated at two sites. All N was surface broadcast right after planting. All sites were no-till. Corn was planted in mid to late April.

Leaf samples were taken at 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 determinations of moisture, test weight, and protein.

Results

Corn results are summarized in Tables 1-4.

Corn yields (both dryland and irrigated) were average to excellent at most sites. Yields at Sandyland were reduced by stress during pollination (Table 3). AgrotaiN and ammonium nitrate often produced higher yields and higher grain protein than urea. Super urea also outperformed urea at the two sites where it was tested. All N sources performed similarly at the North Central Field (Table 4), where rainfall was received shortly after N application. The urease inhibitor in AgrotaiN has potential to reduce both volatilization and immobilization by slowing breakdown of urea and allowing it 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.

Results over the past 4 years indicate that ammonium nitrate and AgrotaiN often outperform urea when N is broadcast in high residue, no-till production systems.

The chlorophyll meter shows promise as an in-field N assessment tool. Chlorophyll meter readings correlate well with leaf N concentrations.

Table 1. Effects of nitrogen management of continuous no-till corn, North Agronomy Farm, Manhattan, KS, 1998.

N Rate	N Source	Tassel N	Grain Yield	Grain Protein
lb/a		%	bu/a	%
0	--	2.03	42	7.8
50	Urea	2.36	81	7.5
100	Urea	2.70	105	8.8
150	Urea	3.01	113	9.7
50	AgrotaiN*	2.59	102	7.3
100	AgrotaiN	2.75	117	9.2
150	AgrotaiN	3.01	118	9.8
50	Am. nit.	2.34	84	7.5
100	Am. nit.	2.93	113	9.2
150	Am. nit.	2.88	115	10.0
	LSD (0.10)	0.23	16	0.7
Mean Values:				
N	50	2.43	89	7.4
Rate	100	2.80	112	9.0
	150	2.97	115	9.8
	LSD (0.10)	0.14	8	0.4
N	Urea	2.69	100	8.6
Source	AgrotaiN	2.79	112	8.8
	Am. nit.	2.72	104	8.9
	LSD (0.10)	NS	8	NS

* AgrotaiN is urea + NBPT

Table 2. Effects of nitrogen management of no-till corn following corn, Kansas River Valley Experiment Field, Topeka, KS, 1998.

N	N	Tassel	Grain	
Rate	Source	N	Yield	Protein
lb/a			bu/a	%
0	--	1.69	31	7.8
75	Urea	2.02	71	7.9
150	Urea	2.32	82	7.8
225	Urea	2.60	77	8.6
75	AgrotaiN	2.09	89	8.0
150	AgrotaiN	2.58	101	8.3
225	AgrotaiN	2.52	116	8.9
75	Am. nit.	2.40	94	8.1
150	Am. nit.	2.52	105	9.4
225	Am. nit.	2.66	117	10.0
75	Super urea	2.20	77	8.0
150	Super urea	2.44	98	8.4
225	Super urea	2.66	116	8.8
	LSD (0.10)	0.25	16	0.5
Mean Values:				
N	75	2.18	83	8.0
Rate	150	2.46	97	8.5
	225	2.61	107	9.1
	LSD (0.10)	0.12	8	0.2
N	Urea	2.31	77	8.1
Source	AgrotaiN	2.40	102	8.4
	Am. nit.	2.52	105	9.2
	Super urea	2.43	97	8.4
	LSD (0.10)	0.14	9	0.3

Table 3. Effects of nitrogen management of no-till corn following wheat, Sandyland Experiment Field, St. John, KS, 1998.

N Rate	N Source	Tassel N	Grain Yield	Grain Protein
lb/a			bu/a	%
0	--	2.19	56	6.9
75	Urea	2.47	131	7.8
150	Urea	2.80	129	9.0
225	Urea	2.75	119	9.6
75	AgrotaiN	2.51	126	8.3
150	AgrotaiN	2.92	146	9.3
225	AgrotaiN	2.68	131	9.9
75	Am. nit.	2.78	142	8.2
150	Am. nit.	2.78	130	10.0
225	Am. nit.	2.98	128	10.1
75	Super urea	2.54	139	8.2
150	Super urea	2.81	130	9.7
225	Super urea	2.79	138	10.0
	LSD (0.10)	0.15	17	0.7
Mean Values:				
N	75	2.58	134	8.1
Rate	150	2.83	134	9.5
	225	2.81	129	9.9
	LSD (0.10)	0.07	NS	0.3
N	Urea	2.67	126	8.8
Source	AgrotaiN	2.71	135	9.2
	Am. nit.	2.85	133	9.4
	Super urea	2.71	136	9.3
	LSD (0.10)	0.09	10	0.4

Table 4. Effects of nitrogen management of no-till corn following corn, North Central Experiment Field, Belleville, KS, 1998.

N	N	Tassel	Grain	
Rate	Source	N	Yield	Protein
lb/a			bu/a	%
0	--	2.56	96	10.4
50	Urea	2.55	121	10.7
100	Urea	2.51	129	10.8
150	Urea	2.63	128	10.9
50	AgrotaiN	2.57	122	10.6
100	AgrotaiN	2.65	128	10.7
150	AgrotaiN	2.58	134	10.9
50	Am. nit.	2.61	119	10.7
100	Am. nit.	2.60	131	10.6
150	Am. nit.	2.52	131	10.6
	LSD (0.10)	0.16	6	0.3
Mean Values:				
N	50	2.57	121	10.7
Rate	100	2.59	129	10.7
	150	2.58	131	10.7
	LSD (0.10)	NS	4	NS
N	Urea	2.56	126	10.8
Source	AgrotaiN	2.60	128	10.7
	Am. nit.	2.58	127	10.6
	LSD (0.10)	NS	NS	0.2

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 1998 indicate that no-till and conventional tillage performed similarly. Nitrogen sources performed similarly in conventional tillage, but urea performed poorly in no-till. Ammonium nitrate and AgrotaiN outperformed urea in no-till. Apparently, N efficiency was reduced by volatilization losses from urea under no-till conditions. Yields were good in 1998, and both yields and grain protein were increased by N application.

Introduction

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

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

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 28, July 31, and October 13, respectively.

Results

Results are summarized in Table 5. 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 in no-till, but N sources performed similarly in conventional till. Apparently, N loss via volatilization was significant from urea. Even with the poor performance of urea in no-till, average yields of the two tillage systems were very similar. Seventeen-year average yields show no difference between no-till and conventional tillage at this site.

Table 5. Effects of nitrogen management and tillage on continuous grain sorghum, North Agronomy Farm, Manhattan, KS, 1998.

N Rate	N Source	Tillage	Leaf N	Grain Yield	Grain Protein
lb/a			%	bu/a	%
0	--	No-till	1.90	50	6.1
30	Am. nit.	No-till	2.31	82	6.9
60	Am. nit.	No-till	2.70	92	7.9
120	Am. nit.	No-till	3.11	114	10.7
30	Urea	No-till	2.40	74	6.4
60	Urea	No-till	2.40	91	7.2
120	Urea	No-till	2.80	89	8.7
30	AgrotaiN	No-till	2.38	84	6.9
60	AgrotaiN	No-till	2.45	89	7.7
120	AgrotaiN	No-till	3.02	106	9.5
0	--	Conventional	1.69	46	6.4
30	Am. nit.	Conventional	2.16	72	6.3
60	Am. nit.	Conventional	2.83	104	8.4
120	Am. nit.	Conventional	3.23	91	11.2
30	Urea	Conventional	2.21	70	7.1
60	Urea	Conventional	2.68	101	8.6
120	Urea	Conventional	3.16	96	11.1
30	AgrotaiN	Conventional	2.43	78	7.2
60	AgrotaiN	Conventional	2.70	95	8.2
120	AgrotaiN	Conventional	2.48	96	11.2
LSD (0.10)			0.46	15	0.7
Mean Values:					
N	30		2.32	77	6.8
Rate	60		2.63	95	8.0
	120		2.97	99	10.4
LSD (0.10)			0.20	7	0.3
N	Am. nit.		2.72	93	8.5
Source	Urea		2.60	87	8.2
	AgrotaiN		2.58	91	8.4
LSD (0.10)			NS	7	0.3
Tillage	No-till		2.62	91	8.0
	Conventional		2.65	89	8.8
LSD (0.10)			NS	NS	0.3

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 1998 to evaluate Cl fertilization on dryland corn and grain sorghum. Results from 1998 indicate that Cl fertilization often can increase corn and grain sorghum yields and leaf tissue Cl concentrations, particularly on soils testing less than 20 lb Cl/a. Yield responses also 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 and grain sorghum at several sites. Nitrogen was balanced on all treatments. All fertilizer materials were broadcast just after planting. Leaf samples were taken at tassel/boot stages for Cl analysis. Grain yields were determined.

Results

Yields in 1998 were average to excellent (Tables 6, 7, 8), and some significant yield increases were noted. Positive yield responses occurred at all sites that had 20 lb Cl/a soil test or less. The yield effects at sites with greater than 20 lb Cl/a soil test were nonsignificant. Chloride fertilization significantly increased leaf tissue Cl concentrations at all sites. Both Cl sources performed similarly. Because of these positive results this work will be continued in 1999.

Table 6. Effects of chloride fertilization on corn and grain sorghum, North Agronomy Farm, Manhattan, KS, 1998.

Cl	Cl	Corn		Grain Sorghum	
Rate	Source	Yield	Tassel Cl	Yield	Tassel Cl
lb/a		bu/a	%	bu/a	%
0	--	107	0.12	101	0.06
20	NaCl	114	0.3	106	0.19
40	NaCl	112	0.39	112	0.23
20	KCl	108	0.28	114	0.18
40	KCl	116	0.37	118	0.21
LSD (0.10)		NS	0.06	11	0.04
Mean Values:					
Cl	20	111	0.29	110	0.19
Rate	40	114	0.38	115	0.22
LSD (0.10)		NS	0.04	NS	0.03
Cl	NaCl	113	0.34	109	0.21
Source	KCl	112	0.32	116	0.2
LSD (0.10)		NS	NS	NS	NS
Soil test Cl (0-24 in.), lb/a		24		12	

Table 7. Effects of chloride fertilization on grain sorghum, Marion Co., KS., 1998.							
Cl	Cl	Site A		Site B		Site C	
Rate	Source	Yield	Boot Cl	Yield	Boot Cl	Yield	Boot Cl
lb/a		bu/a	%	bu/a	%	bu/a	%
0	--	62	0.1	63	0.06	87	0.09
20	NaCl	70	0.32	74	0.3	112	0.25
40	NaCl	76	0.48	69	0.47	109	0.33
20	KCl	70	0.29	69	0.26	107	0.15
40	KCl	76	0.42	72	0.38	103	0.26
LSD (0.10)		8	0.07	7	0.06	15	0.07
Mean Values:							
Cl	20	70	0.3	72	0.28	110	0.2
Rate	40	76	0.45	71	0.43	106	0.3
LSD (0.10)		6	0.05	NS	0.04	NS	0.05
Cl	NaCl	733	0.4	72	0.38	110	0.29
Source	KCl	73	0.36	71	0.32	105	0.21
LSD (0.10)		NS	NS	NS	0.04	NS	0.05
Soil Test Cl (0-24 in.), lb/a		16		9		20	

Table 8. Effects of chloride fertilization on corn and grain sorghum, Osage Co., KS., 1998.

Cl	Cl	Corn		Grain Sorghum	
Rate	Source	Yield	Tassel Cl	Yield	Tassel Cl
lb/a		bu/a	%	bu/a	%
0	--	133	0.29	125	0.17
20	NaCl	133	0.38	121	0.25
40	NaCl	137	0.37	130	0.29
20	KCl	133	0.36	129	0.23
40	KCl	133	0.36	122	0.29
LSD (0.10)		NS	NS	NS	0.07
Mean Values:					
Cl	20	133	0.37	125	0.24
Rate	40	135	0.36	126	0.29
LSD (0.10)		NS	NS	NS	0.04
Cl	NaCl	135	0.38	126	0.27
Source	KCl	133	0.36	126	0.26
LSD (0.10)		NS	NS	NS	NS
Soil Test Cl (0-24 in.), lb/a		40		52	

TILLAGE AND NITROGEN SOURCES EFFECTS ON RESIDUAL NITRATE IN THE SOIL PROFILE

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

Summary

This long-term study (9 years) examines the effect of tillage and nitrogen (N) sources on the amount and distribution on NO_3-N in the soil profile. Two tillage systems (no-tillage and conventional tillage) and two N sources (manure and ammonium nitrate at the rate of 150 bu/a) were used for continuous corn production. Soil samples were taken after harvest each year from 1990 to 1998 to a depth of 120 cm. No-tillage tended to reduce residual NO_3-N in the soil profile. Manure significantly ($p<0.05$) reduced soil profile NO3-N.

Introduction

Concern about groundwater contamination has increased because of expanded use of agricultural practices. Tillage is one agricultural activity that affects transport of NO_3-N to groundwater. Fate and movement of NO_3-N under different tillage systems is not sufficiently understood to predict the conditions under which no-tillage (NT) system would inhibit or enhance NO_3-N leaching. The use of manure fertilizer in agricultural systems is another management practice that also impacts NO_3-N in the soil profile. Evidence is conflicting as to which N source, manure or fertilizer, tends to result in less NO_3-N leaching.

Procedure

Field studies were conducted from 1990 to 1996 at the Kansas State University North Agronomy Farm, Manhattan, KS. The soil is a moderately well drained Kennebec silt loam (fine silty, mixed, mesic Cumulic Hapludolls) previously cropped to oats. Two tillage treatments and two N sources applied at a rate of 150 lb N/a were established in 1990. A no-N check treatment was used in each tillage system. The treatments were arranged in a completely randomized split plot design with four replications in a dryland system. The tillage systems were conventional tillage (CT) and no tillage (NT), and N sources were solid cattle manure (manure) and NH_4NO_3 (fertilizer). Corn (hybrid Pioneer Brand 3379) was planted each spring from 1990 to 1995. Soil samples were taken at 0-5, 5-15, 15-30, 30-45, 45-60, 60-75, 75-90, 90-105, 105-120 cm depths after harvest.

Results

Tillage system did not significantly affect the NO_3-N distribution, but N source was significant ($p<0.05$) (Fig.1). A large accumulation of NO_3-N (average across years 9.61 mg NO_3-N kg soil) occurred between 0 and15 cm depths. At lower depths, NO_3-N was influenced markedly by climatic conditions and clay soil content in both tillage systems. In 1993 and 1995, lower amounts of NO_3-N were observed in the profile in all treatments because of high rainfall amounts during May-September (Table 9), indicating denitri-fication or/and leaching below 1.2m (4 ft). When rainfall was normal and lower than normal, NO_3-N accumulated at depths lower than 30 cm with conventional tillage and N fertilizer (NH_4NO_3). The amount of NO_3-N found with manure rarely was different than that for the control (no N) deep in the soil profile. In summary, even though tillage systems were not significantly different, NT resulted in lower residual NO_3-N, throughout the profile. This would lower the risk of potential groundwater contamination. On the other hand, NO_3-N apparently was available for leaching from fertilizer treatment compared to manure, probably because of higher denitrification and buildup of N in manure-treated plots.

Table 9. Rainfall (cm) during the 1990 to 1996 growing seasons and 30-year average at Manhattan, KS.

Month	1990	1991	1992	1993	1994	1995	1996	30-Yr Avg
May	10.0	13.0	4.19	27.8	8.18	37.4	20.2	11.4
June	12.5	5.11	9.42	17.3	14.4	10.6	9.58	13.4
July	17.9	4.70	33.6	44.6	10.3	9.17	8.52	10.6
August	18.0	5.61	5.13	16.8	8.10	7.47	8.18	8.08
September	2.01	4.37	14.2	8.62	1.10	13.7	8.20	10.3

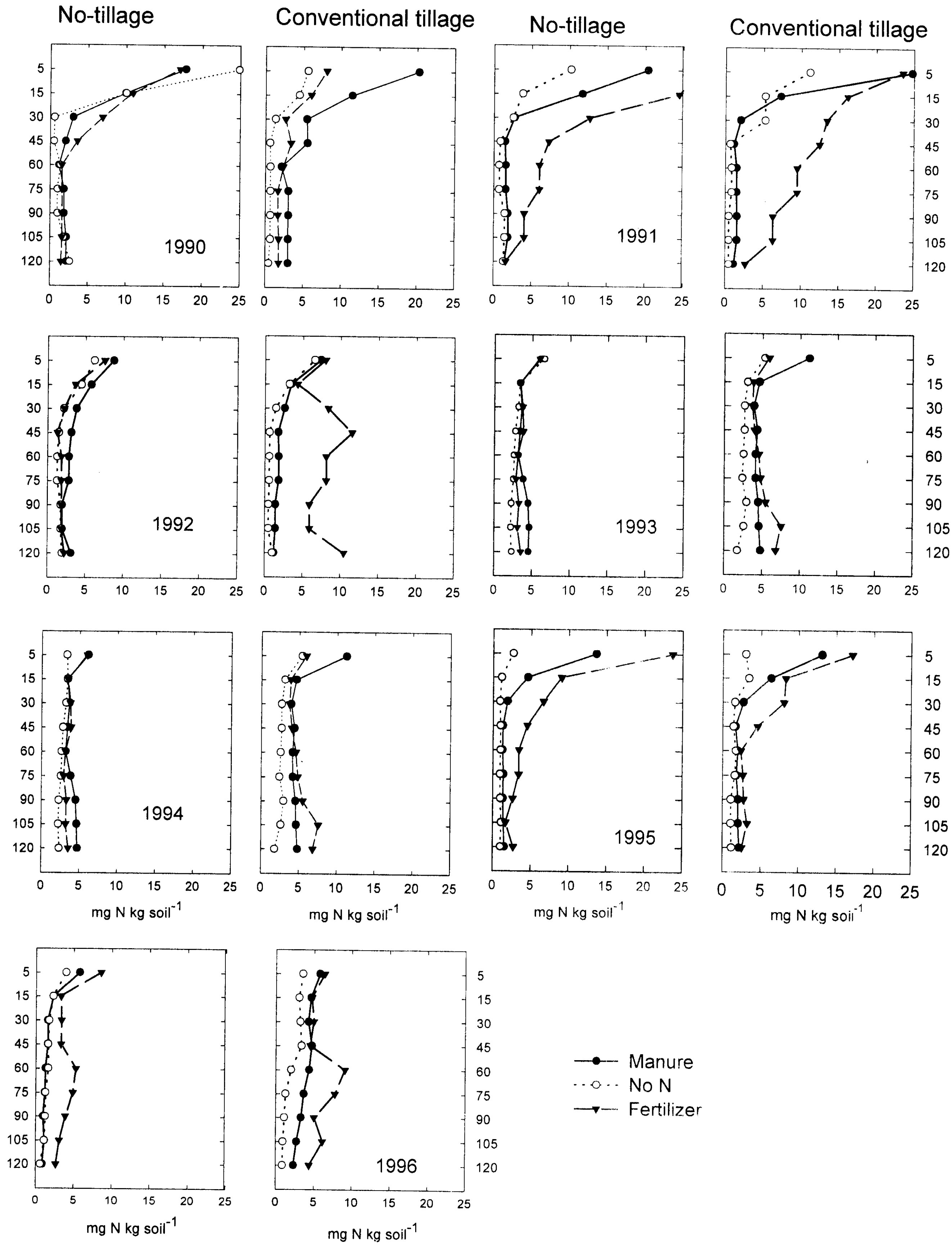

Figure 1. Vertical distribution of residual NO_3-N postharvest from 1990 to 1996, as affected by nitrogen source and tillage, Manhattan, KS.

INFLUENCE OF TILLAGE SYSTEM AND NITROGEN FERTILIZATION ON CORN YIELD

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

Summary

No-tillage (NT) and conventional tillage (CT) and two N sources (manure and commercial fertilizer) were applied for 9 years to a Kennebec silt loam (fine silty, mixed, mesic Cumulic Hapludolls) soil at the North Agronomy Farm, Manhattan, KS. The effects of tillage system and N sources on the amounts and depth distribution of residual NO_3-N were investigated. Conventional tillage tended to increase the amount of NO_3-N in the profile. Fertilizer resulted in significantly ($P<0.05$) higher NO_3-N at depths below 12 in, but no significant difference between manure and fertilizer was found at the soil surface (0-6 in). Therefore, conventional tillage with commercial fertilizer resulted in a higher risk of groundwater contamination.

Introduction

Nitrogen (N) utilization by corn can be influenced by sources and tillage systems. Corn response to N fertilization is different in no-tillage (NT) than in conventional tillage (CT). The differential response is due to soil environmental conditions that affect the relationship between soil N and the crop. Previous studies suggest that at low rates of N fertilization, corn is more N deficient with NT than with CT. Comparisons between manure and fertilizer applications on corn have shown that manure can be more effective in increasing crop production. Effects of the interaction between manure and tillage systems on corn yield and N uptake have been examined less thoroughly. The purpose of this study was to determine the long-term effects of tillage system and N fertilization on corn yields.

Procedures

Field studies were conducted from 1990 to 1998 at the Kansas State University North Agronomy Farm, Manhattan, KS. The soil is a moderately well drained Kennebec silt loam (fine silty, mixed, mesic Cumulic Hapludolls) previously cropped to oats. Two tillage treatments and two N sources applied at two rates of 75 and 150 lb N acre were established in 1990. A no-N check treatment was used in each tillage system. The treatments were arranged in a completely randomized split plot design with four replications in a dryland system. The two tillage systems were conventional tillage (CT) and no-tillage (NT), and the N sources were solid cattle manure (manure) and NH_4NO_3 (fertilizer). Corn (hybrid Pioneer Brand 3379) was planted each spring from 1990 to 1998.

Results

Corn yields responded significantly to N source ($P\leq 0.05$) (Table 10). The average yield with manure and fertilizer across rate of application and tillage systems during the 9 years was 71 bu/a compared to 53 bu/a with no N. The effect of N rate varied with the year. In the first year and from 1993 to 1997, N rate had no significant effects on yield for either tillage system. In 1991 and 1992, a significant increase in yield occurred under NT at the high rate (150 lb N acre). The low corn yields in 1991, 1993, 1996, and 1997 were due to environmental conditions; water was limiting in 1991 and 1997 and excessive in 1993, and wind damaged corn after tasseling in 1996. Corn yield responded to tillage system in 1991, 1992 and 1997, but tillage had no significant effects in the other years. However, CT tended to result in lower yields with manure averaged across years but not for the first 3 years of the study. The difference in corn yields with manure and fertilizer generally was not observed under the NT system.

Increasing amounts of manure did not significantly increase corn yields. However, increasing amounts of fertilizer did. Averaged across years, yields were 79 and 86 bu/a with manure and 85 and 90 bu/a with fertilizer for low and high rates, respectively. These results confirm the conclusion that manure and synthetic fertilizer must be applied according to soil/crop needs. Therefore,

periodic soil testing and/or recommendations based on tests are needed to guarantee that excess of fertilizer is not applied.

In this study, there was no long-term yield difference in tillage systems. Manure, if properly analyzed and applied can support yields without environmental consequences. Long-term application of N fertilizer, has decreased soil pH at the soil surface of NT but does not appear to limit production.

Table 10. Corn yield response over 9 yr. with two rates of manure or fertilizer or no fertilizer in no-tillage and conventional tillage systems, Manhattan, KS.

			Yield									9 - Yr
Tillage Treatment	N Source	N Rate	1990	1991	1992	1993	1994	1995	1996	1997	1998	Avg Yield
		lb/a			--------------------------bu/a--------------------------						
No Tillage	No Nitrogen	0	143	29c	98	42	58	54	31	21	49	58
	Manure	75	151	37c	129	74	100	76	61	40	54	80
		150	148	70a	137	68	86	72	76	37	72	85
	Fertilizer	75	145	47b	131	65	79	101	70	51	72	85
		150	157	56ab	141	90	95	109	77	29	72	92
Conventional	No Nitrogen	0	149	34c	95	52	75	71	59	52	34	69
Tillage	Manure	75	156	34c	114	58	91	85	72	41	51	78
		150	145	48b	136	72	94	89	83	47	61	86
	Fertilizer	75	144	29c	118	77	97	107	87	39	71	85
		150	147	37c	134	53	104	95	100	40	76	87
Tillage x N Source x Rate			NS	*	NS	NS	NS	NS	NS	NS	NS	
No-Tillage			148	48a[¶]	127	63	79	78	64	30	64	
Conventional Tillage			148	33b	119	65	90	87	78	37	58	
Tillage			NS	*	NS	NS	NS	NS	NS	*	*	
No N			146	24b	96b	47b	67b	63c	45b	37	41c	
Manure			150	47a	129a	68a	94a	104a	75a	41	59b	
Fertilizer			147	42a	131a	78a	93a	81b	85a	40	73a	
N Source			NS	*	*	*	*	*	*	NS	NS	
No Nitrogen			146	24c	96b	47	67	63	45	37	41	
Low Manure			153	35b	121a	66	96	81	70	41	51	
High Manure			146	59a	136a	70	90	75	79	42	67	
Low Fertilizer			151	38b	124a	71	88	104	82	45	71	
High Fertilizer			144	46ab	137a	85	100	102	89	35	74	
Rate			NS	*	*	NS	NS	NS	NS	NS	NS	

* Significant at p< 0.05

NS= not significant

Low rate (75 lb N acre) High rate (150 lb N acre)

¶Numbers having different letters in the same columns and the same treatment are significantly different at p<0.05

EFFECTS OF MANAGEMENT SYSTEMS ON DENITRIFICATION

R. Kocyigit, C.W. Rice, and R.E. Lamond

Summary

Soil management can impact N losses by denitrification. Denitrifiers and enzyme activity (DEA) were measured in a tillage-manure experiment after 8 years under continuous corn production. The tillage treatments (no-till and conventional tillage) were treated with either cattle manure or NH_4NO_3 at a rate of 168 kg N ha^{-1}. A no N control also was included. Soil samples were taken before planting in the middle of the growing season, and after harvest. Manure addition increased denitrifier numbers and denitrification activity relative to fertilizer. An interaction between tillage and season resulted in increased potential denitrification under no-till and less response under conventional till after harvest. The denitrification capacity was greater with manure addition.

Introduction

This study was started in 1990 to assess the effects of tillage systems and nitrogen (N) sources on denitrification. Animal manure applied on cultivated land serves as a nutrient source and improves soil quality. Although manure is a valuable N source for crops, it can increase denitrification. Loss of N by denitrification can have positive and negative effects. Denitrification results in a loss of plant-available N. However, denitrification can be beneficial by removing NO_3^- that has leached below the root zone. How manure affects the timing and depth distribution of denitrification is important.

No-till conserves soil and water and improves soil physical properties. However, it can increase water infiltration, thus promoting NO_3^- leaching. No-till also can increase denitrification, which can remove NO_3^- from the soil.

Procedures

The study was located at the North Agronomy Farm in Manhattan KS on a Kennebec silt loam. This was the eighth year of treatments. The field has been under continuous corn production since 1990. No-till (NT) and conventional tillage (CT) systems were used. The N treatments were as follows: no N, 168 kg N ha^{-1} as cattle manure, and 168 kg N ha^{-1} as NH_4NO_3. The treatments were arranged in a completely randomized split plot design with four replications. Inorganic N and soil water contents were measured at all sampling dates. Inorganic N contents (NH_4^+-N and NO_3^- -N) were analyzed using an extraction method at all sampling dates. Moist soils(10 g) were placed in centrifuge bottles with 50 ml 1*M* KCl, shaken for 1 h at 300 RPM on an orbital shaker, and centrifuged for 10 min at 16,000 xg. The supernatant was analyzed calorimetrically on an Alpkem auto-analyzer (Alpkem Corp., Clarkamas, OR). Soil water contents were determined gravimetrically by placing 10 g of soil in tins, drying for 24 h at 105^o C, and reweighing.

Denitrifying enzyme activity also was determined. The stock solution contained 1.8 g L^{-1} glucose, 144.2 mg L^{-1} KNO_3, and 0.225 g L^{-1} chloramphenicol. The sealed serum bottles containing solution and soil samples were made anaerobic by evacuating and flushing with argon (Ar) three times. Bottles were incubated on an orbital shaker at room temperature, and N_2O production from 0 to 30 cm depths were measured four times in a 2 h incubation period. Nitrous oxide production from the subsurface soil (30 to 60 cm) was sampled four times over a 4 h incubation period. Gas samples were taken using a syringe and analyzed by a Tracor 540 gas chromatograph (Tracor Inc., Austin, TX).

Results

Soil inorganic N was measured three times over the year (Fig. 2). The greatest change occurred in the upper 30 cm. Preplant inorganic N in the soil profile was significantly affected by tillage, N source, and depth. The significant interaction between depth and N source was due to higher levels of soil inorganic N in the surface 5 cm with manure application. No significant accumulation of inorganic N occurred at the deeper soil depths with added N.

By June, 5 weeks after N application, soil inorganic N was elevated throughout the soil profile in both tillage systems. All treatment factors and interactions were significant. Enhanced inorganic N was not observed in manure treatments. Apparently, a significant amount of fertilizer N had moved through the soil profile. Also by June, soil N mineralization had increased levels of inorganic N in the control treatment.

After harvest, inorganic N decreased similarly in both NT and CT systems. In NT fertilizer generally resulted in significantly greater inorganic N than the other N sources at all depths except for 15 cm ($P<0.05$). However, in CT, no significant differences occurred between manure and fertilizer through the soil profile. The only significant differences occurred between the control and the other N sources. Nitrate leached into the lower part of the soil profile, with the greatest leaching in the NT fertilized treatment.

Denitrification activity was highest in the manure-treated soil (Fig. 4). Denitrification potential was 359 µg g^{-1} h^{-1} at the surface and decreased substantially with depth. At the 0 - 5 cm depth with NT, manure treatments had significantly higher denitrification activity than fertilizer treatments at all sampling dates ($p<0.05$). The only significant difference between manure and no N treatments was observed in June. With CT, manure significantly increased denitrification activity in April and June probably because of high mineralization of organic matter ($p<0.05$). Also, tillage systems significantly affected denitrification activity in April ($p<0.05$). Denitrifying enzyme activity significantly decreased with depth in both tillage systems. Tillage systems did not affect denitrifying enzyme activity at 5 - 15 cm depth. No significant differences were observed between tillage systems and N sources at 15 - 30 cm. During the growing season, denitrification potential significantly increased at the 30 - 45 cm depth because of high NO_3^- and soluble carbon leaching. No correlation occurred between denitrifying enzyme activity and soil water contents ($r = 0.09$). The apparent denitrification at 30 - 45 cm reduced the potential for NO_3^- to move deeper in the soil profile. The addition of manure further enhanced denitrification, which further reduced the potential for leaching of NO_3^-. Thus, in this soil, manure provided sufficient amounts of N to produce corn yields similar to those with N fertilizer but reduced NO_3^- below the root zone.

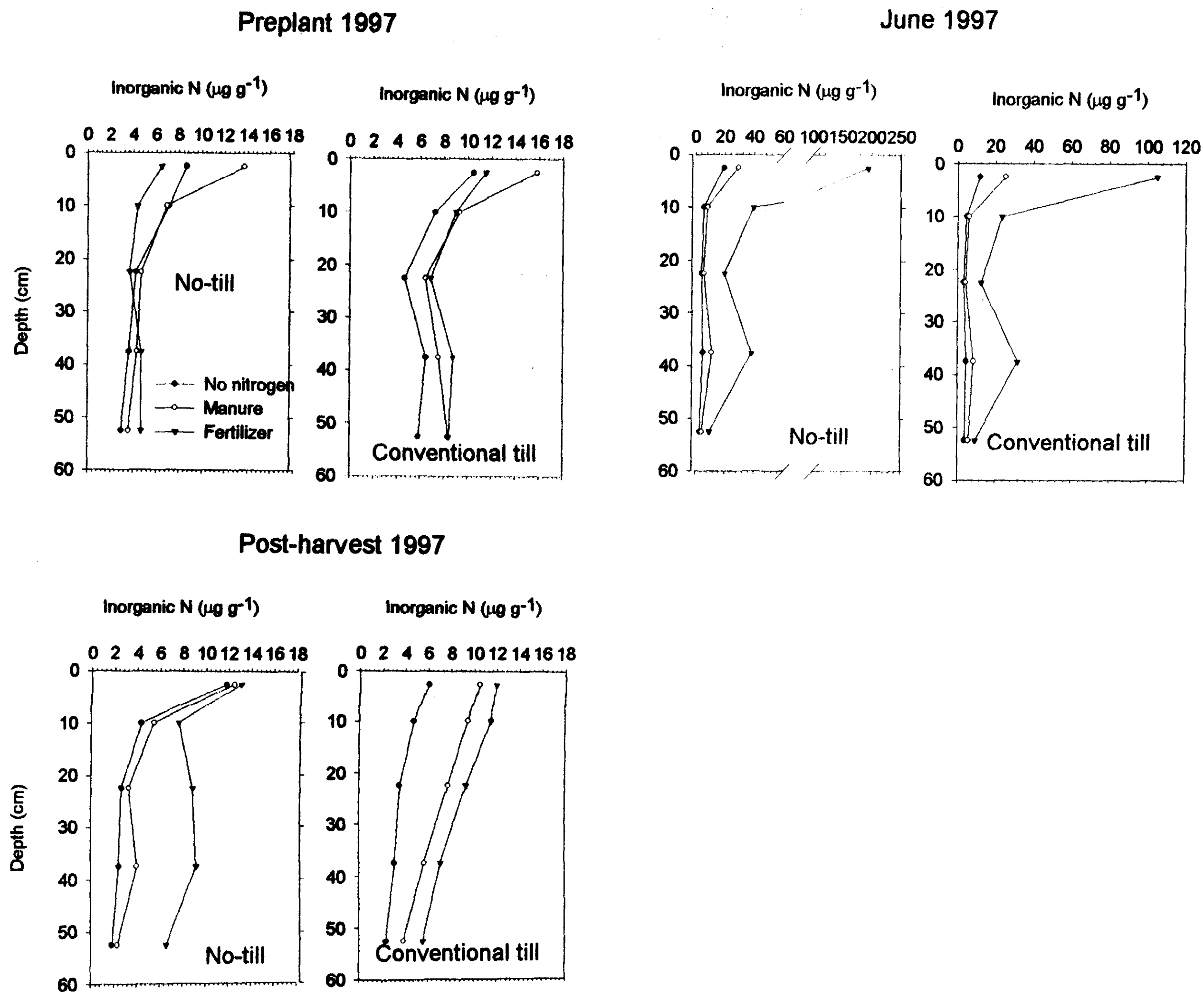

Figure 2. Inorganic nitrogen distribution for the Kennebec silt loam with two tillage systems and two nitrogen sources, Manhattan, KS.

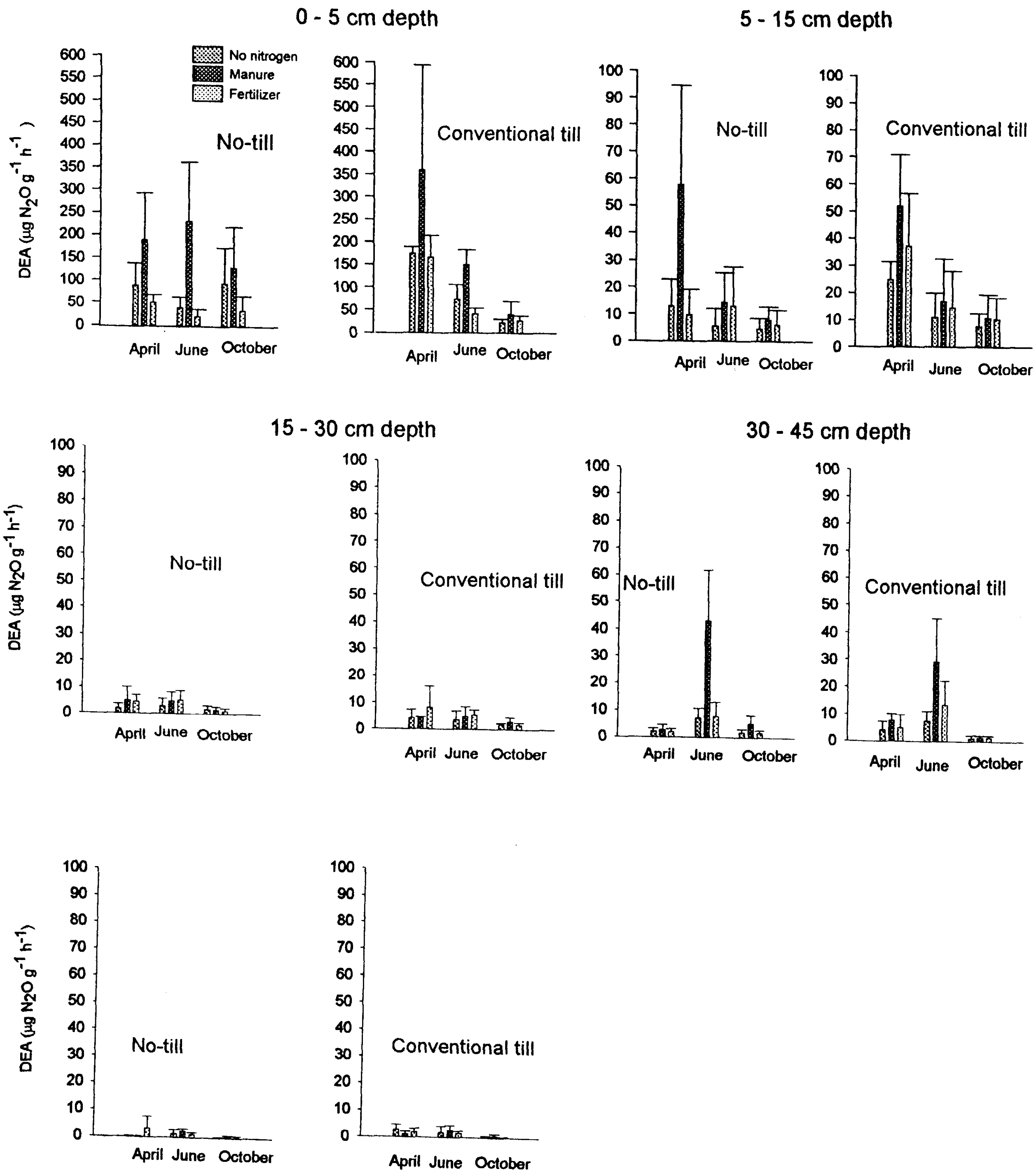

Figure 3. Denitrifying enzyme activity (DEA) for the Kennebec silt loam with two tillage systems and two nitrogen sources, Manhattan, KS.

PHOSPHORUS MANAGEMENT IN SURFACE SOILS WITH STRATIFICATION OF AVAILABLE PHOSPHORUS

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 surface soil phosphorus (P) stratification on wheat and soybean production. We attempted to determine the effects 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 locations (starter, knifed, and broadcast) and a check were used to determine optimal P placement for stratified profiles. At all three sites, after moldboard plowing, available P increased in the 4-6 inch layer and decreased in the surface layer as compared to the conventional and no-till plots. Wheat yields were highest in no-till plots and were increased by the broadcast application of 40 P_2O_5 lbs/a when compared to the knifed treatment. Soybean yields were not affected significantly by P stratification or fertilizer placement.

Introduction

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

Procedures

This was the second year of the P stratification study on three sites in Bourbon County, Kansas. Soil at the Bruner location is classified as a Parsons silt loam, and the George and Wilson sites both have Catoosa silt loams. These sites were selected because soil test P was much greater in the top few inches of the profile than at deeper depths. To study the effect of redistribution, three main-plot tillage treatments were employed: moldboard plow, conventional tillage (disk and field cultivation), and no-till. After the first year, conventional tillage methods were used on both the plowed and conventional plots at the Bruner and Wilson locations but the no-till plots were maintained. These two sites were planted to soybean in 1998 after being in corn and sorghum respectively, in 1997. At the George site (corn in 1997), no-till methods were used for all plots, which were planted to wheat with winter grazing. Soil samples were collected before the first year's tillage operation and after the 1997 harvest at depths of 0 to 2, 2 to 4, 4 to 6, 6 to 9, and 9 to 12 inches. These samples were analyzed for Bray1-P. On each tillage main plot, four P application methods were imposed: 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. These treatments were made each year of the 2-year study. For the two soybean sites, whole plant samples were collected at V3 and leaf samples at R1 to determine nutrient content at each stage. For the wheat site, whole plant samples were collected at the boot stage for dry matter determination and nutrient analysis. Grain yields were measured at maturity (all sites), as well as grain moisture content and test weight. All tissue and grain samples were analyzed for N, P, and K concentrations.

Results

Soil test P results before and after tillage are shown in Table 11. At all three locations, soil test P was reduced in the surface 0 to 2 inches and increased in the 4 to 6 in layer by moldboard plowing. At the George site, plant samples at the boot stage showed lower dry matter production for the 1997 no-till treatments as compared to the plowed treatments; however, grain yields were higher for the no-till plots (Table 12). Yield results suggest that at this soil test P level, stratification is not a problem when wheat is growing.

At both of the locations planted to soybean in 1998, much more dry matter had accumulated by the V3 growth stage in the conventional-tilled plots than in the no-till plots (Tables 13 and 14). Soybeans in plots that received P fertilizer had a higher tissue P concentration than those in the no P check. By the R1 stage, no significant difference in nutrient concentration of the uppermost mature leaf occurred from tillage method. Grain yields were low at both locations because of lack of rain in late July and August, and no significant treatment effect was found.

Table 11. Bray1-P soil test results before and after tillage with depth for the Wilson, Bruner, and George sites, Bourbon Co., KS.

		Before	Tillage[1]		
	Depth	Tillage	No-till	Conventional	Plow
	inches	Bray1-P ppm			
Wilson Site					
	0-2	17	18	15	12
	2-4	12	12	10	9
	4-6	7	9	7	9
	6-9	5	6	6	7
	9-12	4	5	6	5
Bruner Site					
	0-2	16	16	14	8
	2-4	11	9	9	9
	4-6	6	6	7	8
	6-9	4	4	4	5
	9-12	4	4	5	4
George Site					
	0-2	27	20	20	12
	2-4	16	15	15	10
	4-6	5	4	6	11
	6-9	4	3	3	5
	9-12	4	3	3	2

[1]Samples were collected in the fall of 1997 after cropping.

Table 12. Effects of tillage and phosphorus placement (40 lbs P_2O_5/a) on wheat dry matter accumulation and tissue nutrient concentration at the boot stage and grain yield, George site, Bourbon Co., KS.

Tillage	Placement	Boot				Grain Yield
		D.M.	N	P	K	
		lbs/a	%	%	%	bu/a
No-till						
	Check	7244	1.11	0.17	1.24	36
	Broadcast	6908	1.05	0.21	1.25	33
	Knife	5804	1.06	0.20	0.21	27
Conventional						
	Check	7244	1.11	0.18	1.29	32
	Broadcast	6717	1.09	0.18	1.29	39
	Knife	6572	1.08	0.18	1.29	35
Plow						
	Check	8035	1.04	0.17	1.22	41
	Broadcast	6908	1.21	0.20	1.26	38
	Knife	9522	0.95	0.18	1.20	33
LSD (0.1)		1293	NS	NS	NS	5
TILLAGE MEANS:						
	No-till	6652	1.07	0.19	1.23	32
	Conv.	6844	1.07	0.18	1.26	35
	Plow	8155	1.09	0.18	1.23	38
	LSD (0.1)	1170	NS	NS	NS	4
PLACEMENT MEANS:						
	Check	7507	1.09	0.17	1.25	36
	Broadcast	6844	1.12	0.20	1.26	37
	Knife	7299	1.03	0.18	1.20	32
	LSD (0.1)	NS	NS	0.02	NS	4

Table 13. Effects of tillage and phosphorus placement (40 lbs P_2O_5/a) on soybean dry matter accumulation, tissue nutrient concentration at the V3 and R1 stages, and grain yield, Bruner site, Bourbon Co., KS.

Tillage		V3				R1			Grain
	Placement	D.M.	N	P	K	N	P	K	Yield
		lbs/a	%	%	%	%	%	%	bu/a
No-till									
	Check	629	3.9	0.33	1.7	5.3	0.41	1.6	25
	Broadcast	496	3.8	0.36	1.8	5.6	0.44	1.6	24
	Starter	429	4.0	0.37	1.7	5.5	0.42	1.5	25
	Knife	524	3.7	0.34	1.7	5.4	0.40	1.4	25
Conventional									
	Check	723	3.8	0.27	1.5	5.5	0.41	1.4	27
	Broadcast	674	3.8	0.30	1.0	5.4	0.43	1.4	25
	Starter	736	3.5	0.31	1.3	5.5	0.43	1.5	25
	Knife	712	3.8	0.31	1.2	5.4	0.41	1.3	25
Plow									
	Check	678	4.0	0.28	1.6	5.5	0.40	1.5	25
	Broadcast	801	3.7	0.30	1.3	5.5	0.40	1.3	23
	Starter	803	3.6	0.32	1.1	5.5	0.41	1.3	24
	Knife	725	3.8	0.31	1.0	5.5	0.42	1.3	22
LSD (0.1)		102	0.6	0.2	0.4	NS	NS	NS	NS
TILLAGE MEANS:									
	No-till	520	3.8	0.35	1.7	5.5	0.41	1.5	25
	Conv.	709	3.7	0.30	1.3	5.5	0.42	1.4	25
	Plow	752	3.7	0.30	1.3	5.5	0.41	1.3	24
	LSD (0.1)	64	0.1	0.02	0.2	NS	NS	NS	NS
PLACEMENT MEANS:									
	Check	673	3.9	0.29	1.6	5.4	0.41	1.5	26
	Broadcast	657	3.8	0.32	1.4	5.5	0.42	1.4	24
	Starter	655	3.7	0.33	1.4	5.5	0.42	1.4	25
	Knife	653	3.7	0.32	1.3	5.4	0.41	1.3	24
	LSD (0.1)	NS	NS	0.02	NS	NS	NS	NS	NS

Table 14. Effects of tillage and phosphorus placement (40 lbs P_2O_5/a) on soybean dry matter accumulation, tissue nutrient concentration at the V3 and R1 stages, and grain yield, Wilson site, Bourbon Co., KS.

Tillage		V3				R1			Grain
	Placement	D.M.	N	P	K	N	P	K	Yield
		lbs/a	%	%	%	%	%	%	bu/a
No-till									
	Check	437	3.6	0.34	2.1	5.2	0.39	1.8	29
	Broadcast	370	3.2	0.34	2.3	5.2	0.40	1.9	28
	Starter	416	3.4	0.35	2.3	5.3	0.40	1.8	27
	Knife	388	3.8	0.32	2.0	5.3	0.40	1.8	27
Conventional									
	Check	456	3.8	0.31	2.2	5.2	0.36	1.9	28
	Broadcast	541	3.7	0.32	2.0	5.4	0.39	1.7	27
	Starter	453	3.8	0.34	2.3	5.3	0.38	1.9	25
	Knife	512	3.4	0.32	2.2	5.2	0.36	1.8	27
Plow									
	Check	461	4.1	0.31	2.0	5.4	0.37	1.8	26
	Broadcast	515	4.0	0.34	2.2	5.4	0.38	1.9	27
	Starter	524	4.0	0.36	2.2	5.3	0.38	1.8	27
	Knife	475	3.9	0.34	2.1	5.4	0.37	1.8	27
LSD (0.1)		65	0.3	0.2	NS	NS	NS	NS	4
TILLAGE MEANS:									
	No-till	403	3.5	0.35	2.2	5.3	0.40	1.8	28
	Conv.	491	3.7	0.32	2.2	5.3	0.38	1.8	27
	Plow	494	4.0	0.34	2.1	5.4	0.38	1.8	27
	LSD (0.1)	40	0.2	NS	NS	NS	NS	NS	1
PLACEMENT MEANS:									
	Check	451	3.8	0.32	2.1	5.3	0.37	1.8	28
	Broadcast	476	3.6	0.34	2.2	5.3	0.39	1.8	28
	Starter	464	3.8	0.35	2.3	5.3	0.39	1.8	26
	Knife	459	3.7	0.34	2.1	5.3	0.38	1.8	27
	LSD (0.1)	NS	NS	0.02	NS	NS	NS	NS	NS

EFFECTS OF AVAILABLE PHOSPHORUS STRATIFICATION ON CORN

G.J. Schwab, D.A. Whitney, and W.B. Gordon

Summary

A field study was established in Republic County, KS to determine the effects of available phosphorus (P) stratification on corn growth, yield, and nutrient concentration. This site initially had a uniformly low available soil test P throughout the profile. No P or rates of 100 and 200 lbs P_2O_5/a were applied to create stratified main plots. Subplots consisting of three P application methods (starter, knifed, and broadcast) and a check were used to determine optimal P placement for these stratified profiles. In 1997 and 1998, 40 lbs P_2O_5 applied as a starter (2x2) significantly increased V6 dry matter yield as compared to the broadcast P treatment. Grain yields in 1997 were increased by the addition of 40 lbs P_2O_5 applied as a starter as compared to the broadcast and the check. Grain yields in 1998 were not significantly affected by fertilizer placement but were affected by the level of stratification.

Introduction

Stratified soil test P levels have been observed across eastern Kansas as a result of reduced tillage/no-tillage practices. Soil samples from Bourbon and Coffey counties have shown as much as 10 to 20 times higher extractable P in the 0-3 in. depth as compared to the 3-6 in. depth. This study was established in Republic County on a site with a uniformly low level of extractable P in the top 12 in. of the profile. Phosphorus then was surfaced applied to establish a stratified profile. This study method has allowed us to investigate the effects of P stratification without the confounding tillage factors.

Procedures

This irrigated corn site was located in Republic County, Kansas on a Carr fine sandy loam. The study site was selected because the available P level was uniformly low throughout the profile. Phosphorus stratification was created in the spring of 1997 by applying and lightly incorporating 100 and 200 lbs P_2O_5/a (main plots). On each stratified 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 at V6 and leaf samples at early tassel were collected and analyzed for N, P, and K concentrations. Grain yields were taken at maturity and a grain sample was retained for determination of moisture content; test weight; and N, P, and K concentrations.

Results

Soil test P results before and after the establishment of the main plots are listed in Table 15. Available P showed significant increases for the 0-2 and 2-4 in. depths and the 0-2, 2-4, 4-6 and 6-9 in. depths when 100 lbs P_2O_5/a and 200 lbs P_2O_5/a were applied, respectively. Phosphorus applied as a starter consistently increased V6 dry matter production as compared to the knifed application (Table 16). In 1997 at the V6 stage, all placement treatments had higher P concentration than the no P check. No significant stratification by P placement interaction affected grain yield for either year. In 1997, corn yields were increased with a starter application of 40 lbs P_2O_5/a as compared to the broadcast and no P treatments (Table 17). Corn grain yields were not affected significantly by P placement in 1998.

Table 15. Soil test Bray1-P results before and after stratification, Republic Co., KS.

Depth	Before Stratification	Stratification Level (lbs P_2O_5/a)[1] 0	100	200
inches	---------- Bray1-P ppm ----------			
0-2	7	9	32	64
2-4	6	6	18	37
4-6	6	4	7	21
6-9	5	3	5	9
9-12	5	4	4	6

[1] Sampled fall of 1997 after harvest.

Table 16. Effects of tillage and phosphorus placement (40 lbs P_2O_5/a) on corn V6 dry matter accumulation and tissue nutrient concentration at the V6 and tassel stages, Republic County, KS.

Stratification		1997			1998		
		V6		Ear Leaf	V6		Ear Leaf
	Placement	D.M.	P	P	D.M.	P	P
		lbs/a	%	%	%	%	%
No Stratification							
	Check	657	0.24	0.22	615	0.28	0.23
	Broadcast	509	0.30	0.23	502	0.23	0.24
	Starter	844	0.29	0.24	701	0.30	0.25
	Knife	413	0.27	0.23	484	0.27	0.25
100 lbs P_2O_5/a Stratified							
	Check	897	0.33	0.26	679	0.30	0.26
	Broadcast	512	0.38	0.26	592	0.31	0.26
	Starter	843	0.35	0.26	706	0.31	0.27
	Knife	577	0.36	0.28	640	0.28	0.25
200 lbs P_2O_5/a Stratified							
	Check	866	0.36	0.26	773	0.30	0.26
	Broadcast	620	0.39	0.30	694	0.32	0.27
	Starter	843	0.39	0.27	732	0.33	0.27
	Knife	537	0.41	0.29	811	0.32	0.31
LSD (0.1)		126	0.3	0.3	98	0.04	0.03
STRATIFICATION MEANS:							
	No Strat	606	0.28	0.23	576	0.27	0.24
	100 lbs Strat	707	0.35	0.26	655	0.30	0.26
	200 lbs Strat	717	0.39	0.28	753	0.32	0.28
	LSD (0.1)	84	0.2	0.02	61	0.02	0.02
PLACEMENT MEANS:							
	Check	807	0.31	0.25	689	0.29	0.25
	Broadcast	547	0.35	0.27	596	0.29	0.26
	Starter	844	0.34	0.26	713	0.31	0.26
	Knife	509	0.35	0.26	645	0.29	0.27
	LSD (0.1)	90	0.02	0.01	70	NS	NS

Table 17. Effects of tillage and phosphorus placement (40 lbs P_2O_5/a) on corn grain yields and nutrient concentration, Republic County, KS.

Stratification		1997			1998		
	Placement	Yield	N	P	Yield	N	P
		bu/a	%	%	bu/a	%	%
No Stratification							
	Check	157	1.25	0.21	140	1.46	0.21
	Broadcast	175	1.23	0.22	156	1.42	0.21
	Starter	191	1.27	0.23	162	1.39	0.24
	Knife	178	1.22	0.22	153	1.39	0.22
100 lbs P_2O_5/a Stratified							
	Check	184	1.29	0.26	167	1.43	0.23
	Broadcast	183	1.22	0.25	172	1.42	0.26
	Starter	201	1.22	0.25	169	1.42	0.27
	Knife	194	1.24	0.26	168	1.39	0.25
200 lbs P_2O_5/a Stratified							
	Check	188	1.28	0.28	180	1.42	0.26
	Broadcast	201	1.23	0.29	173	1.40	0.28
	Starter	194	1.25	0.28	163	1.40	0.26
	Knife	199	1.25	0.27	168	1.41	0.25
LSD (0.1)		13	0.04	0.01	12	0.04	0.02
STRATIFICATION MEANS:							
	No Strat	176	1.24	0.22	153	1.41	0.22
	100 lbs Strat	191	1.25	0.25	169	1.42	0.25
	200 lbs Strat	196	1.25	0.28	170	1.41	0.26
	LSD (0.1)	8	NS	0.01	8	NS	0.01
PLACEMENT MEANS:							
	Check	176	1.27	0.25	162	1.44	0.23
	Broadcast	186	1.22	0.25	167	1.41	0.25
	Starter	196	1.25	0.26	165	1.40	0.25
	Knife	191	1.24	0.25	163	1.40	0.24
	LSD (0.1)	9	0.03	NS	NS	NS	0.01

STARTER FERTILIZER FOR NO-TILL CORN PRODUCTION

S.A. Staggenborg, B.H. Marsh, L.D. Maddux, and D.A. Whitney

Summary

This no-till planted corn study was initiated to compare phosphorus (P) sources, rates, and methods of application at the Cornbelt Experiment Field. On this low P testing soil, the highest yields were obtained from 10-34-0 at 30 lb/a of P_20_5 placed 2x2 or dual placed with anhydrous ammonia and 6-24-6 at 8 lb/a of P_20_5 in direct seed contact. These three treatments gave significantly higher yields than 30 lb/a of P_20_5 broadcast (no incorporation) and 8 lbs/a of P_20_5 with the seed. Phosphorus fertilizer broadcast and not incorporated was not effective in increasing yield. The data clearly show that placement was critical in getting a response. We hope to repeat this study in 1999.

Introduction

No-till planting of corn and other spring-planted crops often takes place when the seedbed is cool and wet, raising questions about the needs for starter fertilizer. Research at the North Central Experiment Field has shown good response to starter fertilizer by corn and grain sorghum even on soil testing medium or higher in available phosphorus (P). The research also has shown that magnitude of response to the starter has varied among hybrids. The N-P ratio in the starter also has been a factor. Application of starter in direct seed contact using relatively low rates has been promoted by some companies. This study was initiated to evaluate direct seed placement of three P fertilizer materials and to compare direct seed placement to other methods of application.

Procedure

The study was established at the Cornbelt Experiment Field near Powhattan on a Grundy silty clay loam soil. The site was in soybeans in 1997, and the corn hybrid DeKalb DK595 was no-till planted on May 5 at 24,000 seeds/a. A soil sample taken prior to planting showed pH of 5.9, Bray P-1 test of 7 ppm (low), and exchangeable K of 162 (H to VH). Weed control was handled by the experiment field technicians. The P sources used were all liquids - ammonium polyphosphate 10-34-0 and two Alpine products, 9-18-9 and 6-24-6. The three products were used in treatments applied in direct seed contact to supply 8 lb/a of P_20_5. No attempt was made to balance N and K_20 supplied in the starter, but all treatments, except the no fertilizer check, were balanced for total N application at 120 lb/a using anhydrous ammonia applied after planting. In addition to the with-seed starter treatments, 10-34-0 was applied to supply 30 lb/a of P_20_5 either 2x2, broadcast, or dual placed with the anhydrous ammonia. Plots were four 30 in. rows by 30 ft replicated three times. Plots were harvested at maturity using a plot combine, and yields were adjusted to 15.5% moisture.

Results

A tremendous response was obtained to N fertilization (Table 18). Although stand counts were not taken, the direct seed-placed P treatments had no obvious visual effect on emergence or stand. This was not unexpected, because all seed placed-treatments were at less than 10 lb/a of N plus K_20 in direct seed contact, which is within current K-State guidelines for this method. The highest yields were obtained from the 10-34-0 dual and 2x2 and 6-24-6 in direct seed applied. These treatments gave significantly better yields than the broadcast 10-34-0 (not incorporated) and 8 lb/a of P_20_5 placed with the seed as 10-34-0. The data clearly show that starter or dual placement of the P is needed to expect a response on this low testing soil.

Table 18. Effects of phosphorus placement, rate, and source on corn yields at the Cornbelt Experiment Field, Powhattan, KS.

Rate		P	P	Grain
N*	P_2O_5	Source	Placement	Yield
lb/a				bu/a
0	0	--	--	34
120	0	--	--	116
120	30	10-34-0	B'cast	111
120	30	10-34-0	Dual	133
120	30	10-34-0	2x2**	134
120	23	10-34-0	with seed	122
120	8	10-34-0	with seed	113
120	8	9-18-9	with seed	122
120	8	6-24-6	with seed	134
LSD (.05)				18

* Anhydrous ammonia used as N source to balance treatments to 120 lb/a of N
** A 30-30-0 UAN/10-34-0 starter used

NITROGEN SOURCE, RATE, AND APPLICATION TIME FOR SOYBEAN

D.A. Whitney and W.B. Gordon

Summary

Nitrogen (N) application had no effect on mid-season dry matter production or grain yield. At this location, the available N in the soil was adequate for optimum soybean plant growth in the period prior to nodule development. Thus, supplemental N, including polymer-coated urea, was of no benefit.

Introduction

Emerging soybean seedlings are dependent on the nitrogen (N) in the cotyledons and available in the soil for growth until the nodules form. Nodules forming on roots of soybean seedlings do not become fully functional until the V2 to V3 growth stage. If the available N in the soil is quite low, soybean seedlings could experience early season N stress. However, application of readily soluble N sources, such as urea, ammonium nitrate, or UAN, may result in too much available N and suppress nodulation. Pursell Technologies Inc. manufactures a polymer-coated urea (POLYON AG) with a differential release rate. The reactive-layer coating membrane, which encapsulates the urea granule, controls urea release rate by its applied thickness. This slow dissolution rate could be used to control the available N in the soil from early-season application to soybean. The objective of this research was to evaluate polymer-coated urea (PCU) for its effect on early-season growth and yield of soybean.

Procedures

The study was located on the North Central Experiment Field near Belleville on a Crete silty clay loam soil. The site was in corn in 1997, and the stalks were disked prior to soybean planting. The study was planted to soybean variety DK 370 on May 18. Individual plots were four 30 in. rows by 30 ft long. Urea and PCU (43.6% N) were broadcast after planting at rates of 25, 50, and 100 lb/a of N. Additional treatments of urea and PCU at 25 and 50 lb/a of N were broadcast 4 weeks after planting and at the R-1 growth stage. Whole-plant samples were taken at the R-1 growth stage for determining dry matter yield and N and P uptakes from plots receiving N application before that stage. A leaf sample was taken from all plots on August 17 at the R-5.5 growth stage. Grain yields were taken at maturity using a plot combine.

Results

Nitrogen application had no effect on soybean yield or on plant growth (Table 19). A qualitative visual inspection of root systems at 4 weeks after planting revealed similar nodule density for all treatments. Whole plant N, P, and K concentrations at R-1 and leaf concentration at R-5 were not affected by N fertilization. Nitrogen concentrations in the check plots for both sampling dates were at levels considered adequate for normal soybean growth. We plan to repeat the study in 1999.

Table 19. Effects of nitrogen source, rate, and application time on soybean yield and plant composition at the North Central Experiment Field, Belleville, KS.

N	N	Application	Grain	R-1 Whole Plants				R-5.5 Leaf		
Rate	Source	Time	Yield	D.M.	N	P	K	N	P	K
lb/a			bu/a	lb/a	- - - - - % - - - - -			- - - - - % - - - - -		
0	--		43	1310	3.04	.24	2.92	4.93	.30	1.88
25	PCU[1]	at planting	42	1280	3.07	.24	2.97	5.16	.31	1.86
25	Urea		40	1350	3.09	.24	2.95	4.93	.30	1.87
50	PCU		39	1280	3.00	.23	2.91	5.10	.30	1.83
50	Urea		41	1300	3.34	.24	2.90	5.04	.30	1.81
100	PCU		45	1470	3.00	.23	2.92	4.87	.29	1.83
100	Urea		41	1130	3.29	.24	2.86	4.88	.30	1.82
25	PCU	4 wks post	41	1300	3.04	.23	2.89	4.98	.31	1.93
25	Urea		39	1150	3.16	.23	2.81	5.01	.30	1.85
50	PCU		41	1270	3.18	.25	2.92	5.00	.30	1.82
50	Urea		41	1230	3.14	.25	2.93	4.97	.31	1.78
25	PCU	R-1 stage	43					5.19	.31	1.81
25	Urea		40					4.85	.30	1.93
50	PCU		42					4.95	.29	1.91
50	Urea		43					5.00	.30	1.83
LSD (.05)			NS	NS	NS	NS	NS	NS	NS	NS

[1]PCU is polymer-coated urea 43.6% N

SOIL TEST RECOMMENDATION STUDY ANDERSON COUNTY

G.L. Kilgore, J. Zimmerman, and D.A. Whitney

Summary

Fertilizer recommendations from several different laboratories, based upon same soil sample and yield goals, vary considerably. Soil test recommendations from five sources were applied to a field plot in Anderson County. The site was planted to grain sorghum in 1998, and yields were measured. The yield from no treatment was 57.5 bu/a. The highest yield in the fertilized treatments was only 67.8 bu/a, and no difference occurred between the treatments. Fertilizer costs range from $25.75 for KSU recommendations to a high of $47.51 for recommendations from Midwest Laboratories. Return per acre over fertilizer costs was highest for no treatment ($93.15) and lowest for Midwest Laboratory ($54.71). Because of very wet conditions early in the growing season, denitrification may have occurred during that time and resulted in low yields from all fertilized treatments. This study will continue for 4 more years.

Introduction

This study was started in the spring of 1998 to determine the effect of soil test recommendations, based upon the same soil sample and yield goal, from several sources on the yield of crops and changes in soil nutrient contents over several years.

Not all fertilizer dealers or producers use KSU soil test results or even KSU recommendations. Our goal was to determine how those different recommendations affected yields, economic return, and future soil nutrient levels. This study is on-going and will continue for at least 5 years. The results summarized here are for 1998 only.

Procedures

One large composite soil sample 0-6 in. deep was collected from the research area in Anderson County, east of Garnett. The sample was dried, ground, divided, and sent to five different laboratories for analysis and recommendations. We requested recommendations for grain sorghum, corn, soybeans, and wheat with yield goals for each. The fertilizer treatments for whatever crop the farmer decides to plant each year will be applied on each company's plot in three replications. All fertilizer is broadcast and incorporated by the farmer during his seedbed preparation procedure. All tillage, planting, and weed control are done by the cooperating farmer. Plots are hand harvested and threshed in a bundle plot thresher. Soil samples will be taken after each 2-year period of time at 0-3 and 3-6 inch depths.

Results

Recommendations differed among soil testing laboratories. Table 20 gives those recommendations, and Table 21 gives yields and economic return for 1998. Because of low yields and prices, fertilizer didn't pay in this study. We suspect that considerable denitrification occurred during the growing season. On two occasions, over 6 inches of rain fell, and the field was waterlogged for over 10 days during the growing season. With yield responses of less than 10 bushels, we must conclude that something happened to this site.

However, a response that does not happen often was observed. Whether $25.75 or $47.51/a in fertilizer was applied, the farmer lost money. Yields from the no treatment plots returned $93.15/a, whereas the highest cost treatment ($47.51/a) returned only $54.71/a. Of course, these are data from only 1 year, and the study will continue for several more years. In the past, we have seen crops respond to proper fertilization when weather conditions are good and produce higher yields.

Table 20. Soil test laboratory recommendations for grain sorghum, Anderson Co., KS, 1998.

Laboratory	N	P_2O5	K_2O	S	Zn	B
			lb/a			
KSU	110	10	25	-		
Servi-tec	125	0	50	-		
Midwest	110	35	85	10	1.9	0.9
Brummel	100	40	30	-		
Terra	121	58	64	-		

Table 21. Performance and economic return of grain sorghum with soil test recommendations, Anderson Co., KS, 1998.

Item	No Treatment	KSU	Servi-tec	Midwest	Brummel	Terra
Yield, bu/a[1]	57.5	66.5	66.3	63.1	67.8	65.1
Bu. Response to Fertilizer		9.0	8.8	5.6	9.6	7.6
Cost/a Fertilizer[2]	0	$25.75	$29.00	$47.51	$32.70	$45.76
Cost/bu Response		$2.86	$3.30	$8.48	$3.41	$6.02
Return/a over Fertilizer Cost [3]	$93.15	$81.98	$78.41	$54.71	$77.14	$59.70

[1] LSD .05 = 3.6
[2] N = $.18, P_2O_5 = $.27, K_2O = $.13, S (90%) = $.20, B (14%) = $.40, Zn (35%) = $.45
[3] Grain sorghum, $2.90/cwt

CROP

Corn

Forage Grasses, Alfalfa

Grain Sorghum

Soybeans

Wheat

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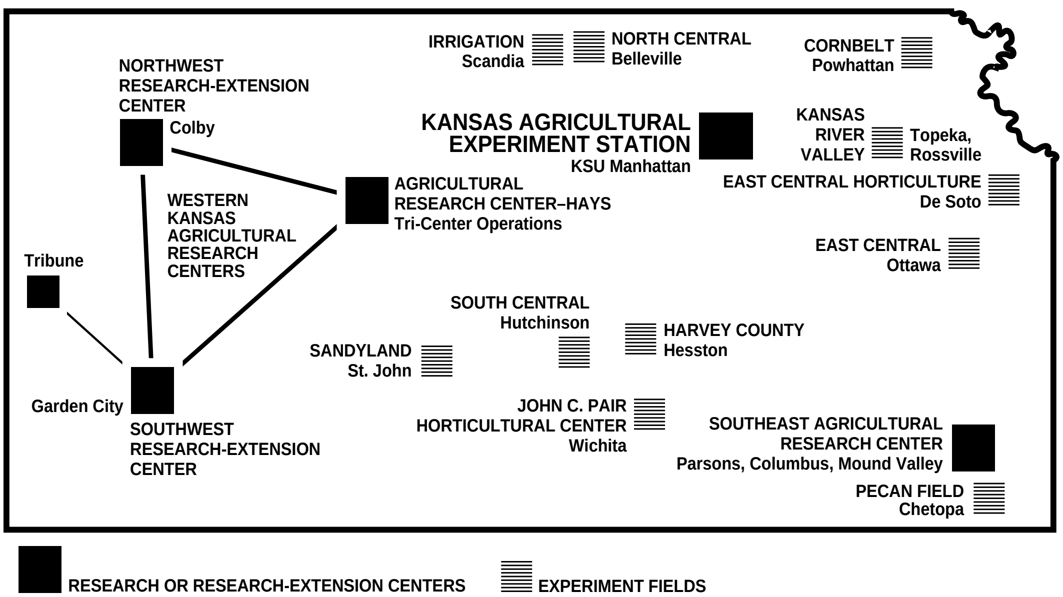

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