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KANSAS FERTILIZER RESEARCH 1999

REPORT OF PROGRESS 847

Kansas State University
Agricultural Experiment Station
and Cooperative Extension Service

INTRODUCTION

The 1999 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.

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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. 00-226-S from the Kansas Agricultural Experiment Station.

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

Precipitation Data (Inches)

1998	Manhattan	S.W.KS RES-EXT.CTR Tribune	S.E.KS AG.RES.CTR. Parsons	E.CEN EXP.FLD Ottawa
August	1.46	1.12	3.42	5.08
September	5.29	0.59	9.02	8.93
October	3.93	1.12	7.92	4.74
November	5.79	1.48	3.58	8.71
December	0.54	0.30	1.76	1.83
Total 1998	40.07	17.49	49.30	48.54
Dept. Normal	7.19	1.83	10.79	10.27
1999				
January	1.46	0.51	1.40	1.71
February	0.51	0.40	2.58	1.01
March	2.05	1.48	3.22	1.35
April	9.52	3.03	7.72	7.11
May	5.17	3.76	6.61	7.27
June	7.50	1.93	8.96	5.45
July	1.80	5.12	1.02	0.52
August	2.49	1.85	0.45	N\A
September	3.82	1.62	4.26	8.43

1998	N.CEN EXP.FLD Belleville	KANSAS.RV VALLEY EXP.FLD.	S.CEN. EXP.FLD. Hutchinson	AG.RES. CNTR. Hays
August	1.54	1.21	0.31	2.42
September	3.12	3.73	3.68	1.17
October	2.49	4.01	3.76	1.21
November	1.46	3.86	5.29	3.10
December	0.42	0.48	0.36	0.17
Total 1998	26.70	30.04	28.94	25.41
Dept. Normal	-0.86	-4.60	1.63	3.58
1999				
January	0.54	0.69	1.66	2.63
February	0.76	0.66	0.09	1.50
March	0.93	0.67	1.50	0.42
April	4.87	6.23	5.35	8.55
May	6.86	4.06	1.99	6.46
June	4.95	3.74	3.76	5.38
July	2.04	0.73	10.22	0.90
August	4.48	0.60	1.83	3.36
September	2.14	3.56	2.18	1.73

WHEAT FERTILIZATION STUDIES
KANSAS STATE UNIVERSITY, DEPARTMENT OF AGRONOMY

EFFECTS OF CHLORIDE RATES AND SOURCES ON WINTER WHEAT IN KANSAS

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

Summary

Research to date on chloride (Cl) shows consistent yield response in Kansas whenever soil Cl is 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 on low Cl soils, even with low disease pressure.

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 1999 in Marion County at two sites. One location was abandoned because of erratic stands caused by heavy October rainfall.

Chloride rates (10, 20 lb/a) and sources (potassium chloride (KCl), magnesium chloride ($MgCl_2$), and sodium chloride (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. Grain yields were determined, and grain samples were retained for analyses.

Results

Grain yields in 1999 were excellent. Chloride fertilization significantly increased yields at both sites (Table 1). The application of 10 lb Cl/a was sufficient to achieve yield response at both sites. Chloride sources performed similarly at Site A, but KCl produced significantly higher yields than $MgCl_2$ at Site B.

Chloride fertilization also significantly increased Cl concentrations in wheat leaf tissue at both sites (Table 1). The 20 lb/a rate resulted in significantly higher leaf Cl than the 10 lb/a rate at both sites.

These results reaffirm earlier work that showed that a wheat yield response is likely when soil Cl levels are less than 20 lb/a.

Table 1. Effects of chloride rates and sources on wheat, Marion Co., KS, 1999.

		Marion Co. "A"			Marion Co. "B"		
Cl Rate	Cl Source	Yield	Test Weight	Leaf Cl	Yield	Test Weight	Leaf Cl
lb/a		bu/a	lb/bu	%	bu/a	lb/bu	%
0	--	65	58	.09	64	60	.05
10	KCl	72	57	.38	78	60	.24
20	KCl	70	57	.44	79	59	.37
10	$MgCl_2$	69	58	.20	73	59	.23
20	$MgCl_2$	73	57	.32	69	60	.31
10	NaCl	72	58	.43	78	60	.27
20	NaCl	69	57	.53	72	60	.43
LSD (0.10)		6	NS	.11	9	NS	.07
Mean Values:							
Cl	10	71	58	.34	77	60	.25
Rate	20	71	57	.46	73	60	.37
LSD (0.10)		NS	NS	.07	NS	NS	.04
Cl	KCl	71	57	.41	79	60	.30
Source	$MgCl_2$	71	58	.28	71	60	.27
	NaCl	70	58	.48	75	60	.35
LSD (0.10)		NS	NS	.09	6	NS	.05
Soil Test Cl (0-24")		18			10		

EVALUATION OF CHLORIDE FERTILIZATION/WHEAT CULTIVAR INTERACTIONS

R.E. Lamond, V.L. Martin, 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 4 years, chloride fertilization significantly increased (P<0.10) wheat yields of one or more cultivars at seven of eight sites. In 1999, 10 of 12 cultivars responded to Cl fertilization at one site and 9 of 12 cultivars responded at the other site. 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 winter wheat cultivars commonly grown in the Great Plains.

Procedures

Studies were continued in Saline and Stafford counties in 1999 to evaluate Cl fertilization/wheat cultivar interactions. Twelve commonly grown winter wheat cultivars were seeded in early October. Chloride as KCl was applied at a rate of 24 lb Cl/a as a February topdressing. Treatments were replicated six times. Nitrogen was balanced on all treatments.

Leaf tissue samples were taken at boot stage and analyzed for Cl content. Grain yields as well as grain test weights were determined. Grain yields were corrected to 13% moisture.

Results

Effects of Cl fertilization and cultivar on wheat grain yield, test weight, and leaf Cl concentrations are summarized in Tables 2 and 3. Chloride fertilization significantly increased plant Cl concentrations at both sites for all 12 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 10 of 12 cultivars in Stafford Co. (Table 2). This site had low soil test Cl (<15 lb/a), and plant Cl concentrations without Cl were 0.12% or less. The addition of Cl at this site also increased grain test weights of several cultivars. Chloride fertilization significantly increased yields of 9 of 12 wheat cultivars in Saline Co. (Table 3). This site also had low soil test Cl (<14 lb/a). The cultivar Ogallala did not respond to Cl at either site. This cultivar has been a consistent nonresponder. 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 12 bu/a in Saline Co. Averaged over all cultivars, Cl increased wheat yields by 6 and 5 bu/a, respectively, at the 1999 sites.

The cultivars Cimarron and Triumph 64 showed classic leaf spotting without Cl. When Cl was applied, the leaf spotting was eliminated.

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.

Table 2. Effects of chloride fertilization on wheat cultivars, Sandyland Experiment Field, St. John, KS, 1999.

		Grain Yield			Test Weight			Leaf Cl		
Cultivar		+Cl*	-Cl	Mean	+Cl	-Cl	Mean	+Cl	-Cl	Mean
			bu/a			lb/bu			%	
Custer		71	66	68	59	56	57	.45	.09	.27
Cimarron		74	57	65	61	60	60	.42	.09	.26
Triumph 64		63	52	58	59	60	60	.37	.10	.23
2163		68	65	67	59	56	58	.42	.09	.26
Ogallala		72	72	72	60	60	60	.26	.11	.18
Karl 92		64	60	62	59	58	58	.36	.10	.23
Champ		68	62	65	57	56	57	.41	.08	.24
Mankato		74	71	73	57	58	57	.42	.10	.26
2137		76	67	71	58	58	58	.33	.10	.22
Jagger		82	73	78	58	60	58	.39	.10	.25
Betty		68	67	68	60	59	59	.49	.10	.30
Heyne		63	60	61	59	59	59	.45	.12	.28
Mean		70	64		59	58		.40	.10	
LSD (0.10)	Between Columns	3			1			.02		
	Between Rows			6			2			.05
	Cultivar x Cl		NS			NS			NS	

*Cl applied at 24 lb/a as KCl top-dressed in February
Soil test Cl: 15 lb/a (0-24")

Table 3. Effects of chloride fertilization on wheat cultivars, Saline Co., KS, 1999.

		Grain Yield			Test Weight			Leaf Cl		
Cultivar		+Cl*	-Cl	Mean	+Cl	-Cl	Mean	+Cl	-Cl	Mean
			bu/a			lb/bu			%	
Custer		86	79	83	57	55	56	.58	.17	.38
Cimarron		65	53	59	56	57	56	.54	.18	.36
Triumph 64		58	52	55	53	55	54	.53	.19	.36
2163		57	55	56	51	52	52	.50	.20	.35
Ogallala		86	84	85	57	57	57	.40	.24	.32
Karl 92		77	73	75	55	57	56	.55	.21	.38
Champ		75	70	73	54	52	53	.54	.23	.39
Mankato		72	63	67	54	54	54	.56	.17	.36
2137		90	83	86	57	56	56	.53	.16	.34
Jagger		81	77	79	54	55	54	.51	.14	.33
Betty		75	71	73	54	54	54	.65	.22	.44
Heyne		80	77	79	54	54	54	.63	.24	.43
Mean		75	70		55	55		.54	.19	
LSD (0.10)	Between Columns	4			1			.03		
	Between Rows			9			2			.07
	Cultivar x Cl		NS			NS			NS	

*Cl applied at 24 lb/a as KCl top-dressed in February
Soil test Cl: 14 lb/a (0-24")

EFFECTS OF NITROGEN RATES AND SOURCES ON WHEAT

R.E. Lamond, C.J. Olsen, T.M. Maxwell, and K. Rector

Summary

Concerns exist about the efficiency of urea-containing nitrogen (N) fertilizers when surface broadcast. Previous work in Kansas has shown that N sources perform similarly when top-dressed on wheat from November through early March. This research was initiated in 1998 and continued in 1999 to evaluate an experimental N fertilizer (UCAN-21) as a top-dressing material on wheat. Wheat forage and grain yields were increased by N fertilization at all sites in 1999. UCAN-21, which is a mixture of liquid calcium nitrate and UAN, generally resulted in higher forage and grain yields than UAN (urea - ammonium nitrate solution), although not all differences were significant. UCAN-21 also often produced higher forage N concentrations, N uptake, and grain protein than UAN.

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 top-dressed on wheat from November through early March. When top-dressing is delayed, volatilization potential increases.

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

Procedures

Studies were initiated at two sites in Marion Co. and two sites in Saline Co. in 1999. Nitrogen rates (30, 60, 90 lb/a) were top-dressed in March as either UCAN-21 or UAN. A no-N treatment was included.

Forage yields were determined in mid-April, and samples were retained for N analysis. Grain yields were determined, and grain samples were retained for protein analysis. One of the Marion Co. locations had flooding, so grain yields were not taken at that site.

Results

Grain yields were good to excellent in 1999. Visual responses to applied N were apparent within a few weeks after topdressing. Nitrogen fertilization increased wheat forage and grain yields at all sites (Tables 4 and 5). The excellent response to N was due to relatively low residual soil N levels because of high yields in 1997. Nitrogen also consistently increased forage N and grain protein at most sites.

Nitrogen sources performed similarly at site A in Marion Co., but UCAN-21 often outperformed UAN at the other sites. It generally produced higher forage and grain yields, higher forage N concentrations, more N uptake and higher grain protein than UAN, though not all increases were statistically significant. This work will be continued in 2000.

Table 4. Effects of nitrogen rates and sources on wheat, Marion Co., KS, 1999.

N	N	Site A*			Site B				
		Forage			Forage			Grain	
Rate	Source	Yield	N	N Uptake	Yield	N	N Uptake	Yield	Prot.
lb/a		lb/a	%	lb/a	lb/a	%	lb/a	bu/a	%
0	--	4010	1.02	40	4390	1.11	49	58	10.1
30	UAN	6860	1.16	81	6250	1.29	81	66	10.0
60	UAN	8870	1.31	119	6160	1.33	81	75	10.6
90	UAN	9270	1.18	110	7070	1.52	108	81	10.4
30	UCAN-21	8750	1.07	94	7640	1.20	92	64	10.1
60	UCAN-21	6750	1.14	77	7440	1.30	96	75	10.3
90	UCAN-21	7930	1.30	104	8210	1.55	127	85	10.8
LSD (0.10)		2340	0.16	36	1990	0.13	23	11	0.3
Mean Values:									
N	30	7800	1.12	87	6940	1.24	86	64	10.0
Rate	60	7800	1.23	98	6800	1.31	89	75	10.4
	90	8600	1.24	107	7640	1.54	118	83	10.7
LSD (0.10)		NS	NS	NS	NS	0.10	17	8	0.4
N	UAN	8330	1.22	103	6490	1.38	90	74	10.3
Source	UCAN-21	7810	1.17	92	7760	1.35	105	75	10.4
LSD (0.10)		NS	NS	NS	1080	NS	13	NS	NS

*Grain harvest not done because of flooding.

Table 5. Effects of nitrogen rates and sources on wheat, Saline Co., KS, 1999.

		Site A					Site B				
		Forage			Grain		Forage			Grain	
N Rate	N Source	Yield	N	N Uptake	Yield	Prot.	Yield	N	N Uptake	Yield	Prot.
lb/a		lb/a	%	lb/a	bu/a	%	lb/a	%	lb/a	bu/a	%
0	--	3550	1.37	48	66	11.5	4190	1.43	60	55	11.0
30	UAN	4600	1.54	70	78	11.6	6090	1.86	111	56	11.7
60	UAN	4380	1.59	68	86	11.4	6130	1.88	117	63	11.9
90	UAN	4620	1.92	89	80	11.4	6090	1.79	109	56	13.1
30	UCAN-21	4500	1.56	68	81	11.9	6380	1.96	125	56	12.7
60	UCAN-21	4870	1.82	88	83	11.9	6450	1.92	124	63	12.8
90	UCAN-21	4750	2.08	99	91	11.7	6820	2.10	142	60	13.2
LSD (0.10)		950	0.16	14	10	NS	1020	0.22	32	7	0.8
Mean Values:											
N	30	4550	1.55	69	79	11.7	6230	1.91	118	56	12.1
Rate	60	4630	1.70	78	85	11.6	6290	1.90	120	63	12.4
	90	4690	2.00	94	85	11.5	6460	1.95	126	58	13.2
LSD (0.10)		NS	0.12	10	NS	NS	NS	NS	NS	6	0.5
N	UAN	4530	1.68	76	81	11.5	6100	1.84	112	58	12.3
Source	UCAN-21	4710	1.82	85	85	11.8	6550	1.99	131	60	12.9
LSD (0.10)		NS	0.10	8	NS	0.3	440	0.13	16	NS	0.4

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 greater than the wheat yield following sorghum in both years (57 vs 47 bu/a in 1998 and 31 vs 25 in 1999). At the lowest seeding rate (60 lb/a) and with no N fertilizer applied, wheat grain yield was less following sorghum than soybean. However, at the highest seeding rates 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.

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

At the North Agronomy Farm, blocks of soybean and grain sorghum were planted in the spring of 1997 and 1998 to establish the previous crop treatments. Sites were on Reading silt loam soils 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, 1997 at 60, 90, or 120 lb/a and on October 30, 1998 at 60, 90, 120, or 150 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 in both years 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 analyses.

Results

A response in grain yield was obtained to all three variables (Table 6). 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. Grain yield 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. This study will be continued in 2000.

Table 6. Effects of previous crop, nitrogen rate, and seeding rate (60, 90, 120 lb/a) on wheat grain yield in 1998 and 1999 at the North Agronomy Farm, Manhattan, KS.

Previous	N	1997 Seeding Rate, lb/a			1998 Seeding Rate, lb/a			
Crop	Rate	60	90	120	60	90	120	150
	lb/a	- - - - - - - bu/a - - - - - - -			- - - - - - - - - bu/a - - - - - - - - -			
Sorghum	0	27	41	35	11	18	18	17
	40	41	52	50	9	32	33	32
	80	46	53	57	15	32	31	38
	120	48	56	58	18	30	27	39
Soybean	0	53	48	56	20	24	33	31
	40	50	60	62	27	38	35	37
	80	58	55	67	22	34	37	42
	120	57	59	57	19	30	42	34
LSD .05			13			17		

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

D.A. Whitney, W.B. Gordon, and V.L. Martin

Summary

An excellent response to nitrogen (N) fertilization was found. The N source, urea vs. PCU (polymer-coated urea), had an effect on yield or other parameters measured. The PCU placed with the seed at 30 lb/a of N did not cause germination damage, whereas urea caused severe stand and yield losses.

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 effects on germination. 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 membrane, which encapsulates the urea granule, controls urea release rate by its applied thickness. This slow dissolution rate could reduce potential wheat germination damage and allow a higher N rate in direct seed contact. This research was initiated to investigate the use of polymer-coated urea (PCU) as a seed-placed and broadcast N source for wheat.

Procedures

Field studies were initiated at the North Central Experiment Field near Belleville and the Sandyland Experiment Field near St. John. The Belleville site was in wheat in 1998, and the wheat straw disked twice prior to wheat planting. The St. John site was in irrigated soybeans in 1998 and disked prior to wheat planting. Both sites were planted with a no-till coulter plot drill with 10 in. row spacing. Wheat (variety 2137) was planted at 75 lb/a of seed on October 13 at Belleville and on October 15 at St. John. Urea, PCU44, and PCU43 were used as starter with the seed plus broadcast to give a total N rate of either 30, 60, or 90 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 were taken at boot to early head emergence. Grain yields were determined at maturity using a plot combine. A sample of the grain was retained for measurements of moisture and N contents.

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 least at both locations. Stand counts were made and agreed with visual observation of the plots and yields. Placing PCU44 and PCU43 at 30 lb/a of N with the seed was not injurious to germination and growth, but urea was very injurious to stand and yield at St. John. Work with PCU will be continued in 2000.

Table 7. Use of polymer-coated urea with the seed starter for wheat production in Kansas, 1999.

Starter N[1]		Broadcast N		Grain Yield	
Rate	Source	Rate	Source	Belleville	St. John[2]
lb/a		lb/a	-	bu/a	bu/a
-	-	0	-	57.8	48.6
0	-	30	Urea	76.9	61.6
30	Urea	0	-	65.8	25.4
30	PCU44	0	-	73.4	58.7
30	PCU43	0	-	75.5	58.6
0	-	60	Urea	75.5	60.2
30	Urea	30	Urea	63.4	33.5
30	PCU44	30	Urea	75.8	60.2
30	PCU43	30	Urea	81.8	52.2
0	-	90	Urea	79.4	59.2
30	Urea	60	Urea	60.5	45.2
30	PCU44[3]	60	Urea	67.5	75.1
30	PCU43	60	PCU44	72.7	57.5
0		60	PCU 43	78.6	58.0
0		60		85.3	54.8
LSD (.05)				6.2	11.0

[1] Starter N applied in direct seed contract
[2] An additional 50 lb/a of N was topdressed on all plots in late February.
[3] PCU44 and PCU43 are POLYON AG polymer-coated urea from Pursell Technologies Inc.

SITE-SPECIFIC MANAGEMENT OF ACID SOILS IN THE CHENEY WATERSHED

C.J. Olsen, J.P. Schmidt, and R.E. Lamond

Summary

In south central Kansas, within-field soil pH may vary from below 5.0 to greater than 7.0. As the soil pH decreases below 5.5, aluminum (Al) concentration in soil solution increases, reducing yield. In four fields, three sites (A, B, C) were selected to represent areas with low, medium, and high lime recommendations, respectively. Two of the four fields had sites that were responsive to lime application. Field 1 showed lime effects and variety effects on both sites B and C. Adding lime increased wheat yield by 7 bu/a on both sites. Coronado (Al tolerant) yielded 16 bu/a greater than Karl 92 (Al susceptible) on site B and 5 bu/a greater than Karl 92 on site C. Field 2 also showed lime effects on sites B and C. Site B had a 16 bu/a increase and site C had a 7 bu/a increase when lime was added.

Introduction

Within-field soil pH may vary from below 5.0 to above 7.0 in south central Kansas. A common management practice to alleviate Al toxicity associated with low soil pH is to band apply phosphorus (P) with seed when wheat is planted. Although P fertilization does not increase soil pH, this has been an effective method to maintain historical yields. This practice often is implemented regardless of soil test P with the consequence of increasing soil test P to unnecessarily high levels. High soil test P can increase environmental risks associated with soil P runoff, leading to eutrophication of surface waters. The appropriate remedy for low soil pH is lime. However, a return on liming often is not realized for several years, so farmers tend to avoid this choice, especially when land is leased. If precision agriculture technologies can be used to target lime application, farmers may be more inclined to apply lime and minimize P fertilizer applications. The objective of this study was to evaluate the potential for variable lime application as a management practice to reduce P fertilization in the Cheney Watershed, Kansas.

Procedures

Four 40-acre fields were selected in Reno County (3 fields) and Rice County (1 field). Variabilities in soil pH and lime recommendation were determined from one soil sample collected per acre. A 6-inch-deep soil sample consisted of six cores taken in a 10-ft radius around the soil sample point. Three sites also were chosen from each field to represent low, medium, and high lime recommendations. Table 8 summarizes soil test information for these sites. The treatment design was a factorial arrangement of treatments including the recommended rate of lime or no lime, no P or 20 lb/a banded P, and either an Al-tolerant or Al-susceptible variety of wheat. Each plot was 10 ft by 10 ft. Grain yields were determined from a 2-ft swath 10 ft long in each plot. The rest of the field was divided into 1.5-acre cells. Two of these cells were blocked together, representing similar lime recommendations. Either no lime or the recommended rate of lime then was applied variably. The field was harvested using a yield monitor and differential global positioning system.

Results

Only two of the four fields were responsive to the treatments applied. On those two fields, the medium and high lime recommendation sites were responsive. The results of these studies are summarized in Tables 9 and 10. Exchangeable Al levels were 25 ppm or greater on all sites that were responsive. Bray-1 P levels were 50 ppm or greater on all responsive sites, as well. Liming had a significant effect on both fields that were responsive. In field 1, planting an Al-tolerant variety (Coronado) significantly increased yield compared to planting an Al-susceptible variety (Karl 92). This study

showed that liming had a positive effect on yields for fields that had low soil pH and increased Al concentrations in soil solution, as did planting an Al-tolerant wheat variety. The results on banding P in this study were inconclusive, but earlier research has shown banding P to significantly increase yields in wheat on fields that have low soil pH and increased Al concentrations in soil solution.

Table 8. Selected site characteristics for two fields, Cheney Watershed, KS.

Site	Lime 100% ECC	Ex. Al	Bray-1 P	Soil pH
	lb/a	ppm	ppm	
Field 1				
A	5000	86	90	4.9
B	7500	58	50	4.8
C	11000	78	63	4.9
Field 2				
A	0	0	27	7.4
B	5000	25	68	4.9
C	7500	27	63	5.1

Table 9. Effects of lime, phosphorus, and variety on wheat yields, Cheney Watershed, KS, 1999.

Site B				Site C			
Lime 100% ECC	P Rate Banded	Variety	Yield	Lime 100% ECC	P Rate Banded	Variety	Yield
lb/a	lb/a		bu/a	lb/a	lb/a		bu/a
Field 1							
0	0	Karl 92	41	0	0	Karl 92	52
0	0	Coronado	62	0	0	Coronado	54
0	20	Karl 92	46	0	20	Karl 92	51
0	20	Coronado	61	0	20	Coronado	57
7500	0	Karl 92	53	11000	0	Karl 92	57
7500	0	Coronado	61	11000	0	Coronado	63
7500	20	Karl 92	54	11000	20	Karl 92	59
7500	20	Coronado	70	11000	20	Coronado	61
LSD 0.10			9				5
Field 2							
0	0	Karl 92	57	0	0	Karl 92	28
0	0	Jagger	55	0	0	Jagger	41
0	20	Karl 92	60	0	20	Karl 92	33
0	20	Jagger	56	0	20	Jagger	27
5000	0	Karl 92	68	7500	0	Karl 92	37
5000	0	Jagger	79	7500	0	Jagger	31
5000	20	Karl 92	74	7500	20	Karl 92	39
5000	20	Jagger	73	7500	20	Jagger	51
LSD 0.10			26				12

Table 10. Main effects of lime and variety on wheat yields, Cheney Watershed, KS, 1999.

	Field 1				Field 2	
	Lime Effect		Variety Effect		Lime Effect	
Treatment	Site B Yield	Site C Yield	Site B Yield	Site C Yield	Site B Yield	Site C Yield
	bu/a	bu/a	bu/a	bu/a	bu/a	bu/a
Lime	59	60			73	39
No Lime	52	53			57	32
LSD (0.10)	5	3			14	6
Coronado			64	59		
Karl 92			48	54		
LSD (0.10)			5	3		

GRASS FERTILIZATION STUDIES
KANSAS STATE UNIVERSITY - DEPARTMENT OF AGRONOMY

BROMEGRASS FERTILIZATION STUDIES

R.E. Lamond, H.C. George, C.J. Olsen, and G.L. Kilgore

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 1999 at four sites in Miami County 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 late May at all sites. Forage samples were retained for analyses.

Results

The 1999 results are summarized in Table 1. Forage yields were average to excellent at all locations, and yields were increased by N application at all four Miami Co. locations (Table 1). Nitrogen fertilization also significantly increased forage protein levels at all sites. Phosphorus fertilization increased brome forage yields at all four sites. The yield increases with P fertilization were significant at the two sites with the lowest P soil tests. Averaged over all four sites, the addition of 30 lb of P_2O_5/a increased forage yields nearly 1000 lb/a.

The addition of S fertilizer produced higher yields at three of four sites, though not all of the yield increases were statistically significant. At site A, addition of 20 lb S/a increased forage yields by over 1100 lb/a. These results confirm earlier work that indicated bromegrass is a consistent responder to S fertilization. Producers who are managing bromegrass for maximum forage production should consider including S in their nutrient management plans. These studies will be continued in 2000.

Table 1. Fertility management on bromegrass, Miami Co., KS, 1999.

			Site A				Site B				Site C				Site D			
N	P_2O_5	S	Yield	Prot.	P	S	Yield	Prot.	P	S	Yield	Prot.	P	S	Yield	Prot.	P	S
	lb/a		lb/a	----%----			lb/a	----%----			lb/a	----%----			lb/a	----%----		
0	0	0	3490	6.4	.13	.13	3530	5.3	.18	.14	2180	9.2	.14	.17	2450	8.5	.24	.16
40	0	0	4740	8.0	.11	.11	6600	7.3	.15	.12	3860	10.2	.14	.15	6550	9.1	.22	.12
80	0	0	5900	9.8	.13	.12	6730	7.4	.13	.13	4220	11.6	.13	.16	7880	9.6	.20	.12
120	0	0	6150	10.6	.12	.12	7770	10.1	.13	.14	4540	11.7	.11	.14	8560	11.9	.23	.14
40	30	0	5440	7.2	.16	.11	6310	7.3	.17	.12	5180	9.9	.16	.13	7090	9.2	.23	.13
80	30	0	6590	8.7	.15	.11	7290	9.6	.21	.13	6990	10.8	.21	.14	7310	9.4	.23	.13
120	30	0	7260	9.7	.16	.12	9370	11.1	.20	.15	6820	12.7	.20	.15	8870	11.7	.23	.14
80	30	20	7740	8.7	.17	.13	7550	8.2	.15	.14	6030	11.6	.18	.17	8200	10.6	.22	.17
	LSD (0.10		870	1.6	.03	NS	1500	3.0	.02	.02	990	2.5	.04	.03	1490	1.3	NS	.02
	Mean Values:																	
N	40		5090	7.6	.13	.11	6450	7.3	.16	.12	4520	10.0	.15	.14	6820	9.2	.22	.12
Rate	80		6240	9.2	.14	.11	7010	8.5	.17	.13	5600	11.2	.17	.15	7600	9.5	.21	.13
	120		6700	10.2	.14	.12	8570	10.6	.16	.14	5680	12.2	.16	.14	8720	11.8	.23	.14
	LSD (0.10)		590	1.2	NS	NS	1150	2.4	NS	.01	810	2.0	NS	NS	1250	0.7	NS	NS
P_2O_5	0		5590	9.5	.12	.12	7030	8.3	.13	.13	4090	11.2	.13	.15	7660	10.2	.21	.12
Rate	30		6430	8.6	.15	.11	7650	9.3	.19	.13	6260	11.1	.18	.14	7760	10.1	.23	.13
	LSD (0.10)		480	NS	.01	NS	NS	NS	.01	NS	660	NS	.02	NS	NS	NS	NS	NS
	Soil Test P, ppm			4				7				3				14		

SOIL FERTILITY RESEARCH
SOUTHWEST RESEARCH - EXTENSION CENTER

RESIDUAL SOIL NITROGEN AND PHOSPHORUS AFTER MANURE APPLICATIONS

A.J. Schlegel, C.W. Rice, M. Alam, and L. Stone

Summary

Soil chemical properties were measured in irrigated fields in western Kansas with a history of animal waste applications. The fields varied in the type of waste applied (solid cattle manure or effluent water from swine or cattle wastewater lagoons) and the duration of application (3 to 30 years). In the surface soil (0-6 inch depth), soil phosphorus (P) levels ranged from about 45 to more than 300 ppm Mehlich-3 P. Soil nitrate content varied considerably among the sites. Movement of nitrate past the crop root zone was detected at several sites. At two sites, residual nitrate levels below 5 ft were greater than 100 ppm. No accumulation of Zn or Cu was observed at any site.

Introduction

Application of animal wastes can enhance soil chemical and biological properties and serve as a valuable nutrient source for crop production. However, improper use of animal manure can adversely affect the environment. Two concerns associated with land application of animal waste are P loss in surface water runoff causing eutrophication of streams and lakes and nitrate leaching through the soil profile into the groundwater. The purpose of this study was to sample fields that have received land applications of animal wastes and compare the soil chemical properties to those of similar fields that had not received manure applications.

Procedures

Soil samples were collected (in cooperation with local landowners) from eight irrigated fields in western Kansas that had a history of manure application. The type of manure, number of years of application, and application method varied from site to site. The application rate was unknown for most sites. The longest history of application was about 30 years. Two sites received swine wastes (effluent water), and the others received cattle manure (solid manure on three and lagoon effluent water on three). Each field was divided into three subfields. In each subfield, three soil cores to a depth of 10 ft were collected, divided into 12-inch increments (except for the surface foot), and composited. For the surface foot of soil, six additional cores were collected; divided into 0-2 inch, 2-4 inch, 4-6 inch, 6-8 inch, and 8-12 inch increments; and composited. Similar fields that had not received manure (identified by the landowners) also were sampled in the same manner. The samples were dried and sent to the KSU Soil Testing Laboratory for analyses.

Results

On the three sites that had received applications of solid cattle manure, soil P levels ranged from 120 to more than 300 ppm Mehlich-3 P (0-6 inch depth). Soil P levels in nonmanured fields averaged 42 ppm Mehlich-3 P (0-6 inch depth). Soil nitrate levels were also greater in manured fields (Table 2), with some N accumulation below the crop root zone (most crop roots are in the top 5 ft of soil). For instance, soil nitrate was more than 30 ppm in the 9-10 ft depth at two sites receiving cattle manure compared to 2 ppm in fields not receiving animal wastes.

The effects of applying effluent water from wastewater lagoons at cattle facilities varied considerably among the three sites (Table 1). At one site, soil P levels were relatively unchanged following 10 years of effluent water application. At the site with the

longest history of effluent water application (about 15 years), soil P level was about 120 ppm Mehlich-3 P. At a site that had received effluent water for only 3 years, the soil P level was more than 200 ppm Mehlich-3 P. Soil nitrate levels were elevated at all sites receiving effluent water from cattle operations (Table 2). At the site receiving effluent water for 3 years, most of the residual nitrate was in the upper profile and readily available for crop growth. However, nitrate accumulation below 5 ft was measured at all sites, and over 50-ppm nitrate occurred in the 5 to 10 ft depths at one site.

Two sites were sampled that had received applications of effluent water from swine lagoons. At the site with the longest history of application (about 30 yr), soil P level was about 130 ppm Mehlich-3 P in the surface 6 in. of soil (Table 1). There was considerable accumulation of nitrate in the soil profile with the highest concentration (170 ppm nitrate) at the 5 to 6 ft depth (Table 2). Nitrate had leached past the crop root zone, and about 59 ppm occurred at the 9 to 10 ft depth. At another site that had received effluent water for about 8 years, soil P was about 110 ppm Mehlich-3 P, and the highest level of soil nitrate (>100 ppm) was at the 5 to 8 ft depth. Below 8 feet, soil nitrate levels decreased to 34 ppm in the lowest depth (9 to 10 ft). A concern with application of swine waste is accumulation in the soil of heavy metals (copper and zinc) that have toxic effects on crop growth. For these two sites, heavy metal accumulation was not a problem with less than 2 ppm DTPA-extractable Cu and 4 ppm DTPA-extractable Zn in the surface soil (data not shown).

Table 1. Phosphorus levels in fields with a history of animal waste application, western Kansas, 1999.

Depth	10 yr-CS	13 yr-CS	30 yr-CS	3 yr-LEC	10 yr-LEC	15 yr-LEC	8 yr-LES	30 yr-LES	Control
inch					Mehlich-3 P (ppm)				
0-2	119	307	155	263	59	133	110	174	58
2-4	142	330	150	267	46	124	117	137	44
4-6	121	287	114	200	31	116	102	88	25
6-8	31	180	72	103	20	100	80	54	15
8-12	14	76	51	47	21	61	40	32	13

CS - solid manure from cattle.
LEC - lagoon effluent from cattle.
LES - lagoon effluent from swine.
Control values are averages of 5 fields that had not received manure.

Table 2. Nitrate levels in fields with a history of animal waste application, western Kansas, 1999.

Depth	10 yr-CS	13 yr-CS	30 yr-CS	3 yr-LEC	10 yr-LEC	15 yr-LEC	8 yr-LES	30 yr-LES	Control
					NO_3-N (ppm)				
0-2"	7	24	63	107	8	14	4	61	6
2-4"	2	16	25	113	10	10	6	32	5
4-6"	2	14	19	122	17	21	8	30	8
6-8"	1	18	15	120	21	21	12	30	9
8-12"	2	20	15	133	24	32	18	27	8
1-2'	5	16	62	94	24	9	18	29	5
2-3'	15	14	48	77	17	13	31	26	3
3-4'	26	24	32	58	30	31	56	39	3
4-5'	15	17	31	47	37	59	86	94	3
5-6'	7	17	16	29	33	84	122	171	2
6-7'	5	17	7	30	24	93	116	160	4
7-8'	5	20	11	25	14	88	114	116	4
8-9'	6	29	23	20	13	68	65	66	4
9-10'	6	43	32	23	13	53	34	59	2

CS - solid manure from cattle.
LEC – lagoon effluent from cattle.
LES - lagoon effluent from swine.
Control values are averages of 5 fields that had not received manure.

SOIL FERTILITY RESEARCH
AGRICULTURAL RESEARCH CENTER - HAYS

EFFECTS OF THE CROSS-LINKED POLYACRYLAMIDE STOCKOSORB ON WHEAT, TRITICALE, AND GRAIN AND FORAGE SORGHUMS IN CENTRAL KANSAS

C.A. Thompson

Summary

Polyacrylamides have been around for a long time. Great claims have been put forth as to their effectiveness in the field of agriculture. Some claims are true, but caution should be used when contemplating any new product on your farm. Try a few acres using current recommendations. If it works, expand; if it does not, proceed with caution. The cross-linked polyacrylamide used in these investigations is called Stockosorb AGRO. It is a potassium-based, high-molecular weight, white crystalline granule produced by Stockhausen, Inc. in Germany. The crystal is capable of absorbing many times its weight in water, resulting in a hydrated gel.

As the crystals absorb soil moisture, the gel-like substance formed probably also incorporates water-soluble nutrients. Thus, when plant roots grow into the gel, both water and soil nutrients are available for uptake. Some success has been achieved with both grain and forage crops. An attempt is being made to take the research to farmer's fields and use replicated trials to ascertain the reliability of the product.

Because of Stockosorb AGRO's high affinity for moisture, plugging can occur inside the metering tubes during application. Using simple precautions can reduce this problem. If possible, do not leave the Stockosorb material inside the distribution box overnight. When the humidity is high, leave the lid on the box. When possible, blend Stockosorb AGRO with dry starter fertilizer to ensure uniform flow. Use an air hose to blow out the metering tubes and distribution box on a daily basis.

Mounting evidence shows that Stockosorb is more effective when blended with liquid or dry N or N+P fertilizers. This should not be a big problem whether using the standard Stockosorb AGRO or the new Stockosorb AGRO F. Blending Stockosorb AGRO F with liquid fertilizer has shown enough promise that research will continue in this area. The fact that the AGRO F product does not gel when blended with 10-34-0 or 28-0-0 before banding is encouraging. The Stockosorb stays in suspension and with minor agitation is ready for use. This investigator plans to check the compatibility of Stockosorb AGRO F with other liquid fertilizers.

Introduction

Because of the high cost-low price squeeze on our farm crops, farmers are being forced to use management strategies that will ensure a more consistent return on their investment. Weather in the central plains is quite variable. Availability of plant nutrients often declines under droughty conditions or under conditions where soil nutrients are leached easily below the root zone of the growing crop. This variability does not allow a consistent flow of plant nutrients to the crop. Any material or method that extends the time or amount of nutrient uptake potentially can affect plant growth and grain production.

Because of their high absorption capacity, cross-linked polyacrylamides may fit not only in the diaper industry, but also in the agricultural arena. The cross-linked polyacrylamide Stockosorb will absorb many times its original weight in liquid. The hypothesis is that water-soluble plant nutrients also will be also be absorbed into this hydrated gel. Other studies indicate that plant roots can grow easily into this gel and gradually extract the water-soluble nutrients contained in the gel.

Included in this report are the 1999 results for winter wheat, winter triticale, and grain and forage sorghums. Studies were located on and off-station on farmer's fields in a nine-county area surrounding the KSU Agricultural Research Center, Hays. The investigator located, planted, and harvested all studies. The cooperation of the farmers involved is deeply appreciated.

Procedures

Stockosorb AGRO is a dry crystalline polyacrylamide with crystals about 2mm in size. Because the crystals have a high affinity for moisture, buildup of the hydrated gel can occur inside the tubing during application, causing limited to major plugging. Thus, to enhance uniform metering and distribution in the row when banding, prepackaged Stockosorb AGRO was blended with sand. When dry fertilizer was blended with Stockosorb AGRO, no sand was added. Both materials were applied with a cone/spinner mechanism mounted on the drill/planter to ensure uniform application of the prepackaged material.

A very fine form of Stockosorb AGRO (AGRO F) was blended with two liquid fertilizers, 10-34-0 and 28-0-0. This mixture, with limited agitation, stayed in suspension even when water was added later to the mixture. A total of 20 gpa was banded in the row using a John Blue pump and a 1/16 ID tube. No orifices were used. Orifices have been tried in the past with limited success. Liquid pressure inside the tubes ranged from 30 to 45 lb. Each plastic tube went through metal tubing welded to the back of each opener. The angle of the bottom part of the metal tubing was very critical. The bottom 3-4 inches of the metal tubing were angled back 30 to 45 degrees to eliminate mud buildup around the seed opening.

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

On and off-station test sites were established on silt loam and silty clay loam soils. Unless otherwise indicated in the tables, the soil type was a Harney silt loam. A grain drill was used to plant all crops in a 12-inch row spacing. The wheat variety 2137 was used in all wheat studies, Presto winter triticale was used in the small grain hay study, DeKalb DK36 (medium-early maturing) was used in the grain sorghum studies, and Canex forage sorghum was used in the summer hay and silage studies. Wheat was seeded at 60 lb/a, triticale at 75 lb/a, grain sorghum at 80,000 seeds/a (superthick sorghum), and forage sorghum at 20 lb/a. The amount and form of fertilizer are indicated in each table. Treatments were replicated four times. Six rows from the center of each 8-row 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 visual rating notes were taken at harvest. Data were analyzed with SAS using ANOVA or GLM.

Results

Small Grains

Stockosorb AGRO Rate x Nitrogen Fertilizer

This is the fourth year of comparing banded rates of Stocksorb with and without banded N fertilizer and with and without irrigation. Table 1 shows the effects on winter wheat in the dryland portion of this study. The N fertilizer resulted in significant increases in yield, net return, plant height, and visual rating. Although there was a trend favoring the use of 1 lb/a Stockosorb, it was not significant at the .05 probability level.

Stockosorb and N fertilizer were compared under dryland and irrigated management (Table 2). Irrigated and N treatments were significantly better than dryland in nearly all aspects. Again, although there was a trend favoring the use of Stockosorb, it was not significant.

Stockosorb AGRO Rate x Starter Fertilizer

Five sites on station received five rates of Stockosorb with and without starter fertilizer. Wheat yields of this study are shown in Table 3. Use of starter fertilizer

resulted in significant increases in yields at all five sites. Several rates including the 1 lb/a rate of Stockosorb when in combination with starter fertilizer resulted in significant yield increases at all five sites. However, in the absence of starter fertilizer, yield increases from Stockosorb were significantly lower.

The net returns from this study are shown in Table 4. Results were similar to yield with some significant exceptions. One of these exceptions was that the return from using Stockosorb in the absence of fertilizer was negative, not positive. Secondly, even when combined with starter fertilizer, the 12-lb/a Stockosorb rate resulted in a significant negative return. On a positive note, the low rates of Stockosorb in combination with starter fertilizer produced significant positive returns.

Dry and Liquid Stockosorb Comparison

This author has been able to add a fine Stockosorb material (Stockosorb AGRO F) to two liquid fertilizers (10-34-0 and 28-0-0) with great success (Table 5). The highest Stockosorb rate was 3 lb/a. All three Stockosorb rates stayed in suspension for several days. Only minor agitation was necessary before use in the field. Although significant wheat yield increases occurred in most of the added treatments, the most significant increases were with the blend of Stockosorb AGRO F and liquid fertilizer. This is a significant finding in that it will open the door to greater Stockosorb usage because of the flexibility that liquid fertilizer offers.

Net returns from this study are shown in Table 6. Here again, the greatest and most significant return was with the Stockosorb and liquid fertilizer blend. The simplicity of adding Stockosorb AGRO F to liquid fertilizer without fear of plugging will likely be of interest to many farmers.

Stockosorb AGRO Rate and Placement on Presto Triticale

The results of three rates and two placement methods for winter triticale are shown in Table 7. When 1 lb/a Stockosorb is placed in a half-inch band with the seed, this is equivalent to broadcasting 24 lb/a on the surface. The entire study received 25+25+0 using ammonium nitrate and 18-46-0. Significant positive yield results occurred in both forage and grain production under both application methods. However, because of the increased costs of the higher broadcast rates, only the banded treatments resulted in significant net returns. Significantly less lodging occurred in the grain crop when Stockosorb was banded than when it was broadcast. The return from banding would be greater, if we were to take into account the added time and machine wear to harvest the grain in the lodged broadcast treatments.

Summer Crops

Stockosorb AGRO Rate x Nitrogen Fertilizer

The effects of Stockosorb and N fertilizer on grain sorghum have been evaluated for several years on the KSU Ag Research Center. Table 8 shows the 1999 effects under dryland conditions. The significant increases from the use of N fertilizer are very apparent. Although significant yield increases resulted from the use of Stockosorb, they were not reflected consistently in net return and test weight.

Table 9 adds irrigation to this study as a variable. As expected, significant positive results occurred with irrigation. The remainder of the results were similar to those for dryland. Although a 5 to 6 bu/a increase resulted from Stockosorb, this failed to be economically significant because of low sorghum prices at the elevator.

An off-station study was conducted at six sites comparing five Stockosorb rates with and without N fertilizer (Table 10). Four of the six sites resulted in significant sorghum yield increases when Stockosorb was added to N fertilizer. Stockosorb by itself was less effective. Because of high humidity during planting, more tube plugging occurred than in previous years, thus reducing the even flow of Stockosorb and N fertilizer.

Table 11 shows net returns from this study. Although only two of six sites resulted in significant positive net returns, there was a general trend favoring the low 1 lb/a rate of Stockosorb with N fertilizer.

Dry and Liquid Stockosorb Comparison

Blending of the finely sieved Stockosorb (AGRO F) with liquid fertilizer did not have such positive effects on grain sorghum as on winter wheat, but the trend over all sites still favored the use of the blended product rather than adding them separately (Table 12). The crystal form of Stockosorb by itself was ineffective.

The net returns from this study are shown in Table 13. The overall net return from any treatment, even liquid fertilizer, was insignificant. Even though there was trend favoring the 1-lb/a rate of Stockosorb with liquid fertilizer, it was not significant, as it was in 1998. Low sorghum prices at the elevator are largely to blame for the change.

Stockosorb AGRO Rate and Placement on Forage Sorghum

Table 14 shows the effects of two placement methods and six rates of Stockosorb on Canex forage sorghum hay and silage. Both sites had a uniform application of 60 lb N/a. Placement method had no effect on yields or net return at either site at comparable Stockosorb rates (1 lb/a in a half-inch band = 24 lb/a broadcast). Added Stockosorb significantly raised hay and silage yields on both sites. Because of the higher Stockosorb rates used in the broadcast method, costs were also higher, which significantly lowered net returns per acre. Thus, a significant difference occurred in net returns favoring the banding method. Because this is the first year of such a trial, caution should be used in assuming that the treatments would perform similarly on all soils and in all precipitation zones.

Table 1. Winter wheat results for 1999 as affected by Stockosorb AGRO 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 from Stockosorb[2]	Test Weight	Plant Height	Visual Rating at Harvest[3]
lb/a	lb N/a	bu/a	$/a	lb/bu	inch	
0	0	18.9	42.46	59.5	27.8	4.2
1	0	21.3	43.98	59.7	28.2	5.0
2	0	18.7	35.16	57.3	27.8	4.8
3	0	18.8	32.17	59.5	27.8	4.8
0	20	30.8	62.42	60.2	32.0	6.5
1	20	34.3	67.10	60.1	30.1	6.8
2	20	32.2	59.58	60.2	32.2	7.0
3	20	34.0	60.41	60.1	31.8	7.0
LSD (P<.05)						
Stockosorb Rate		NS	NS	NS	NS	NS
Nitrogen Rate		2.7	6.09	NS	1.1	0.7
Stockosorb X N Rate		NS	NS	NS	NS	NS
P Values						
Stockosorb Rate		0.27	0.06	0.43	0.89	0.18
Nitrogen Rate		<.01	<.01	0.14	<.01	<.01
Stockosorb X N Rate		0.75	0.69	0.44	0.07	0.09

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

[2] Sorghum @ $1.30/bu; Stockosorb @ $3.00/lb; N fertilizer @ $6.00/a; banding costs @ $1.00/a.

[3] Visual rating is the general condition of the crop to include such items as stand density; skips in stand, and head size; 1=poorest, 10=best.

Table 2. Winter wheat results for 1999 as affected by Stockosorb AGRO 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 from Stockosorb[2]	Test Weight	Plant Height	Visual Rating at Harvest[3]
	lb/a	lb N/a	bu/a	$/a	lb/bu	inch	
Dryland	0	0	18.9	42.46	59.5	27.8	4.2
Dryland	2	0	18.7	35.16	57.3	27.8	4.8
Dryland	0	20	30.8	62.42	60.2	32.0	6.5
Dryland	2	20	32.2	59.58	60.2	32.2	7.0
Irrigated	0	0	32.0	72.10	59.6	30.5	7.0
Irrigated	2	0	33.8	69.11	59.6	30.5	7.0
Irrigated	0	20	45.1	94.48	60.0	32.8	7.8
Irrigated	2	20	50.2	100.05	60.0	33.5	8.5
LSD (P<.05)							
Dryland vs Irrigated			6.7	15.08	NS	1.0	0.4
Nitrogen Rate			3.2	7.21	NS	0.6	0.2
Stockosorb Rate			NS	NS	NS	NS	0.3
Dry/Irr X N Rate			NS	NS	NS	NS	NS
Dry/Irr X Stockosorb			NS	NS	NS	1.0	0.5
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	0.01	0.40	0.01	<.01
Nitrogen Rate			<.01	<.01	0.14	<.01	<.01
Stockosorb Rate			0.10	0.40	0.41	0.61	0.04
Dry/Irr X N Rate			0.07	0.07	0.33	0.71	0.69
Dry/Irr X Stockosorb			0.19	0.19	0.24	0.02	<.01
N Rate X Stockosorb			0.11	0.07	0.36	0.46	0.26
Dry/Irr X N Rate X Stockosorb			0.54	0.54	0.36	0.71	0.26

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

[2] Sorghum @ $1.30/bu; Stockosorb @ $3.00/lb; N fertilizer @ $6.00/a; banding cost @ $1.00/a.

[3] Visual rating is the general condition of the crop to include such items as stand density, skips in stand, and head size; 1=poorest, 10=best.

Table 3. Five-site summary of 1999 winter wheat yields as affected by Stockosorb AGRO applied with and without starter fertilizer, all placed in a band with the seed at planting under dryland conditions, KSU Agricultural Research Center–Hays, KS.

Stockosorb Rate w/Seed	Starter Fertilizer w/Seed[1]	Yield Site #1	Site #2	Site #3	Site #4	Site #5	Five-Site Average
lb/a		- - - - - - - -	- - - - - - - -	- - - - bu/a	- - - - - - - -	- - - - - - - -	- - - -
0	No	33.3	59.8	20.7	51.4	19.6	37.0
1	No	34.3	60.7	22.0	51.7	20.6	37.9
2	No	34.4	62.6	22.2	54.0	21.9	39.0
3	No	36.4	62.5	23.4	54.2	22.5	39.8
6	No	40.2	64.1	23.6	55.5	23.2	41.3
12	No	41.0	66.5	24.8	56.3	24.5	42.6
0	Yes	42.8	64.0	30.2	64.9	32.4	46.9
1	Yes	48.8	70.5	36.4	73.8	39.9	53.9
2	Yes	49.0	71.4	37.2	76.2	40.7	54.9
3	Yes	50.3	71.6	38.4	79.9	43.8	56.8
6	Yes	50.8	71.9	37.8	79.5	43.0	56.6
12	Yes	51.4	72.0	38.6	84.1	44.6	58.1
LSD (P<.05)							
Stockosorb Rate		4.6	3.5	3.1	3.0	4.0	1.5
Starter Fertilizer		3.8	3.4	4.7	10.1	3.5	1.7
Stockosorb X Starter		NS	NS	NS	NS	NS	3.0
P Values							
Stockosorb Rate		0.02	0.01	0.01	<.01	<.01	<.01
Starter Fertilizer		<.01	0.01	<.01	<.01	<.01	<.01
Stockosorb X Starter		0.58	0.45	0.71	0.08	0.29	<.01

[1] 30+30+0 starter fertilizer using a blend of 18-46-0 and ammonium nitrate (34-0-0).

Table 4. Five-site summary of net return from 1999 winter wheat as affected by Stockosorb AGRO applied with and without starter fertilizer, all placed in a band with the seed at planting under dryland conditions, KSU Agricultural Research Center–Hays, KS.

Stockosorb Rate w/Seed	Starter Fertilizer w/Seed	Net Return Site #1	Site #2	Site #3	Site #4	Site #5	Five-Site Average
lb/a		- - - - - - - -	- - - - - - - -	- - - - - - - -	$/a[1]	- - - - - - - -	- - - - - - - -
0	No	74.87	134.66	46.58	115.76	44.01	83.18
1	No	73.12	132.52	45.65	112.33	42.30	81.18
2	No	70.34	133.96	42.98	114.56	42.22	80.82
3	No	71.79	130.68	42.76	112.01	40.68	79.59
6	No	71.40	125.23	34.10	105.94	33.31	73.99
12	No	55.36	112.57	18.80	89.73	18.18	58.93
0	Yes	79.98	127.90	51.80	129.82	56.80	89.26
1	Yes	90.47	139.32	62.53	146.78	70.62	101.95
2	Yes	87.91	138.50	61.56	149.16	69.46	101.32
3	Yes	87.97	135.88	61.19	154.54	73.20	102.56
6	Yes	80.18	127.49	50.70	144.73	62.72	93.16
12	Yes	63.42	109.78	34.72	137.00	48.09	78.60
LSD (P<.05)							
Stockosorb Rate		10.33	7.96	7.03	6.72	9.03	3.48
Starter Fertilizer		8.58	NS	10.53	22.66	7.94	3.84
Stockosorb X Starter		NS	NS	NS	NS	NS	6.86
P Values							
Stockosorb Rate		<.01	<.01	<.01	<.01	<.01	<.01
Starter Fertilizer		0.02	0.57	0.02	<.01	<.01	<.01
Stockosorb X Starter		0.53	0.39	0.64	0.06	0.24	<.01

[1] Wheat @ $2.25 /bu; Stockosorb @ $3.00/lb; starter fertilizer at $15.21/a; banded application @ $1.00/a.

Table 5. Five-site summary of 1999 winter wheat yields as affected by liquid and dry Stockosorb applied with and without liquid fertilizer, all placed in a band with the seed at planting in five counties near the KSU Agricultural Research Center–Hays, KS.

	Yield					
Treatments Banded in Furrow w/Seed	Ellis County	Graham County	Ness County	Rooks County	Russell County	Five-Site Average
	- - - - - - - - - - - - - - - bu/a- - - - - - - - - - - - - - -					
Control	30.9	64.0	40.8	24.5	27.7	37.6
Stockosorb AGRO @ 1 lb/a	29.0	70.3	51.8	37.2	39.8	45.6
Stockosorb AGRO @ 2 lb/a	28.1	70.1	48.2	31.5	36.3	42.8
Stockosorb AGRO @ 3 lb/a	28.0	69.8	49.8	34.3	41.1	44.6
Liquid Fertilizer[1]	33.6	67.5	50.6	35.8	44.7	46.4
Stockosorb AGRO F @ 1 lb/a blended w/liq	41.2	72.0	63.3	46.7	54.2	55.5
Stockosorb AGRO F @ 2 lb/a blended w/liq	40.6	71.2	60.6	47.5	61.4	56.3
Stockosorb AGRO F @ 3 lb/a blended w/liq	44.6	72.3	55.0	47.3	52.0	54.2
Stockosorb AGRO @ 1 lb/a + liq fert	39.2	69.2	59.7	46.1	46.3	52.1
Stockosorb AGRO @ 2 lb/a + liq fert	41.3	68.6	61.5	43.8	49.4	52.9
Stockosorb AGRO @ 3 lb/a + liq fert	38.7	70.0	62.6	41.5	48.4	52.2
LSD (P<.05)	6.1	4.2	7.0	7.7	7.9	3.0
P Values	<.01	<.01	<.01	<.01	<.01	<.01

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

Table 6. Five-site summary of net return of 1999 winter wheat as affected by liquid and dry Stockosorb applied with and without liquid fertilizer, all placed in a band with the seed at planting in five counties near the KSU Agricultural Research Center–Hays, KS.

	Net Return[1]					
Treatments Banded in Furrow w/Seed	Ellis County	Graham County	Ness County	Rooks County	Russell County	Five-Site Average
	- - - - - - - - - - - - - - $/a - - - - - - - - - - - - - -					
Control	69.47	143.90	91.93	55.08	62.32	84.54
Stockosorb AGRO @ 1 lb/a	61.14	154.14	112.61	79.70	85.44	98.60
Stockosorb AGRO @ 2 lb/a	56.19	150.61	101.40	63.90	74.66	89.35
Stockosorb AGRO @ 3 lb/a	52.92	147.05	102.05	67.15	82.44	90.32
Liquid Fertilizer	59.44	135.58	97.59	64.38	84.42	88.28
Stockosorb AGRO F @ 1 lb/a blended w/liq	73.64	142.76	123.24	85.87	102.72	105.65
Stockosorb AGRO F @ 2 lb/a blended w/liq	69.13	138.12	114.16	84.70	115.98	104.42
Stockosorb AGRO F @ 3 lb/a blended w/liq	75.10	137.49	98.63	81.34	91.74	96.86
Stockosorb AGRO @ 1 lb/a + liq fert	68.98	136.50	115.11	84.58	84.94	98.02
Stockosorb AGRO @ 2 lb/a + liq fert	70.69	132.23	116.18	76.33	89.05	96.90
Stockosorb AGRO @ 3 lb/a + liq fert	61.80	132.29	115.68	68.17	83.72	92.33
LSD (P<.05)	13.80	9.36	15.85	17.29	17.84	6.82
P Values	0.03	<.01	0.01	0.01	<.01	<.01

[1] Wheat @ $2.25/bu; Stockosorb @ $3.00/lb; liquid fertilizer @ $15.21; banded application @ $1.00/a.

Table 7. Forage and grain results of 1999 winter triticale as affected by Stockosorb AGRO applied preplant broadcast and incorporated and banded with the seed at planting (Sept 15) on an Armo loam soil, Fort Hays State University farm, Hays, KS.

Stockosorb Rate	Stockosorb Placement Method	Forage - Boot Stage: Plant Height	Dry Matter Yield		Net Return from Stockosorb[3]	Growth Rating[2] Dec	Growth Rating[2] Apr	Grain[1]: Yield	Net Return from Stockosorb[3]	Test Weight	Plant Height	Lodging	Growth Rating[2] July
lb/a		inch	%	lb/a	$/a			lb/a	$/a	lb/bu	inch	%	
0		28	20.6	9456	0.00	7.8	5.2	3332	0.00	51.6	45	11.2	7.0
24	Broadcast	29	21.5	10712	-30.66	7.5	7.0	3530	-67.05	52.4	46	6.2	7.5
48	Broadcast	28	20.6	10807	-99.32	7.8	7.2	3830	-127.06	52.7	46	18.8	8.0
72	Broadcast	29	21.9	10916	-167.49	7.8	7.2	3829	-199.08	52.1	46	15.0	8.0
0		28	21.0	9408	0.00	7.8	5.0	3363	0.00	52.6	44	7.5	6.8
1	Banded	28	21.7	10712	42.00	8.0	7.2	3562	3.96	52.4	45	5.0	8.0
2	Banded	29	19.8	10742	40.08	7.5	7.2	3632	3.79	52.2	46	7.5	7.5
3	Banded	29	21.5	10579	31.32	7.5	7.2	3862	9.97	52.8	45	6.2	8.0
LSD (P<.05)													
Stockosorb Rate		NS	NS	392	13.84	NS	0.5	118	4.76	NS	1	NS	0.4
Placement		NS	NS	NS	10.06	NS	NS	NS	5.58	NS	NS	5.6	NS
Stockosorb X Place		NS	NS	NS	30.21	NS	NS	NS	5.37	NS	NS	NS	NS

[1] Variety planted: Presto; grain harvest was July 13, 1999. A uniform application of 25+25+0 was applied on all treatments.

[2] Growth rating was the general condition of the crop to include such items as stand density, tillering, and head size; 1=poorest, 10=best.

[3] Triticale hay @ $60/ton @ 15% moisture; triticale grain @ $0.04/lb; Stockosorb AGRO @ $3.00/lb, broadcast @ $3.00/a, banding @ $1.00/a.

Table 8. Grain sorghum results for 1999 as affected by Stockosorb AGRO 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 [2]	Test Weight	Plant Height	Visual Rating at Harvest[3]
lb/a	lb N/a	bu/a	$/a	lb/bu	inch	
0	0	55.1	71.66	59.3	34.0	5.2
1	0	59.6	73.41	59.2	35.0	5.8
2	0	62.8	74.63	59.6	36.5	6.8
3	0	60.3	68.38	59.2	38.0	6.0
0	20	72.6	87.38	59.6	32.0	7.5
1	20	79.0	92.68	59.7	36.8	8.0
2	20	78.6	89.21	59.4	38.8	8.0
3	20	80.0	88.00	59.6	40.0	8.2
LSD (P<.05)						
Stockosorb Rate		3.1	NS	NS	0.8	0.4
Nitrogen Rate		3.2	4.14	NS	0.9	0.3
Stockosorb X N Rate		NS	NS	NS	NS	NS
P Values						
Stockosorb Rate		<.01	0.09	0.92	<.01	<.01
Nitrogen Rate		<.01	<.01	0.08	<.01	<.01
Stockosorb X N Rate		0.53	0.48	0.06	0.13	0.50

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

[2] Sorghum @ $1.30/bu; Stockosorb @ $3.00/lb; N fertilizer @ $6.00/a; banding costs @ $1.00/a.

[3] Visual rating is the general condition of the crop to include such items as stand density; skips in stand, and head size; 1=poorest, 10=best.

Table 9. Grain sorghum results for 1999 as affected by Stockosorb AGRO 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 [2]	Test Weight	Plant Height	Visual Rating at Harvest[3]
	lb/a	lb N/a	bu/a	$/a	lb/bu	inch	
Dryland	0	0	55.1	71.66	59.3	34.0	5.2
Dryland	2	0	62.8	74.63	59.6	36.5	6.8
Dryland	0	20	72.6	87.38	59.6	36.8	7.5
Dryland	2	20	78.6	89.21	59.4	38.8	8.0
Irrigated	0	0	83.5	108.55	59.7	37.2	7.5
Irrigated	2	0	83.7	101.81	59.5	37.5	7.2
Irrigated	0	20	99.6	122.54	59.8	38.8	9.0
Irrigated	2	20	104.9	123.37	60.0	40.2	9.0
LSD							
Dryland vs Irrigated			1.7	2.17	NS	0.4	0.5
Nitrogen Rate			2.3	2.95	NS	0.5	0.2
Stockosorb Rate			3.6	NS	NS	0.4	0.4
Dry/Irr X N Rate			NS	NS	NS	NS	NS
Dry/Irr X Stockosorb			3.5	4.61	NS	1.0	0.9
N Rate X Stockosorb			NS	NS	NS	NS	NS
Dry/Irr X N Rate X Stockosorb			NS	NS	0.4	NS	NS
P Values							
Dryland vs Irrigated			<.01	<.01	0.13	<.01	<.01
Nitrogen Rate			<.01	<.01	0.23	<.01	<.01
Stockosorb Rate			0.02	0.86	0.72	<.01	0.04
Dry/Irr X N Rate			0.24	0.24	0.14	0.43	0.76
Dry/Irr X Stockosorb			0.03	0.03	0.84	0.01	0.02
N Rate X Stockosorb			0.32	0.15	0.73	0.43	0.37
Dry/Irr X N Rate X Stockosorb			0.06	0.06	0.05	0.08	0.15

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

[2] Sorghum @ $1.30/bu; Stockosorb @ $3.00/lb; N fertilizer @ $6.00/a; banding cost @ $1.00/a.

[3] Visual rating is the general condition of the crop to include such items as stand density, skips in stand, and head size; 1=poorest, 10=best.

Table 10. Six-site summary of 1999 grain sorghum yields as affected by Stockosorb AGRO applied with and without nitrogen fertilizer, placed in a band with the seed at planting in six counties near KSU Agricultural Research Center–Hays, KS.

Stockosorb Rate w/Seed	Nitrogen Rate w/Seed[1]	Yield Barton County	Graham County	Osborne County	Rooks County	Russell County	Trego County	Six-Site Average
lb/a	lb N/a	- - - - - - - -	- - - - - - - -	- - - - - - - -	bu/a	- - - - - - - -	- - - - - - - -	- - - - - - - -
0	0	34.9	25.2	104.6	45.9	20.6	110.3	56.9
1	0	38.6	24.9	105.0	52.4	17.8	111.6	58.4
2	0	37.0	25.6	106.1	51.0	18.9	112.2	58.5
3	0	39.3	20.0	105.5	48.7	20.0	111.5	57.5
6	0	38.8	18.4	107.0	52.5	22.5	113.0	58.7
12	0	35.9	18.9	105.9	54.3	19.1	112.2	57.7
0	25	45.6	41.7	108.2	62.9	26.0	111.7	66.0
1	25	55.5	40.5	111.7	64.2	32.2	115.1	69.9
2	25	53.4	40.4	112.4	66.6	30.7	118.7	70.4
3	25	51.8	43.4	114.0	67.7	32.0	116.8	71.0
6	25	48.6	36.9	104.6	69.3	32.6	116.3	68.0
12	25	45.2	33.9	106.2	81.8	33.0	117.2	69.6
LSD (P<.05)								
Stockosorb		4.1	3.8	NS	3.7	1.7	2.7	1.8
Nitrogen		3.2	1.9	NS	4.6	2.5	1.2	0.9
Stockosorb X Nitrogen		NS	NS	NS	3.8	3.2	NS	5.4
P Values								
Stockosorb Rate		0.01	<.01	0.86	<.01	<.01	0.05	0.01
Nitrogen Rate		<.01	<.01	0.08	<.01	<.01	<.01	<.01
Stockosorb X Nitrogen		0.43	0.11	0.45	<.01	<.01	0.68	0.05

[1] 25+0+0 fertilizer using ammonium nitrate.

Table 11. Six-site summary of 1999 grain sorghum yields as affected by Stockosorb AGRO applied with and without nitrogen fertilizer, placed in a band with the seed at planting, located in six counties near the KSU Agricultural Research Center–Hays, KS.

Stockosorb Rate w/Seed	Nitrogen Rate w/Seed	Net Return[1]						
		Barton County	Graham County	Osborne County	Rooks County	Russell County	Trego County	Six-Site Average
lb/a	lb N/a	- - - - - - - - - - - - - - - - - - $/a - - - - - - - - - - - - - - - - - -						
0	0	45.34	32.74	135.95	59.72	26.84	143.42	74.00
1	0	46.14	28.32	132.58	64.15	19.10	141.06	71.89
2	0	41.14	26.22	130.96	59.33	17.59	138.86	69.02
3	0	41.10	16.06	127.12	53.28	16.06	134.94	64.76
6	0	31.40	4.87	120.13	49.28	10.28	127.82	57.30
12	0	9.62	12.52	100.64	33.56	-12.17	108.96	38.01
0	25	50.85	45.72	132.14	73.24	25.30	136.68	77.32
1	25	61.64	41.14	133.71	71.96	30.38	138.12	79.49
2	25	54.95	37.97	131.59	72.14	25.40	139.75	76.97
3	25	49.84	38.92	130.62	70.51	24.10	134.39	74.73
6	25	36.68	21.46	109.43	63.59	15.90	124.66	61.95
12	25	14.25	-0.43	93.54	61.85	-1.56	107.89	45.92
LSD (P<.05)								
Stockosorb		5.29	4.91	11.14	4.87	2.22	3.57	2.29
Nitrogen Rate		4.11	2.52	NS	6.01	3.21	1.51	1.14
Stockosorb X Nitrogen		NS	NS	NS	4.92	4.24	NS	6.97
P Values								
Stockosorb Rate		<.01	<.01	<.01	<.01	<.01	<.01	<.01
Nitrogen Rate		0.01	<.01	0.24	<.01	<.01	0.02	<.01
Stockosorb X Nitrogen		0.34	0.11	0.44	<.01	<.01	0.57	0.02

[1] Sorghum @ $1.30/bu; Stockosorb @ $3.00/lb; nitrogen fertilizer (am nitrate) @ $7.50/a; banded application @ $1.00/a.

Table 12. Six-site summary of 1999 grain sorghum yields as affected by liquid and dry Stockosorb applied with and without liquid fertilizer, all placed in a band with the seed at planting in six counties near the KSU Agricultural Research Center–Hays, KS.

Treatments	Yield						
Treatments Banded in Furrow w/Seed	Barton County	Graham County	Osborne County	Rooks County	Russell County	Trego County	Six-Site Average
	- - - - - - - -	- - - - - - - -	- - - - - - - -	bu/a	- - - - - - - -	- - - - - - - -	
Control	54.3	31.4	117.1	33.5	15.9	102.0	59.0
Stockosorb AGRO @ 1 lb/a	54.6	34.8	115.7	39.6	14.8	108.5	61.3
Stockosorb AGRO @ 2 lb/a	56.4	35.0	118.2	35.0	18.3	106.7	61.6
Stockosorb AGRO @ 3 lb/a	55.8	35.2	119.1	30.6	15.0	108.2	60.6
Liquid Fertilizer[1]	69.5	37.5	118.5	50.6	26.7	113.4	69.4
Stockosorb AGRO F @ 1 lb/a blended w/liq fert	71.8	44.3	117.0	55.6	37.6	117.1	73.9
Stockosorb AGRO F @ 2 lb/a blended w/liq fert	73.4	44.8	114.7	56.3	36.2	120.8	74.4
Stockosorb AGRO F @ 3 lb/a blended w/liq fert	75.1	51.4	102.4	57.9	39.8	116.7	73.9
Stockosorb AGRO @ 1 lb/a + liq fert	70.4	44.9	112.2	47.3	31.3	120.3	71.1
Stockosorb AGRO @ 2 lb/a + liq fert	69.1	43.4	114.6	50.8	36.8	121.6	72.7
Stockosorb AGRO @ 3 lb/a + liq fert	74.4	53.8	105.8	57.0	34.5	114.3	73.3
LSD (P<.05)	13.3	10.4	NS	13.3	6.6	6.7	4.6
P Values	<.01	<.01	0.17	<.01	<.01	<.01	<.01

[1] 25+25+0 liquid fertilizer using a blend of 10-34-0 and 28-0-0 metered through a ground-driven John Blue pump.

Table 13. Six-site summary of net return of 1999 grain sorghum as affected by liquid and dry Stockosorb applied with and without liquid fertilizer, all placed in a band with the seed at planting in six counties near the KSU Agricultural Research Center–Hays, KS.

Treatments Banded in Furrow w/Seed	Barton County	Graham County	Osborne County	Rooks County	Russell County	Trego County	Six-Site Average
	Net Return [1]						
	$/a						
Control	70.54	40.76	152.24	43.57	20.64	132.60	76.73
Stockosorb AGRO @ 1 lb/a	66.92	41.16	146.46	47.48	15.25	137.03	75.72
Stockosorb AGRO @ 2 lb/a	66.36	38.55	146.65	38.52	16.82	131.72	73.10
Stockosorb AGRO @ 3 lb/a	62.48	35.73	144.86	29.73	9.48	130.72	68.83
Liquid Fertilizer	74.14	32.59	137.92	49.54	18.50	131.17	73.97
Stockosorb AGRO F @ 1 lb/a blended w/liq fert	74.17	38.34	132.94	53.04	29.73	133.02	76.87
Stockosorb AGRO F @ 2 lb/a blended w/liq fert	73.15	36.07	126.91	50.95	24.90	134.86	74.47
Stockosorb AGRO F @ 3 lb/a blended w/liq fert	72.38	41.60	107.83	50.09	26.46	126.54	70.82
Stockosorb AGRO @ 1 lb/a + liq fert	72.33	39.20	126.70	42.30	21.54	137.19	73.21
Stockosorb AGRO @ 2 lb/a + liq fert	67.66	34.29	126.79	43.76	25.57	135.84	72.32
Stockosorb AGRO @ 3 lb/a + liq fert	71.60	44.65	112.27	48.82	19.61	123.43	70.06
LSD (P<.05)	NS	NS	16.30	NS	8.66	NS	NS
P Values	0.94	0.82	<.01	0.29	<.01	0.07	0.15

[1] Sorghum @ $1.30/bu; Stockosorb @ $3.00/lb; liquid fertilizer @ $15.21; banded application @ $1.00/a.

Table 14. Hay and silage results of 1999 Canex forage sorghum as affected by Stockosorb AGRO applied preplant broadcast and incorporated and banded with the seed at planting (site #1- June 2 and site #2- June 15) on a Harney silt loam soil, KSU Agricultural Research Center–Hays.[1]

Stockosorb Rate	Stockosorb Placement Method	Site #1 Hay - Boot Stage Plant Height	Site #1 Hay ODW	Site #1 Hay Net Return [2]	Site #1 Silage - Soft Dough Plant Height	Site #1 Silage ODW	Site #1 Silage Net Return [2]	Site #2 Hay - Boot Stage Plant Height	Site #2 Hay ODW	Site #2 Hay Net Return[2]	Site #2 Silage - Soft Dough Plant Height	Site #2 Silage ODW	Site #2 Silage Net Return [2]
lb/a			lb/a	$/a		lb/a	$/a		lb/a	$/a		lb/a	$/a
0		76	5312	140.61	88	11683	350.48	45	1987	52.60	60	5994	179.82
24	Broadcast	76	6137	87.47	88	13920	342.58	48	2677	-4.14	64	7327	144.80
48	Broadcast	78	6312	20.08	90	14212	279.35	47	2773	-73.60	64	7435	76.06
72	Broadcast	76	6476	-47.56	88	14482	215.48	48	2857	-143.37	66	7482	5.48
0		79	5270	139.50	91	11656	349.69	44	1957	51.80	59	5933	177.98
1	Banded	78	6572	169.96	90	13252	393.54	48	2868	71.92	64	7168	211.05
2	Banded	76	6812	173.33	88	14323	422.70	49	2890	69.48	66	7479	217.38
3	Banded	77	7026	175.98	89	14568	427.05	48	2928	67.50	66	7635	219.06
LSD (P<.05)													
Stockosorb Rate		NS	814	21.55	NS	1067	32.00	1	182	4.82	1	269	8.07
Placement		NS	NS	18.34	NS	NS	14.69	NS	NS	5.50	NS	NS	16.01
Stockosorb X Place		NS	NS	14.72	NS	NS	13.95	NS	NS	6.93	NS	NS	15.38

[1] A uniform application of 60+0+0 was applied broadcast and incorporated on all treatments.

[2] Canex forage sorghum hay @ $45/ton @ 15% moisture and silage @ $18/ton @ 70% moisture; Stockosorb AGRO @ $3.00/lb, broadcast @ $3.00/a; banding @ $1.00/a.

EFFECTS OF LIQUID AMISORB ON WINTER WHEAT IN CENTRAL KANSAS

C.A. Thompson

Summary

AmiSorb was evaluated on five off-station sites, and positive responses occurred on all five. These sites were located within a 60-mile radius of the KSU Agricultural Research Center–Hays. Over the five sites, little difference occurred between banded and foliar applications, with both methods showing significant yield increases over the control. If consistent, this will allow farmers more flexibility in their management program. Even though there was a general trend favoring the 2 qt/a over the 1 qt/a rate and the split application over a one-time application, these differences would not be cost-effective under the current grain market prices. Therefore, farmers who already are applying liquid starter fertilizer with their drills may wish to consider adding the 1 qt/a rate to their mixture. Foliar applications of liquid AmiSorb at seven growth stages at one on-station site did not show significant differences, although there was a trend favoring the 4-inch growth stage in the spring. Yield responses to AmiSorb occurred for six of the seven growth stages. These findings may mean that the time of application is not as important as formerly thought.

Introduction

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

AmiSorb has a high density of negative charges, which produces a high cation exchange capacity (the ability to adsorb and hold 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.

Studies in Kansas have had mixed reviews. The objectives of the studies reported here were to (1) determine the effects of liquid AmiSorb when applied in a band with the seed and foliar applied in the spring and (2) attempt to determine the optimum time of application in the spring based on growth stages.

Procedures

The wheat variety 2137 was seeded at 60 lb/a for all studies. Liquid Amisorb was banded with seed at planting time using a John Blue ground-driven pump with a 1/16 ID tube. Foliar applications were made with a three-nozzle boom mounted on a back-pack sprayer. Enough water was blended with the AmiSorb to give 20 gpa. Each study had four replications using a randomized complete block design. Each site was planted with an eight-row hoe drill using 2-inch single wheel packers. Six of eight rows were harvested with a Massey MF-8 plot combine. Test weight was measured with a Dickey-John. Plant height and visual ratings were taken at harvest. Data were analyzed with SAS using ANOVA or GLM.

Results

<u>Banded vs Foliar AmiSorb</u>

Banded and foliar treatments in the Ellis County site responded similarly to liquid AmiSorb additions (Table 15). All treatments were significantly superior to the control for both yield and visual ratings. Good correlation occurred between the visual ratings at harvest and corresponding yields. AmiSorb had no significant effect on test weight or plant height. There was a trend favoring 2 qt/a AmiSorb over 1 qt/a.

Increased grain yields and plant height resulted from AmiSorb additions at the

Graham County location (Table 16). No significant differences occurred between AmiSorb treatments. Test weight and visual ratings were not significant at the .05 probability level.

At the Ness County site, yields from all AmiSorb treatments were significantly higher than the control (Table 17). One qt/a was slightly inferior to the other AmiSorb treatments. A good correlation existed between the visual ratings and grain yields. AmiSorb had no significant effects on test weight and plant height.

Table 18 shows the effects of AmiSorb at the Rooks County site. Yields from all AmiSorb treatments were significantly higher than the control. There was a trend favoring 2 qt/a over 1 qt/a. The highest yield came from the split application of banded AmiSorb at planting and foliar application in the spring. Plant height and visual ratings correlated well with yield response. AmiSorb had no effect on test weight.

In Russell County (Table 19), yield increases from the use of AmiSorb ranged from 17.4 to 25.6 bu/a. Even though the differences in these yields were not significant, there was a definite trend favoring 2 qt/a over 1 qt/a and split application over one-time banding or foliar applications. Plant height and visual rating correlated well with yield increases. AmiSorb had no effect on test weight.

The yield summary of the five sites where liquid AmiSorb was banded and foliar applied is shown in Table 20. Significant increases over the control averaged from 10.6 to 15.0 bu/a. Even though there was a trend favoring the 2 qt/a rate over 1 qt/a and split over one-time applications, the cost-effectiveness of increased inputs needs to be considered carefully. For those farmers who are already applying liquid starter fertilizer, it makes sense to blend in 1 qt/a AmiSorb on enough acres to determine its effectiveness under their local conditions.

<u>Optimal Application Date</u>

On a continuous wheat site at the KSU Agricultural Research Center–Hays, liquid AmiSorb was applied at different growth stages to determine the optimal application date. At each growth stage, liquid N at 40 lb N/a was applied with and without AmiSorb. AmiSorb applied at six of the seven growth stages resulted in significant yield increases (Table 21). There was a trend favoring the 4-inch growth stage, but it was not significant at the .05 probability level. There was no interaction with AmiSorb and growth date. AmiSorb had no effect on test weight, plant height, or visual ratings. A similar study was conducted in the greenhouse with no significant effects.

Table 15. Winter wheat results for 1999 as affected by banded and foliar-applied liquid AmiSorb on the A. J. Pfannenstiel farm in Ellis County, KS in a wheat-sorghum-fallow rotation on a Harney silt loam soil.[1]

AmiSorb Rate	Application Method	Grain Yield	Test Weight	Plant Height	Visual Rating at Harvest[2]
qt/a		bu/a	lb/bu	inch	
0		22.5	59.2	33.5	4.8
1	Banded w/seed	37.6	59.6	37.0	6.2
2	Banded w/seed	39.4	60.1	35.2	6.5
1	Foliar in spring	36.2	59.8	35.5	6.5
2	Foliar in spring	39.4	60.0	34.8	6.8
1	Banded w/seed	40.2	59.9	34.8	7.0
+ 1	Foliar in spring				
LSD (P<.05)		4.1	NS	NS	0.7
P Value		<.01	0.11	0.07	<.01

[1] 30+30+0 using 10-34-0 and 28-0-0 was banded with the seed on treatment 1. For treatments 2 and 3, 30+30+0 was banded with liquid AmiSorb. 9+30+0 using 10-34-0 was banded with the seed for treatments 4, 5, and 6; all foliar treatments received 21 lb N/a in spring with liquid AmiSorb.

[2] Visual rating is the general condition of the crop to include such items as stand density, minor lodging, and head size; 1 = poorest, 10 = best.

Table 16. Winter wheat results for 1999 as affected by banded and foliar-applied liquid AmiSorb on the Vo-Ag farm in Graham County, KS in a wheat-sorghum-fallow rotation on a Coly silt loam soil.[1]

AmiSorb Rate	Application Method	Grain Yield	Test Weight	Plant Height	Visual Rating at Harvest[2]
qt/a		bu/a	lb/bu	inch	
0		58.0	59.4	37.5	7.0
1	Banded w/seed	64.0	59.1	39.0	8.0
2	Banded w/seed	64.4	59.3	39.8	8.0
1	Foliar in spring	65.5	59.5	39.5	7.5
2	Foliar in spring	65.6	59.4	39.8	8.0
1	Banded w/seed	64.4	59.6	40.8	8.2
+ 1	Foliar in spring				
LSD (P<.05)		4.5	NS	1.5	NS
P Value		0.02	0.63	0.01	0.14

[1] 30+30+0 using 10-34-0 and 28-0-0 was banded with the seed on treatment 1. For treatments 2 and 3, 30+30+0 was banded with liquid AmiSorb. 9+30+0 using 10-34-0 was banded with the seed for treatments 4, 5, and 6; all foliar treatments received 21 lb N/a in spring with liquid AmiSorb.

[2] Visual rating is the general condition of the crop to include such items as stand density, minor lodging, and head size; 1 = poorest, 10 = best.

Table 17. Winter wheat results for 1999 as affected by banded and foliar-applied liquid AmiSorb on the Alex Nichepor farm in Ness County, KS in a wheat-sorghum-fallow rotation on a Harney silt loam soil.[1]

AmiSorb Rate	Application Method	Grain Yield	Test Weight	Plant Height	Visual Rating at Harvest[2]
qt/a		bu/a	lb/bu	inch	
0		56.0	59.5	34.5	7.0
1	Banded w/seed	62.0	59.6	35.8	7.8
2	Banded w/seed	63.4	59.8	35.5	7.8
1	Foliar in spring	60.8	59.4	35.8	7.2
2	Foliar in spring	62.6	59.5	35.5	8.0
1	Banded w/seed	64.9	59.6	35.8	8.5
+ 1	Foliar in spring				
LSD (P<.05)		3.4	NS	NS	0.8
P Value		<.01	0.54	0.08	0.01

1 30+30+0 using 10-34-0 and 28-0-0 was banded with the seed on treatment 1. For treatments 2 and 3, 30+30+0 was banded with liquid AmiSorb. 9+30+0 using 10-34-0 was banded with the seed for treatments 4, 5, and 6; all foliar treatments received 21 lb N/a in spring with liquid AmiSorb.

2 Visual rating is the general condition of the crop to include such items as stand density, minor lodging, and head size; 1 = poorest, 10 = best.

Table 18. Winter wheat results for 1999 as affected by banded and foliar-applied liquid AmiSorb on the Darrell Hrabe farm in Rooks County, KS in a wheat-sorghum-fallow rotation on a Wakeen silt loam soil.[1]

AmiSorb Rate	Application Method	Grain Yield	Test Weight	Plant Height	Visual Rating at Harvest[2]
qt/a		bu/a	lb/bu	inch	
0		26.1	60.0	25.8	4.8
1	Banded w/seed	34.3	60.0	31.0	6.2
2	Banded w/seed	36.7	60.0	32.0	6.2
1	Foliar in spring	35.0	59.8	30.5	6.5
2	Foliar in spring	38.4	60.0	32.5	6.5
1	Banded w/seed	42.3	59.6	33.5	7.2
+ 1	Foliar in spring				
LSD (P<.05)		6.4	NS	1.7	0.8
P Value		<.01	0.58	<.01	<.01

1 30+30+0 using 10-34-0 and 28-0-0 was banded with the seed on treatment 1. For treatments 2 and 3, 30+30+0 was banded with liquid AmiSorb. 9+30+0 using 10-34-0 was banded with the seed for treatments 4, 5, and 6; all foliar treatments received 21 lb N/a in spring with liquid AmiSorb.

2 Visual rating is the general condition of the crop to include such items as stand density, minor lodging, and head size; 1 = poorest, 10 = best.

Table 19. Winter wheat results for 1999 as affected by banded and foliar-applied liquid AmiSorb on the Jerry Ross farm in Russell County, KS in a wheat-sorghum-fallow rotation on a Harney silt loam soil.[1]

AmiSorb Rate	Application Method	Grain Yield	Test Weight	Plant Height	Visual Rating at Harvest[2]
qt/a		bu/a	lb/bu	inch	
0		42.1	60.0	34.0	6.8
1	Banded w/seed	59.4	59.8	37.2	7.5
2	Banded w/seed	65.2	59.8	37.0	8.2
1	Foliar in spring	55.8	59.8	37.8	7.8
2	Foliar in spring	66.4	59.9	38.8	8.2
1	Banded w/seed	67.7	59.8	39.5	8.8
+ 1	Foliar in spring				
LSD (P<.05)		9.9	NS	1.6	0.9
P Value		<.01	0.86	<.01	<.01

[1] 30+30+0 using 10-34-0 and 28-0-0 was banded with the seed on treatment 1. For treatments 2 and 3, 30+30+0 was banded with liquid AmiSorb. 9+30+0 using 10-34-0 was banded with the seed for treatments 4, 5, and 6; all foliar treatments received 21 lb N/a in spring with liquid AmiSorb.

[2] Visual rating is the general condition of the crop to include such items as stand density, minor lodging, and head size; 1 = poorest, 10 = best.

Table 20. Five-site summary of 1999 winter wheat yields as affected by liquid AmiSorb banded with the seed and foliar applied in five counties in western Kansas.[1]

AmiSorb Rate	Application Method	Ellis County	Graham County	Ness County	Rooks County	Russell County	Five-Site Average
qt/a							
0		22.5	58.0	56.0	26.1	42.1	40.9
1	Band w/seed	37.6	64.0	62.0	34.3	59.4	51.5
2	Band w/seed	39.4	64.4	63.4	36.7	65.2	53.8
1	Foliar in spring	36.2	65.5	60.8	35.0	55.8	50.7
2	Foliar in spring	39.4	65.6	62.6	38.4	66.4	54.5
1	Band w/seed	40.2	64.4	64.9	42.3	67.7	55.9
+1	Foliar in spring						
LSD (P<.05)		4.1	4.5	3.4	6.4	9.9	2.6
P Value		<.01	0.02	<.01	<.01	<.01	<.01

[1] 30+30+0 using 10-34-0 and 28-0-0 was banded with the seed on treatment 1. For treatments 2 and 3, 30+30+0 was banded with liquid AmiSorb. 9+30+0 using 10-34-0 was banded with the seed for treatments 4, 5, and 6; all foliar treatments received 21 lb N/a in the spring with liquid AmiSorb.

Table 21. Winter wheat results for 1999 as affected by liquid AmiSorb applied with liquid fertilizer, foliar applied at seven dates on an Armo loam soil on continuous wheat rotation, KSU Agricultural Research Center–Hays, KS.[1]

Growth Date Foliar Applied	AmiSorb Rate	Grain Yield	Test Weight	Plant Height	Visual Rating at Harvest[2]
	qt/a	bu/a	lb/bu	inch	
Predormancy	0	30.4	59.5	29.0	4.8
Predormancy	1	33.2	59.4	28.8	4.5
Dormancy	0	28.8	59.4	28.5	4.0
Dormancy	1	31.8	59.2	28.8	4.5
Early Greenup	0	30.5	59.5	28.5	4.8
Early Greenup	1	33.1	59.4	29.5	5.0
2-inch Growth	0	31.0	59.2	29.0	5.5
2-inch Growth	1	34.2	59.2	28.2	5.0
4-inch Growth	0	30.2	59.4	28.2	5.2
4-inch Growth	1	38.3	59.3	30.0	5.5
6-inch Growth	0	30.7	59.3	28.0	4.8
6-inch Growth	1	32.4	59.3	28.0	5.0
8-inch Growth	0	29.6	59.4	28.0	4.8
8-inch Growth	1	32.0	59.3	28.2	4.8
LSD (P<.05)					
Growth Date		NS	NS	NS	NS
Amisorb Rate		2.1	NS	NS	NS
Date X Rate		NS	NS	NS	NS
P Values					
Growth Date		0.29	0.54	0.42	0.12
Amisorb Rate		0.01	0.35	0.35	0.76
Date X Rate		0.73	0.99	0.64	0.93

[1] A blanket application of liquid fertilizer @ 40 lb N/a using 28-0-0 was applied on a plots.

[2] Visual rating is the general condition of the crop to include such items as stand density, minor lodging, and head size; 1=poorest, 10=best.

SOIL FERTILITY RESEARCH
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EFFECTS OF PREVIOUS CROP, NITROGEN RATE, AND NITROGEN METHOD ON NITROGEN REQUIREMENT FOR WINTER WHEAT

K.W. Kelley and D.W. Sweeney

Summary

Wheat yields were influenced significantly by previous crop, tillage method, fertilizer nitrogen (N) placement, and N rate. In the first study that evaluated both reduced- and no-tillage systems, grain yields were highest for wheat following soybean with reduced tillage and lowest for wheat planted no-till following grain sorghum. Applying fertilizer N (28% UAN) below crop residues with a coulter-knife applicator also significantly increased grain yield compared with broadcast fertilizer N treatments, regardless of previous crop or tillage system. In the second study that evaluated only no-tillage, wheat yields also were influenced by previous crop and fertilizer N and phosphorus (P) application method and N rate. Grain yields averaged nearly 40 bu/a following short-season corn or soybean but only 25 bu/a following grain sorghum. Averaged over previous crops and N rates, grain yields were highest with knifed N-P applications, intermediate for surface strip banding, and lowest for surface broadcast treatments.

Introduction

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

Procedures

<u>Conventional and No-Tillage (Table 1)</u>

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

<u>No-Tillage (Table 2)</u>

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

was liquid 10-34-0. Potassium fertilizer was broadcast applied to all treatments at a constant rate of 120 lbs K_2 0/a. All fertilizers were fall-applied prior to planting. Wheat was planted with a no-till drill.

Results

Conventional and No-Tillage (Table 1)

Wheat yield was influenced significantly by previous crop, tillage method, N rate, and N placement. Yield averaged 10 bu/a higher for wheat following soybean compared to wheat following grain sorghum. Reduced tillage (disking) resulted in slightly higher grain yield than no-till, regardless of previous crop. Yields were reduced in 1999 because of above-normal rainfall during April and May, which produced water-logged soil conditions.

Fertilizer N placement and N rate also affected grain yields for all previous crop and tillage systems. Grain yields were significantly higher when liquid 28% N was placed below crop residues with a coulter-knife applicator compared with broadcast N treatments, regardless of previous crop or tillage system. Plant N analyses for 1999 are still pending; however, grain yield results suggest that wheat was able to utilize subsurface knifed N applications more efficiently. When wheat followed grain sorghum, the split application (fall and late-winter) of urea gave higher yields than the preplant broadcast treatment at the same N rate of 120 lbs/a. However, when wheat followed soybeans, the preplant broadcast N treatment was higher than the urea split application, especially for the no-till system. Rainfall was above normal in the fall after wheat planting, which likely moved broadcast N below the soil surface. However, in the case of wheat following grain sorghum, fertilizer N likely was immobilized to a greater extent because of higher residue levels compared to soybean.

No-Tillage (Table 2)

When wheat was planted no-till, yields were influenced significantly by previous crop, N-P application method, and N rate. Grain yields averaged nearly 40 bu/a following short-season corn or soybean, but only 25 bu/a following grain sorghum. Averaged over previous crops and N rates, grain yields were highest with knifed N-P applications, intermediate for surface strip banding, and lowest for surface broadcast treatments. Grain yields also increased with increasing N rates, except for the knifed application following soybean. When wheat followed soybean, the 80 lb N rate was nearly the same as the 120 lb N rate. Where wheat followed grain sorghum, the 120 lb N rate likely was not high enough to optimize grain yield because of greater immobilization of fertilizer N compared to wheat following corn or soybean.

Soil samples taken in the fall after harvest and before wheat fertilization showed that residual nitrate-N levels in the top 12 in. of soil were 10 ppm following corn, 2 ppm following grain sorghum, and 15 ppm following soybean. Ammonium-N levels were similar across all previous crops, averaging slightly less than 20 ppm in the top 12 in. Soil organic matter averaged 2.7% (0 to 6 in.), and soil P level was 17 ppm in the top 6 in. and 5 ppm at the 6 to 12 in. depth.

Although above-normal rainfall occurred in the fall after planting and during the late spring period from March through early June, yield results suggest that N losses from leaching or denitrification were minimal at this site, where soil slope prevented ponding of surface water.

In this study, previous crop residues did not appear to affect wheat germination or early seedling growth through the process of allelopathy. Thus, wheat yield differences between previous crops and N-P placement methods appear to be related primarily to greater availabilities of N and P following corn or soybean and to immobilization of applied N following grain sorghum.

Table 1. Effects of previous crop, tillage method, nitrogen rate, and nitrogen method on nitrogen requirements for hard winter wheat, Parsons, KS, 1999.

			Wheat Yield After			
N	N	N	Grain Sorghum		Soybean	
Rate	Method	Source	NT	RT	NT	RT
lb/a			--------------------	bu/a	--------------------	
0	---	---	12.9	13.0	21.3	22.5
60	B'cast	UAN	18.3	19.4	27.9	31.1
60	Knife	UAN	28.4	30.5	37.5	39.1
120	B'cast	UAN	25.8	28.9	39.9	42.4
120	Knife	UAN	42.6	48.0	49.9	55.4
120[1]	B'cast	Urea	34.0	35.7	32.3	41.1
Avg.			27.0	29.3	34.8	38.6

Means: (No N and 120 N as urea omitted)	
Grain sorghum	30.2
Soybean	40.4
LSD (0.05)	1.1
Reduced tillage	36.8
No-tillage	33.8
LSD (0.05)	1.1
B'cast	29.2
Knife	41.4
LSD (0.05)	1.0
60 lb N/a	29.0
120 lb N/a	41.6
LSD (0.05)	1.0

[1]60 lb N/a applied in the fall and 60 lb N/a top-dressed in late Feb.
UAN = urea ammonium nitrate 28% N solution.
NT = no tillage, RT = reduced tillage (disk)
Planting date = Oct. 25, 1998; variety = Jagger
All plots received 60 lbs/a P_20_5 and 75 lbs/a K_20

Table 2. Effects of previous crop, nitrogen and phosphorus application method, and nitrogen rate for hard winter wheat, Parsons, KS, 1999.

N and P Applic. Method	Fertilizer Rate N	Fertilizer Rate P_2O_5	Wheat Yield After Corn	Wheat Yield After Grain Sorghum	Wheat Yield After Soybean
	----- lbs/a -----		----- bu/a -----		
Knife	20	68	30.1	18.4	32.1
Knife	40	68	36.9	21.4	39.6
Knife	80	68	45.8	37.9	51.3
Knife	120	68	52.3	43.5	52.8
Strip Band	20	68	34.0	14.5	32.2
Strip Band	40	68	38.1	21.6	38.1
Strip Band	80	68	45.2	27.9	42.6
Strip Band	120	68	49.1	35.3	47.7
Broadcast	20	68	28.6	13.8	32.5
Broadcast	40	68	36.3	18.6	35.2
Broadcast	80	68	41.1	23.1	41.5
Broadcast	120	68	46.3	30.2	45.3
Knife Control	0	0	22.8	14.2	25.3
Control	0	0	24.3	14.1	27.3
LSD (0.05)			2.6	2.6	2.6
Means: (controls omitted)			40.3	25.5	40.9
N-P Application Method					
Knife			41.3	30.3	43.9
Strip Band			41.6	24.8	40.1
Broadcast			38.1	21.4	38.6
LSD (0.05)			1.3	1.3	1.3
N Rate (lb/a)					
20			30.9	15.5	32.2
40			37.1	20.5	37.6
80			44.0	29.6	45.1
120			49.2	36.3	48.6
LSD (0.05)			1.5	1.5	1.5

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

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

D.W. Sweeney

Summary

In 1998, the sixteenth cropping year of a grain sorghum-soybean rotation, tillage and residual N management systems did not affect soybean yields. Long-term average yields also were unaffected by these management options.

Introduction

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

Procedure

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

Similar to the long-term average, 1998 soybean yields were unaffected by tillage or the residual from N fertilization applied to the grain sorghum crop in the previous year (Table 3).

Table 3. Effects of tillage and nitrogen fertilization on yield of soybean grown in rotation with grain sorghum, Southeast Agricultural Research Center, Parsons, KS.

Treatment	1998 Yield	Avg. Yield 1984-1998
	-------------------- bu/a	--------------------
Tillage		
Conventional	25.0	24.7
Reduced	25.8	24.7
No tillage	26.0	24.9
LSD (0.05)	NS	NS
N Fertilization		
Check	25.4	24.6
Anhydrous NH_3	26.2	25.2
UAN broadcast	24.8	24.0
Urea broadcast	25.9	25.1
LSD (0.05)	NS	NS
T x N Interaction	NS	NS

MANAGEMENT OF PHOSPHORUS-STRATIFIED SOIL FOR EARLY-SEASON CORN PRODUCTION[1]

D.W. Sweeney, G.J. Schwab, and D.A. Whitney

Summary

In 1998 at two sites, short-season corn yield was affected little by soil P stratification, tillage, or P fertilizer placement.

Introduction

Phosphorus (P) stratification in soils in reduced- or no-tillage cropping systems has been well documented. If dry conditions occur during the summer, P uptake from the surface few inches can be limited. This can be alleviated by redistribution of the stratified P or by subsurface placement of additional fertilizer P. The objective of this study was to determine the effectiveness of tillage and/or P placement to alleviate the effects of P stratification in soil on short-season corn grown with no tillage.

Procedure

Two adjacent sites were established for this study. Site 1 was backgrounded with a soybean crop in 1996 followed in 1997 and 1998 with the short-season corn experiment; site 2 was backgrounded in 1997 and followed in 1998 with short-season corn. Stratified or nonstratified areas were established prior to planting the background soybean crop. This was accomplished by applying P fertilizer and incorporating by chisel, disk (deep), and field cultivation for the unstratified profile or only incorporating to a depth of 2 in. with a field cultivator for the stratified profile. These main plots were subdivided in 1997 for Site 1 and in 1998 for Site 2 by tillage (chisel/disk and no tillage), and sub-subplots were P placement methods (no P, broadcast 40 lb P_2O_5/a, and knife 40 lb P_2O_5/a at 4 in.). Corn was planted on April 24, 1997 and April 22, 1998.

Results

In 1998 at Site 1, short-season corn yield averaged about 78 bu/a and was unaffected by stratification, tillage, or P fertilization (data not shown). At Site 2, average corn yield was 91 bu/a and was affected by an unexplainable interaction resulting from lower yield from broadcast application of P when the soil was stratified than obtained with knife application or even no P fertilizer. Little difference in yield was observed otherwise.

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

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

D.W. Sweeney

Summary

Delaying all phosphorus and potassium (P-K) fertilizer to late winter reduced wheat yields in 1998. Double-crop soybean yields were affected only by tillage. Because of replanting, no tillage resulted in lower yields than reduced tillage.

Introduction

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

Procedure

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

Results

In 1998, wheat yield was increased by more than 20 bu/a with fertilization (data not shown.) Wheat yields were lower when all P-K was delayed until late winter in the no-till system, but no differences occurred in the reduced-tillage system. Wheat yield was unaffected by timing of N fertilization. Double-crop soybean yields were about 7 bu/a less with no tillage, likely because of a poor initial stand and replanting about 2 weeks later than in the reduced system. Double-crop soybeans were unaffected by the timing of N-P-K fertilization applied to the wheat crop.

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

J. L. Moyer and D. W. Sweeney

Summary

In the year of application (1998), forage yield was increased by 60% from the first 45 lb/a increment of N application and by another 45% with the next 45 lb. With 90 lb/a of N applied in 1998, the 1999 yield was increased by 40% compared to no N and by 23% compared to 45 lb/a of N applied in 1998. Knife N application at the 90 lb/a rate resulted in higher yields compared to broadcast application for the 2-cut system in both 1998 and 1999.

Introduction

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

Procedure

Established (20-year-old) Pete eastern gamagrass was fertilized with 54 lb P_2O_5/a and 61 lb K_2O/a in each of the past 8 years and burned each spring except 1996. In 1998, nitrogen (urea-ammonium nitrate, 28% N) treatments of 0, 45, or 90 lb/a were applied on April 23 to 8 ft x 20 ft plots by broadcast or knife (4-inch) placement. Nitrogen was not applied in 1999 so that residual responses could be tested.

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

Results

Yields in 1998 were increased (P<.05) by 60% with the first 45 lb/a increment of N and by an additional 41% with the next 45-lb increment (Fig. 1). Application of 90 lb/a of N in 1998 compared to no N resulted in 40% greater (P<.05) forage yield in 1999. Also in 1999, yield was 23% higher for the 90 lb N rate compared to 45 lb/a of N applied in 1998 (Fig. 1).

Knifing N in 1998 resulted in significant (P<.05) yield interactions between N rate and N placement factors for the 2-cut system in 1998 and 1999. Figure 2 illustrates that in 1998, total yield for the 2-cut system increased (P<.05) with each increment of added N, and that knife placement increased yield more than broadcast at the 90 lb/a N rate. In 1999, yield was increased (P<.05) by 1998 knife placement of 90 lb N/a compared to all other 1998 treatments (Fig. 2).

The two-harvest systems resulted in similar total yields in 1998. In 1999, however, the 1-cut harvest system resulted in 20% more total yield than the 2-cut system, 2.99 vs. 2.49 tons/a. No interaction occurred between harvest system and N application treatments; i.e., 1-cut and 2-cut harvest systems responded similarly to the N treatments (data not shown).

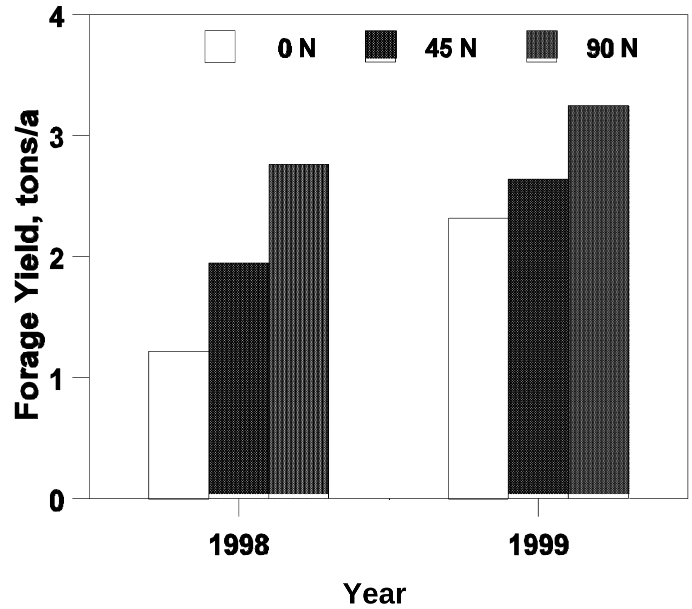

Figure 1. Eastern gamagrass forage yields (12% moisture) for 1998 and 1999 from different N application rates in 1998, Southeast Agricultural Research Center, Parsons, KS.

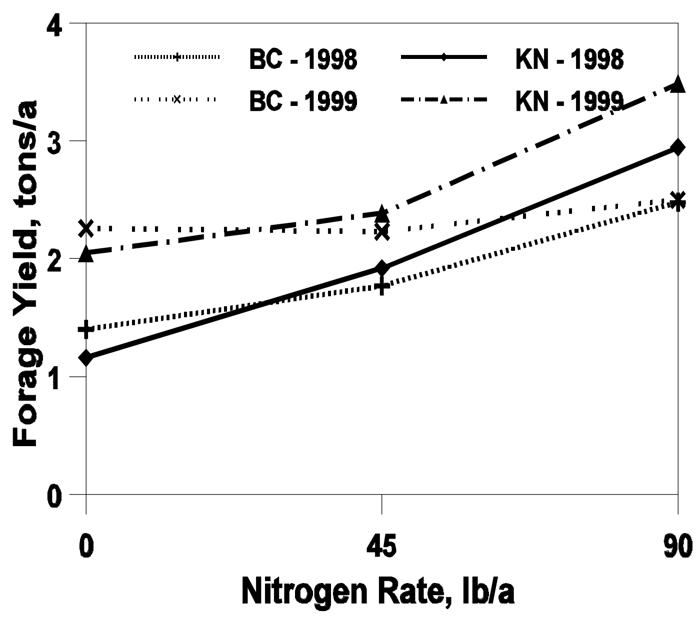

Figure 2. Eastern gamagrass forage yields (12% moisture) in the 2-cut system for 1998 and 1999 from different N application methods and rates in 1998, Southeast Agricultural Research Center, Parsons, KS.

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 more 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 28% UAN) were evaluated during 1982-1989. No grain sorghum yield differences resulted from N source. The 18-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 1996-1999, 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 non-legume crop. Other benefits of legume rotations include; breaking disease and insect cycles, helping weed control programs, and decreasing the toxic effects of crop residues. This study evaluates N rates for continuous grain sorghum and grain sorghum grown in annual rotation with 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, anhydrous ammonia was used as the sole N source. In each year, N was knife applied 7-14 days prior to planting. Grain sorghum was planted at the rate of 60,000 seed/a, and 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 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 more than continuous sorghum. When four additional N rates were added, yields were greater in the soybean rotation than in the continuous system at all levels of N in 3 of 4 years (Table 2). Addition of N alone did not make up yield losses in a continuous sorghum production system. Over the 18-year period (1982-1999), soybean yields averaged 36 bu/a and were not affected by N applied to the previous sorghum crop (Table 3). Two knife-applied N sources, anhydrous ammonia and 28% UAN, were evaluated from 1982-1989. When averaged over cropping system and N rate, yields were 60 and 59, bu/a for anhydrous ammonia and UAN, respectively. When averaged over N rates, the number of days from emergence to mid-bloom was 7 days shorter in the rotated system than in the continuous system (Table 1).

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

N Rate	Cropping System	Grain Yield 1982-1995	Days to 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, 1996-1998, Belleville, KS.

N Rate	Cropping System	Yield 1996	1997	1998	1999	Avg.
lb/a		- - - - - - - - - - - - - - -	- - -	bu/a	- - - - - - - - - - - - - - -	
0	Continuous	92	51	55	73	68
	Rotated	120	88	87	112	102
30	Continuous	110	71	75	95	88
	Rotated	137	108	115	119	120
60	Continuous	131	110	118	115	119
	Rotated	164	128	142	127	140
90	Continuous	143	121	126	125	129
	Rotated	163	141	144	126	144
120	Continuous	148	122	128	123	130
	Rotated	162	144	145	128	145
150	Continuous	148	120	127	123	130
	Rotated	162	143	145	129	145
180	Continuous	148	121	128	126	131
	Rotated	162	144	145	129	145
210	Continuous	148	122	128	126	131
	Rotated	162	145	145	129	145
System Means						
	Continuous	134	105	111	113	116
	Rotated	154	130	134	125	136
N Rate Means						
0		106	70	71	92	85
30		124	90	95	107	104
60		148	119	130	121	130
90		153	131	135	126	136
120		155	133	137	126	138
150		155	132	136	126	137
180		155	133	137	127	138
210		155	134	137	127	138
LSD(0.05)		8	6	6	6	

Table 3. Yield of soybeans grown in rotation with grain sorghum, 1982-1999*, Belleville, KS.

Year	Yield	Year	Yield
	bu/a		bu/a
1982	38	1991	12
1983	15	1992	58
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	1999	42

*Average 1982-1999= 36 bu/a

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 North Central Kansas Experiment Field, located near Scandia, on a Crete silt loam soil. Starter fertilizer (7-21-7) included three sources of potassium (K): sulfate of potassium (SOP), potassium chloride (KCL), and potassium thiosulfate (KTS). The test also included two placement methods (in-furrow with the seed and 2 in. to the side and 2 in. below the seed at planting) and four application rates (50, 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 2x2. Corn yield was reduced 36 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, no yield reduction occurred until the rate exceeded 100 lb/a. Grain yield with KTS applied in-furrow was equal to that with SOP at the 50 lb/a rate. When averaged over sources and rates, corn yields were 20 bu/a less for in-furrow fertilizer placement than for 2x2 placement. When starter fertilizer was placed in-furrow with soybean seed, yields and plant populations were reduced compared to the no-starter check.

Procedures

This irrigated ridge-tilled filled experiment was conducted at the North Central Experiment Field, near Scandia, on a Crete silt loam soil. Analysis by the KSU Soil Testing Laboratory 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 three potassium sources applied either in-furrow or 2 x 2 at five different rates. A no-starter check also was included. The three sources of K were sulfate of potassium (SOP), potassium chloride (KCL), and potassium thiosulfate (KTS). A liquid 7-21-7 fertilizer was made using ammonium polyphosphate (10-34-0) and either SOP, KCL, or KTS and was applied at 50, 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 NC+ 5445 was planted on 20 April at the rate of 32,000 seed/a. The soybean variety Dekalb CX370RR was planted on 15 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, until rate exceeded 100 lb/a. 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 also were reduced by in-furrow application of 150 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 2x2 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 4510 plants/a. When in-furrow rate of starter fertilizer containing KTS exceeded 50 lb/a, yield, plant population, and V6 dry weight all were reduced compared to 2x2 fertilizer placement. When starter fertilizer containing KCL or KTS was placed in-furrow with the soybean seed, yield and plant population were reduced regardless of rate (Table 5). When averaged over source and rate, in-furrow application reduced yield by 13 bu/a compared to 2x2 placement. Starter fertilizer placed 2x2 increased soybean yield by 7 bu/a compared to the no-starter check, when averaged over source.

In both the 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, 1999.

Source	Placement	Rate of 7-21-7	Yield 1999	Population 1999	V6 Dry Weight 1999
		lb/a	bu/a	plants/a	lb/a
		0*	175	32580	266
SOP**	In-furrow	50	182	26917	405
		100	180	26917	428
		150	174	24735	425
		200	170	24153	420
	2 x 2	50	184	31282	480
		100	186	31719	490
		150	204	32010	510
		200	201	32446	501
KCL***	In-furrow	50	174	25026	385
		100	166	23862	370
		150	168	22843	285
		200	159	22407	219
	2 x 2	50	186	29536	410
		100	184	31573	463
		150	197	31573	505
		200	195	30264	528
KTS****	In-furrow	50	182	25171	399
		100	175	24880	388
		150	163	22407	256
		200	166	21825	241
	2 x 2	50	184	30991	420
		100	186	31719	489
		150	197	31137	520
		200	201	31864	522
LSD(0.05)			8	405	45

*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.
****7-21-7 Starter fertilizer made using potassium thiosulfate (KTS) as the 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, 1999.

Source	Placement	Rate of 7-21-7	Yield 1999	Population 1999	V-6 Dry Weight 1999
		lb/a	bu/a	plant/a	lb/a
		0*	64	112367	290
SOP**	In-furrow	50	71	88666	322
		100	61	81200	335
		150	58	63600	280
		200	51	70933	258
	2 x 2	50	72	102533	344
		100	72	105840	365
		150	72	101466	360
		200	76	100533	367
KCL***	In-furrow	50	62	82000	288
		100	57	66933	250
		150	56	64266	220
		200	50	66400	211
	2 x 2	50	67	109570	314
		100	69	114400	322
		150	74	105359	330
		200	73	101266	328
KTS****	In-furrow	50	59	79733	300
		100	59	69066	269
		150	56	63833	260
		200	56	64133	255
	2 x 2	50	69	111240	330
		100	69	104381	355
		150	74	102600	351
		200	75	106708	361
LSD(0.05)			5	8236	21

*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.
****7-21-7 Starter fertilizer made using potassium thiosulfate.

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

W.B. Gordon and D.A. Whitney

Summary

This experiment was conducted at the North Central Kansas Experiment Field, located near Belleville, on a Crete silt loam soil. Soil test P was in the "high" range. Treatments consisted of tillage systems and starter fertilizer placement and composition. Tillage systems consisted of no-tillage and minimum tillage (spring disk and harrow treatment). Methods of starter fertilizer application included placement 2 in. to the side and 2 in. below the seed at planting and dribbled in a band on the soil surface 2 in. beside the seed row. Liquid starter fertilizer treatments consisted of N and P_2O_5 combinations giving 15, 30, and 45 lb N/a and 30 lb P_2O_5/a. Starter treatments containing 30 lb N or 30 lb P_2O_5/a applied alone and a no-starter check also were included. In both tillage systems, yields were maximized by 2x2 placement of starter fertilizer containing either 30 or 45 lb N/a with 30 lb P_2O_5/a. Although dribble applications improved yields over the no-starter check, they were not as effective as 2x2 starter fertilizer placement.

Introduction

Greater use of reduced-tillage systems by producers raises questions concerning fertilization practices. These systems have proven to be effective in reducing soil erosion; however, large amounts of surface residues can adversely affect early-season growth, nutrient uptake, and yield of crops. Starter fertilizers have proved beneficial in correcting these problems. This research is aimed at minimizing fertility problems that arise with reduced-tillage systems, thus making conservation tillage more attractive to producers.

Procedures

The experiment was conducted at the North Central Kansas Experiment Field on a Crete silt loam soil. Analysis by the KSU Soil Testing Laboratory showed that initial soil pH was 6.2, organic mater was 2.2%, Bray P-1 was 42 ppm, and exchangeable K was 320 ppm in the top 6 inches of soil. Treatments consisted of two tillage systems (no-tillage and minimum tillage). The minimum-tillage treatment received one disking and harrowing operation in the spring 3 weeks prior to planting. Starter fertilizer was placed either 2 in. to the side and 2 in. below the seed at planting (2x2) or dribbled in a band on the soil surface 2 in. beside the seed at planting. Starter fertilizer treatments consisted of N and P_2O_5 combinations giving 15, 30, or 45 lb N/a with 30 lb P_2O_5/a. Treatments consisting of either 30 lb N/a or 30 lb P_2O_5/a applied alone and a no-starter check also were included. Starter combinations were made using 10-34-0 and 28% UAN. After planting, knife applications of 28% UAN were made to bring N applied to each plot to a total of 140 lb/a. Grain sorghum (NC+ 7R83) was planted at the rate of 60,000 seed/a on May 28, 1999. Plots were harvested on Oct 12, 1999.

Results

Although dribble-applied starter fertilizer increased grain yield over the no-starter check, yields were higher when fertilizer was placed 2x2 (Table 6). The greatest yields in both tillage systems occurred with 2x2 applications of starter fertilizer containing either 30 or 45 lb N/a with 30 lb P_2O_5/a. The N alone or the P alone treatments did not perform as well as the higher N starter combinations. The treatment containing only 15 lb N/a with 30 lb P_2O_5/a also was not as effective as starters containing more N. Use of starter fertilizer resulted in greater yields in both tillage systems.

Table 6. Effects of tillage system and starter fertilizer placement and composition grain sorghum yield and V6-stage dry matter accumulation, Belleville, KS, 1999.

		Starter			
Tillage	Placement	N	P_2O_5	Yield	V6 Dry Matter
		lb/a		bu/a	lb/a
Reduced		0	0	124	543
	2x2	0	30	132	680
		30	0	130	764
		15	30	141	798
		30	30	150	948
		45	30	151	933
	Dribble	0	30	133	646
		30	0	134	648
		15	30	134	755
		30	30	136	822
		45	30	135	883
No-Tillage		0	0	118	313
	2x2	0	30	144	593
		30	0	141	572
		15	30	145	766
		30	30	155	872
		45	30	155	916
	Dribble	0	30	135	466
		30	0	133	613
		15	30	130	613
		30	30	134	635
		45	30	133	675
LSD(0.05)				6	49
CV%				3.2	12.8

SOIL FERTILITY RESEARCH
HARVEY COUNTY EXPERIMENT FIELD

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

M.M. Claassen

Summary

Wheat following sorghum that had been fertilized with 120 lb/a of nitrogen (N) yielded an average of 7 bu/a more than wheat following sorghum that had received only 60 lb/a of N. This effect was not eliminated as wheat N rates increased. A large positive yield response resulted from each 40 lb/a increment of fertilizer N. Highest yields averaging 75 bu/a were obtained with 120 lb/a of N following 120 lb/a of N on sorghum. Test weight, plant height, and plant N concentration also increased with N rate. Contrary to expectations, wheat yields tended to be highest when seeded at 60 lb/a, rather than 90 or 120 lb/a. Although no significant interaction occurred between seeding rate and N rate effects on yield, there was a trend toward lower average yields at the highest seeding rates when N was limiting. The absence of a yield benefit from increased seeding rate appeared to be the result of unusually high rainfall and excellent stand establishment.

Introduction

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

Procedures

The experiment site was located on a Geary silt loam soil with pH 6.4, 2.4% organic matter, 20 lb/a of available phosphorus (P), and 493 lb/a of exchangeable potassium. Grain sorghum had been grown continuously on the site for a period of years. A split-plot design was utilized with main plots of 60 and 120 lb/a N rates on the preceding sorghum crop and subplots of 0, 40, 80, and 120 lb/a of N on wheat in a factorial combination with seeding rates of 60, 90, and 120 lb/a. Pioneer 8500 grain sorghum was planted at 38,100 seeds/a in 30-in. rows on May 20 and harvested on September 10, 1998. Soil was sampled to a depth of 2 ft for residual N shortly after sorghum harvest. Nitrogen rates were applied as ammonium nitrate on September 19. Variety 2137 was planted into undisturbed sorghum stubble with a no-till drill equipped with double-disk openers on 8-in. spacing. P_2O_5 at 37 lb/a was banded in the seed furrow. Whole-plant wheat samples were collected at heading to early bloom stage for determination of N and P concentrations. Wheat was harvested on June 28, 1999. Grain subsamples were analyzed for N and P levels.

Results

Sorghum yields averaged 81 and 110 bu/a with 60 and 120 lb/a of N, respectively. Soil nitrate N (0 to 2 ft) after sorghum differed little between treatments, averaging 24 and 23 lb/a following these N rates. Abundant rains totaling 7.61 in. fell between N fertilizer application and wheat planting, and an additional 9.57 in. fell during the first 4 weeks

after planting. Precipitation was somewhat below normal in December, February, and March, but well above average during the remaining months of the growing season. Average temperatures were near to or slightly above normal in the fall, above normal from November through February, and cooler than normal during March through June.

Despite little measured difference in residual soil nitrate N following N rates on sorghum, the residual effect of those treatments was clearly seen in the succeeding wheat crop (Table 1). When averaged over wheat N rates and seeding rates, the high versus low sorghum N rate significantly increased wheat plant height by 0.8 in., whole-plant N content by 0.04%, yield by 7 bu/a, and grain test weight by 0.3 lb/bu. No significant interactions occurred between sorghum N rate and wheat seeding rate. A significant interaction between sorghum N rate and wheat N rate occurred only in wheat plant N. This was noted as increased N concentration in response to 120 lb/a of N fertilizer following the high N rate on sorghum, but not after the low N rate.

The N rate effect on wheat yield was highly significant, with large increases resulting from each 40 lb/a increment of fertilizer. Top yields of 75 bu/a were obtained with 120 lb/a of N following 120 lb/a of N on sorghum. Test weight, plant height, and plant N concentration (low because of late sampling) also increased with N rate. Plant P concentration and grain protein were highest at the zero N rate, reflecting the dilution effect of greater plant growth and higher yields that resulted from fertilizer application.

The anticipated pattern of a positive effect of seeding rate on wheat yield did not occur because of unusually high fall precipitation, which resulted in complete stand establishment and likely diminished allelopathic effect of sorghum residue. Contrary to expectations, wheat yields tended to be highest when seeded at 60 lb/a, rather than 90 or 120 lb/a. Although no significant interaction occurred between seeding rate and N rate effects on yield, a trend toward lower average yields at the highest seeding rates was observed at the lowest levels of N fertilizer. Seeding rate did not affect plant height, plant N, or grain test weight. Plant P decreased slightly at the highest seeding rate. Grain protein increased slightly with seeding rate.

Table 1. Effects of nitrogen and seeding rate on no-till winter wheat after grain sorghum, Hesston, KS, 1999.

Sorghum N Rate[1]	Wheat N Rate	Seeding Rate	Yield	Bushel Wt	Plant Ht	Plant N[2]	Plant P[2]	Grain Protein[3]
-------------------lb/a-----------------			bu/a	lb	inch	------------------%------------------		
60	0	60	19.6	58.5	24	.83	.23	10.4
		90	15.2	58.6	24	.86	.22	11.4
		120	14.3	58.7	23	.80	.21	11.3
	40	60	31.9	58.8	29	.74	.19	10.2
		90	28.5	58.9	27	.79	.20	10.4
		120	30.8	58.8	28	.74	.18	10.2
	80	60	55.8	59.5	33	.75	.17	10.2
		90	51.9	59.2	32	.73	.17	9.5
		120	48.2	59.3	33	.78	.15	10.2
	120	60	69.4	60.0	35	.87	.17	10.1
		90	69.4	59.9	35	.83	.17	10.2
		120	68.0	59.9	35	.82	.16	10.7
120	0	60	22.2	58.8	25	.79	.22	10.8
		90	20.6	58.9	25	.80	.23	11.3
		120	19.0	58.9	24	.81	.21	11.2
	40	60	40.0	59.5	30	.77	.20	10.0
		90	36.4	59.3	30	.78	.20	10.1
		120	39.2	59.3	30	.76	.18	10.5
	80	60	61.8	59.7	33	.87	.18	9.8
		90	59.9	59.8	33	.81	.17	10.0
		120	59.5	59.6	33	.79	.18	10.1
	120	60	75.5	60.0	35	.98	.17	10.4
		90	75.8	60.1	35	.99	.17	10.5
		120	73.5	60.3	35	.91	.17	10.8
LSD .05			5.8	0.46	1.8	.12	.025	0.78
Means: Sorghum N Rate								
60			41.9	59.2	30	.80	.18	10.4
120			48.6	59.5	31	.84	.19	10.5
LSD.05			3.9	0.09	0.4	.04	NS	NS
	N Rate							
	0		18.5	58.7	24	.82	.22	11.1
	40		34.5	59.1	29	.77	.19	10.3
	80		56.2	59.5	33	.79	.17	10.0
	120		71.9	60.0	35	.90	.17	10.5
	LSD .05		2.4	0.19	0.7	.04	.009	.32
		Seed Rate						
		60	47.0	59.3	30	.83	.19	10.2
		90	44.7	59.3	30	.83	.19	10.5
		120	44.1	59.3	30	.80	.18	10.7
		LSD .05	2.1	NS	NS	NS	.008	0.27

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

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

M.M. Claassen

Summary

Nitrogen response of sorghum grown in the second cycle of a vetch-sorghum-wheat rotation was compared with that of sorghum in a sorghum-wheat rotation at N rates of 0 to 90 lb/a. Vetch was terminated by tillage (disking) or herbicides (no-till). Heavy rainfall after hairy vetch planting resulted in little or no fall growth. After winter reseeding, hairy vetch established stands late and produced an average of 1.18 ton/a of dry matter by mid-June. The average potential amount of N to be mineralized for use by the sorghum crop was 70 lb/a. However, in the absence of fertilizer N, the cover crop failed to increase sorghum leaf N. Also, when averaged over all N rates, sorghum leaf N concentration did not increase where hairy vetch was included in the rotation. On average, N rates tended to increase leaf N up to 60 lb/a. This occurred notably in no-till sorghum after vetch and in sorghum without a cover crop. In sorghum after disked vetch, leaf N reached a maximum at 30 lb/a of fertilizer N. Averaged across N rates, sorghum yields declined by 8.3 bu/a following hairy vetch. The main effect of N rate on grain yield was significant. Maximum yields occurred with 60 lb/a in sorghum without a cover crop and in NT sorghum after vetch, whereas no significant yield increase occurred with increasing N rate in sorghum after disked vetch.

Introduction

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

Procedures

The experiment was established on a Geary silt loam soil with the initial planting of hairy vetch following winter wheat in the fall of 1995. Another cycle of these procedures was begun on a second site in the fall of 1996. Here sorghum was grown in 1997 after vetch had been terminated, and the comparison again was made with sorghum in annual rotation with wheat alone. Wheat was planted without tillage into sorghum shortly after harvest and later top-dressed with the same N rates that had been applied to the preceding sorghum crop. After wheat harvest, volunteer wheat and weeds were controlled with Roundup Ultra. In this second cycle of the rotation, hairy vetch plots were no-till planted at 31 lb/a in 8-in. rows with a grain drill equipped with double-disk openers on October 27, 1998 and replanted at 40 lb/a on February 19, 1999. One set of vetch plots was terminated by disking on June 15. Hairy vetch in a second set of plots was terminated at that time with Roundup Ultra + 2,4-D_{LVE} + Banvel (1 qt + 1.5 pt +0.25 pt/a). Weeds were controlled with tillage in plots without hairy vetch.

Vetch forage yield was determined by harvesting a 1 sq m area from each plot on June 14, 1999. Nitrogen fertilizer treatments were broadcast as ammonium nitrate on June 30. All plots received 35 lb/a of P_2O_5, which was banded as 0-46-0 at sorghum planting. Pioneer 8505, treated with Concep III safener and Gaucho insecticide, was planted after rain delay at approximately 42,000 seeds/a on July 6, 1999. Weeds were controlled with a preemergence application of Dual II + AAtrex 4L (1 qt + 0.5 pt/a). Grain sorghum was combine harvested on October 29.

Results

Wet conditions prevented timely planting of hairy vetch. Excessive rainfall shortly after planting resulted in little or no vetch emergence in the fall. Replanting during the winter enhanced the of stands, which eventually established and produced a late-developing cover crop. Hairy vetch was beginning to bloom at the time of termination in June. Vetch dry matter yield averaged 1.18 ton/a, and N content was 2.99% (Table 2). The average potential amount of N to be mineralized for use by the sorghum crop was 70 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. However, sorghum stands after vetch averaged 1,600 plants/a less than stands where no cover crop had been grown. Drought stress occurred at varying degrees between late July and early September. When averaged over N rates, hairy vetch did not result in higher N concentrations in sorghum flag leaves at boot to early heading stage. When averaged over cover crop/tillage systems, N rates tended to increase leaf N up to 60 lb/a, but more notably in no-till sorghum after vetch and in sorghum without a cover crop. In sorghum after disked vetch, leaf N reached a maximum at 30 lb/a of fertilizer N.

Grain sorghum maturity (days to half bloom) was not affected by any of the treatments. The number of heads per plant increased slightly with 60 and 90 lb/a of N versus lower fertilizer rates. Sorghum without a cover crop and sorghum after disked vetch had a slightly higher head/plant ratio than no-till sorghum after vetch. When averaged over N rates, hairy vetch lowered sorghum yields by 8.3 bu/a. The main effect of N rate on grain yield was significant. Maximum yields occurred with 60 lb/a in sorghum without a cover crop and in no-till sorghum after vetch, whereas no significant yield increase occurred with increasing N rate in sorghum after disked vetch.

Table 2. Effects of hairy vetch cover crop, termination method, and nitrogen rate on grain sorghum after wheat, Hesston, KS, 1999.

Cover Crop/ Termination	N Rate[1]	Vetch Yield[2] Forage	Vetch Yield[2] N	Grain Sorghum Grain Yield	Bushel Wt	Stand	Half[3] Bloom	Heads/ Plant	Leaf N[4]
	lb/a	ton/a	lb	bu/a	lb	1000' s/a	days	no.	%
None	0	--	--	86.3	59.2	38.2	59	1.1	2.52
	30	--	--	90.2	59.4	37.2	58	1.1	2.45
	60	--	--	99.1	59.4	36.7	59	1.2	2.71
	90	--	--	98.8	59.2	35.3	59	1.3	2.67
Vetch/Disk	0	0.90	55	86.8	59.4	36.0	59	1.1	2.52
	30	1.32	80	87.3	58.9	36.3	59	1.1	2.65
	60	1.26	70	88.1	59.1	33.6	59	1.3	2.64
	90	1.12	63	87.9	59.0	34.6	59	1.2	2.53
Vetch/No-till	0	1.50	92	72.8	58.2	35.5	59	1.0	2.39
	30	1.13	67	81.4	58.9	34.3	59	1.1	2.57
	60	1.26	71	91.6	58.7	35.3	59	1.2	2.67
	90	0.97	58	87.1	58.4	35.9	58	1.2	2.61
LSD .05		NS	NS	13.0	0.71	3.0	NS	0.1	NS
LSD .10		NS	NS	----	----	----	NS	---	0.21
Means: Cover Crop/ Termination									
None		--	--	93.6	59.3	36.8	58	1.2	2.59
Vetch/Disk		1.15	67	87.5	59.1	35.1	59	1.2	2.58
Vetch/No-till		1.21	72	83.2	58.6	35.3	59	1.1	2.56
LSD .05		NS	NS	6.5	0.35	1.5	NS	NS	NS
LSD .10		NS	NS	----	----	----	NS	NS	NS
N Rate									
0		1.20	73	82.0	58.9	36.5	59	1.1	2.48
30		1.22	74	86.3	59.1	35.9	58	1.1	2.56
60		1.26	71	92.9	59.1	35.2	59	1.2	2.67
90		1.04	60	91.3	58.9	35.3	59	1.2	2.60
LSD .05		NS	NS	7.5	NS	NS	NS	0.07	NS
LSD .10		NS	NS	----	NS	NS	NS	----	0.12

[1] N applied as 34-0-0 on June 30, 1999.
[2] Oven dry weight and N content on June 14, 1999.
[3] Days from planting (July 6, 1999) to half bloom.
[4] Flag leaf at late boot to early heading.

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

M.M. Claassen

Summary

Wheat production was evaluated in the second cycle of annual wheat-sorghum and wheat-vetch-sorghum rotations. Treatment variables included disk and herbicide termination methods for hairy vetch and N fertilizer rates of 0 to 90 lb/a. Residual soil nitrate N was greatest after sorghum following hairy vetch terminated by disking, primarily at the 90 lb/a N rate. Both hairy vetch and N rate significantly increased wheat yield. At 0 lb/a of fertilizer N, the residual effect of hairy vetch increased wheat yields by 29 and 15 bu/a in disk and no-till systems, respectively. These residual vetch benefits were equivalent to 35 and 16 lb/a of fertilizer N, respectively. In wheat after sorghum without vetch, each 30 lb/a increment of fertilizer N significantly increased yield. The trend suggested that yields had not exceeded the maximum at 90 lb/a of fertilizer N. In wheat after vetch-sorghum, yields also increased with increasing fertilizer N but appeared to be closer to a maximum at 60 lb/a of N.

Introduction

Hairy vetch can be planted in September following wheat and used as a winter cover crop ahead of grain sorghum in an annual wheat-sorghum rotation. Soil erosion protection and N contribution to the succeeding crop(s) are potential benefits of including hairy vetch in this cropping system. The amount of N contributed by hairy vetch to grain sorghum has been under investigation. The longer-term benefit of vetch in the rotation is also of interest. This experiment concluded the second cycle of a 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 1995. Sorghum was grown in 1996 with or without the preceding cover crop and fertilized with N rates of 0, 30, 60, or 90 lb/a. Winter wheat was no-till planted in 8-inch rows into sorghum stubble in the fall of 1996. In the second cycle of the rotation, hairy vetch plots were seeded at 20 lb/a in 8-in. rows on September 16, 1997. 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 sorghum planting. After a rain delay, Pioneer 8505 was planted in 30-in. rows 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. After a rain delay, soil was sampled to a depth of 2 ft on November 23. Variety 2137 winter wheat was no-till planted in 8-in. rows into sorghum stubble on November 24, 1998, at 120 lb/a with 32 lb/a of P_2O_5 fertilizer banded in the furrow. Fertilizer N was broadcast as 34-0-0 on March 17, 1999, at rates equal to those applied to the prior sorghum crop. Wheat was harvested on June 29.

Results

Hairy vetch terminated in mid-May, 1998, produced an average of 1.64 ton/a of dry matter, yielding 94 lb/a of N potentially available to the sorghum that followed (Table 3). However, the contribution of vetch to the yield of sorghum was equivalent to approximately 30 lb/a of fertilizer N. Prior hairy vetch cover crop/termination method as well as N rates significantly affected soil nitrate N (0 to 2 ft) at the time of wheat planting. Averaged over N rates, soil nitrate N averaged about 9 lb/a greater after disked vetch-sorghum than after no-till vetch-sorghum or sorghum without a cover crop. Following sorghum without a cover crop and sorghum after disked vetch, N fertilizer increased residual soil nitrate N at the 90 lb/a rate but had no significant effect on soil N in no-till sorghum after vetch.

At 0 lb/a of fertilizer N, the residual effect of hairy vetch increased wheat yields by 29 and 15 bu/a in disk and no-till systems, respectively. These residual vetch benefits were equivalent to 35 and 16 lb/a of fertilizer N, respectively. Averaged over N rates, hairy vetch in these systems accounted for yield increases of 14 and 8 bu/a. In wheat after sorghum without vetch, each 30 lb/a increment of fertilizer N significantly increased yield. The trend suggested that yields had not exceeded the maximum at 90 lb/a of fertilizer N. In wheat after vetch-sorghum, yields also increased with increasing fertilizer N but appeared to be closer to a maximum at 60 lb/a of N.

Vetch treatments averaged over N rates had no significant residual effect on wheat test weight but tended to increase plant N and grain N slightly. Nitrogen rates increased plant N mainly at 60 and 90 lb/a but decreased grain N somewhat at 30 and 60 lb/a.

Table 3. Residual effects of hairy vetch cover crop, termination method, and nitrogen rate on no-till wheat after grain sorghum, Hesston, KS, 1999.

Cover Crop/ Termination[1]	N Rate[2]	Vetch Yield[3] Forage	Vetch Yield[3] N	Sorghum Yield 1998	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	--	--	66.6	8	18.3	60.2	0.95	1.92
	30	--	--	77.9	12	45.8	60.0	1.02	1.72
	60	--	--	80.3	16	60.3	59.8	1.12	1.76
	90	--	--	79.1	20	73.8	59.6	1.47	1.89
Vetch/Disk	0	1.89	119	79.6	18	47.1	60.7	1.00	1.90
	30	1.36	78	66.6	19	62.1	60.1	1.19	1.76
	60	1.95	106	77.9	19	71.3	60.0	1.33	1.88
	90	1.57	77	79.8	36	71.6	59.5	1.53	2.03
Vetch/No-till	0	1.88	110	77.1	13	32.8	60.7	1.01	1.95
	30	1.75	107	72.5	15	58.5	60.3	1.10	1.79
	60	1.56	85	81.4	14	68.6	60.2	1.26	1.81
	90	1.35	77	70.4	17	71.3	59.5	1.57	1.95
LSD .05		NS	NS	NS	9.6	6.7	0.51	0.19	.095
Means: Cover Crop/ Termination									
None		--	--	76.0	14	49.5	59.9	1.14	1.82
Vetch/Disk		1.69	95	76.0	23	63.0	60.1	1.26	1.89
Vetch/No-till		1.63	95	75.4	15	57.8	60.2	1.23	1.87
LSD .05		NS	NS	NS	4.8	3.3	NS	0.10	.047
N Rate									
0		1.88	115	74.5	13	32.7	60.5	0.99	1.92
30		1.56	93	72.3	15	55.5	60.1	1.10	1.76
60		1.75	96	80.0	16	66.7	60.0	1.24	1.81
90		1.46	77	76.4	24	72.3	59.5	1.52	1.96
LSD .05		NS	NS	NS	5.5	3.9	0.30	0.11	.055

[1] Hairy vetch planted in mid-September, 1997, and terminated in the following spring.
[2] N applied as 34-0-0 on June 11, 1998 for sorghum and on March 17, 1999 for wheat.
[3] Oven dry weight and N content just prior to termination.
[4] Mean nitrate nitrogen at 0 - 2' depth on November 23, 1998.
[5] Whole-plant N concentration at early heading.

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

STARTER FERTILIZER MANAGEMENT FOR NO-TILL CORN PRODUCTION

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

Summary

With the interest in and importance of the use of starter fertilizers in no-till production systems, research was initiated to evaluate rates of N in starter fertilizers placed in direct seed contact or in a 2x2 configuration. The use of starter fertilizer containing N, P, and K significantly increased corn grain yields compared to an N-only program. Increasing N rates in starter fertilizer up to 50 lb/a placed in direct seed contact did not increase yields. Even though the 20, 40, and 50 lb N/a rates placed in direct seed contact did not reduce final stands at the North Farm, they did at Scandia. These rates are above the recommended rate of no more than 10 lb/a of N + K_20 placed in direct seed contact. Application of 30 to 120 lb N/a in a 2x2 starter band increased yields at both sites. The addition of 10 lb S/a in the starter fertilizer significantly increased corn yields at the North Farm. The inclusion of NBPT with starter N had minimal effects on yields.

Introduction

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

This research was initiated to evaluate starter fertilizer management in a no-till production system, including placement (direct seed and 2x2), applying higher N rates in starter, and the use of an additive to reduce the risk of germination damage associated with higher N rates placed in direct seed contact.

Procedures

Studies were initiated at the North Agronomy Farm (Manhattan, dryland) and the North Central Experiment Field (Scandia, irrigated) to evaluate both direct seed contact and 2x2 starter placements. In the direct seed contact studies, N rates (10, 20, 40, 50 at Manhattan and 5, 15, 30, 45 at Scandia) with or without NBPT (AgrotaiN) were evaluated as part of a starter fertilizer placed directly in the seed furrow at planting. Total N was balanced on all treatments at 150 lb/a (Manhattan) and 200 lb/a (Scandia).

In the 2x2 studies, N rates of 30, 60, 90, and 120 lb/a were evaluated at both sites as part of a starter fertilizer containing P and K placed 2 in. to the side and 2 in. below the seed at planting.

In both studies at both sites, final plant populations were determined, V6 dry matter yields were measured, and leaf samples were retained for analysis. Tassel-stage leaf samples also were taken for analysis. Grain yields and grain protein levels were determined.

Results

Grain yields were good to excellent in 1999, and the use of starter fertilizer either in direct seed contact or in a 2x2 placement increased yields (Tables 1-4). Increasing N rates in starter fertilizer did not increase yields, even though the final plant populations were not dramatically affected by up to 50 lb N/a in direct seed contact. This was probably due to very wet soil conditions at both sites. Current recommendations suggest no more than 10 lb/a of N plus K_2O placed in direct seed contact. These results suggest that applying more than 10 lb N/a in direct contact starter did not increase yields. The inclusion of NBPT (AgrotaiN) in the starter did not reduce the impact of N on plant stands.

In the 2x2 starter placement studies, applying either 30, 60, 90, or 120 lb N/a increased yields over the no-starter treatment. At Scandia, no significant differences occurred between these N rates, but at Manhattan, the 120 lb N/a rate produced significantly higher yields than the other N rates. The inclusion of 10 lb S/a in the starter significantly increased grain yields at Manhattan. Soil test P and K levels were high at both sites.

Results to date suggest that increasing N in direct-seed-contact starter fertilizer does not improve yields and carries the risk of stand reduction. Application of up to 120 lb N/a in a 2x2 starter placement increased yields compared to broadcast N without the risk of stand reduction. The use of starter fertilizers in no-till corn production consistently increased early-season growth and grain yields. This work will be continued in 2000.

Table 1. Evaluation of starter fertilizer placed in direct seed contact on no-till dryland corn, North Agronomy Farm, Manhattan, KS, 1999.

B'cast	Starter Fertilizer				Plant	V-6					Tassel				Grain	
N	N	P_2O_5	K_2O	NBPT	Population	Dry Wt.	N	P	K	S	N	P	K	S	Yield	N
lb/a	- - - lb/a - - -				1000 plants/a	lb/a	- - - - - % - - - - -				- - - - - % - - - - -				bu/a	%
150	0	0	0	No	26	256	3.99	.45	4.84	.17	2.49	.32	1.98	.14	82	1.50
140	10	15	5	No	26	282	4.20	.49	4.55	.17	2.33	.33	2.01	.14	123	1.45
130	20	15	5	No	26	277	3.81	.42	4.48	.19	2.11	.31	2.01	.23	121	1.42
110	40	15	5	No	24	288	4.12	.47	4.60	.24	2.33	.28	1.94	.18	110	1.37
100	50	15	5	No	26	262	4.06	.47	4.10	.26	2.33	.30	1.93	.18	109	1.36
140	10	15	5	Yes	26	196	4.13	.48	4.68	.18	2.38	.29	2.08	.13	99	1.47
130	20	15	5	Yes	25	397	4.20	.45	4.53	.24	2.45	.30	1.93	.19	108	1.38
110	40	15	5	Yes	25	256	3.99	.42	4.19	.24	2.43	.27	2.00	.18	120	1.36
100	50	15	5	Yes	25	352	4.27	.44	4.09	.24	2.32	.27	1.91	.19	105	1.42
LSD(0.10)					NS	NS	NS	NS	NS	.03	NS	NS	NS	NS	16	NS
Main Values:																
Starter	10				26	224	4.16	.49	4.62	.18	2.36	.31	205	.14	111	1.46
N	20				26	337	4.01	.43	4.50	.22	2.28	.31	1.97	.21	115	1.40
	40				26	272	4.05	.45	4.39	.24	2.38	.28	1.97	.18	115	1.37
	50				25	307	4.17	.45	4.10	.25	2.33	.28	1.92	.19	107	1.39
LSD (0.10)					NS	NS	NS	NS	NS	.02	NS	NS	NS	NS	NS	NS
NBPT	No				25	277	4.05	.46	4.43	.22	2.28	.31	1.97	.18	116	1.40
	Yes				26	292	4.15	.45	4.37	.23	2.39	.28	1.98	.17	108	1.41
LSD (0.10)					NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

[1] Broadcast N applied as ammonium nitrate after planting [2] Starter was placed in direct seed contact

Table 2. Evaluation of starter fertilizer placed 2x2 on no-till dryland corn, North Agronomy Farm, Manhattan, KS, 1999.

B'cast	Starter Fertilizer[2]				Plant	V-6					Tassel				Grain	
N[1]	N	P_2O_5	K_2O	S	Population	Dry Wt.	N	P	K	S	N	P	K	S	Yield	N
lb/a	- - - lb/a - - -				1000 plants/a	lb/z	- - - - - % - - - - -				- - - - - % - - - - -				bu/a	%
150	0	0	0	0	26	256	3.99	.45	4.84	.17	2.49	.32	1.98	.14	82	1.50
120	30	30	10	0	26	320	3.71	.48	4.52	.13	2.35	.31	2.23	.10	87	1.50
120	30	30	10	10	26	448	3.68	.45	4.63	.24	2.32	.32	2.10	.14	109	1.40
90	60	30	10	0	26	326	3.82	.49	4.65	.15	2.37	.31	2.13	.13	107	1.50
60	90	30	10	0	26	377	4.04	.51	4.65	.14	2.37	.34	2.07	.10	102	1.50
30	120	30	10	0	26	403	3.85	.46	4.65	.16	2.28	.32	2.20	.13	130	1.47
LSD(0.10)					NS	160	NS	NS	NS	.02	NS	NS	NS	NS	14	NS

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

Table 3. Effects of in-furrow placed starter fertilizer on irrigated corn production, Scandia, KS, 1999.

Starter Fertilizer						V-6
N	P_2O_5	K_2O	NBPT	Yield	Population	Dry Weight
	lb/a			bu/a	plants/a	lb/a
0	0	0	--	173	31505	557
5	15	5	No	183	26861	633
15	15	5	No	187	26041	635
30	15	5	No	187	26865	655
45	15	5	No	187	27056	632
5	15	5	Yes	184	27069	647
15	15	5	Yes	185	26516	658
30	15	5	Yes	184	26574	644
45	15	5	Yes	185	28745	651
LSD (0.05)				NS*	1400	NS

* Not significant at the 0.05 level of probability.

Table 4. Effects of starter fertilizer placed 2 inches to the side and 2 inches below the seed at planting on irrigated corn production, Scandia, KS, 1999.

Starter Treatment*			V-6
N	Yield	Population	Dry Weight
lb/a	bu/a	plants/a	lb/a
No starter check	172	30730	471
30	208	31010	806
60	207	31430	804
90	206	31010	798
120	207	30520	800
30 + NBPT	199	31220	821
60 + NBPT	201	31220	850
90 + NBPT	201	31850	839
120 + NBPT	199	31710	846
30 + ATS	201	31430	831
30 + N-Serve	201	31080	810
LSD (0.05)	9	NS**	93

* In addition to N, starter treatments contained 30 lb P_2O_5, 10 lb K_2O, and 5 lb S/a.
** Not significant at the 0.05 level of probability.

EFFECTS OF NITROGEN RATES AND SOURCES ON NO-TILL CORN

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

Summary

The poor performance of surface-applied urea-containing fertilizers in no-till corn production system likely is due to volatilization N loss as the urea is hydrolyzed. Earlier work in Kansas has shown that the urease inhibitor NBPT (sold under the trade name AgrotaiN) is effective in improving the performance of such fertilizers. This research was initiated in 1999 to evaluate an experimental N fertilizer (UCAN-21) surface broadcast on no-till corn (Sandyland and Manhattan) and in various starter sidedressing combinations (Scandia). UCAN-21 is a mixture of 2/3 UAN solution and 1/3 liquid calcium nitrate. Results indicate that UCAN-21 produced significantly higher yields than urea-ammonium nitrate solution (UAN) and UAN + NBPT when broadcast on no-till corn. When side-dressed at 50 lb N/a, UCAN-21 produced higher yields than UAN at Scandia. At higher N rates, however, yields did not differ.

Introduction

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

Procedures

Studies were initiated at two sites (irrigated corn, Sandyland Field; dryland corn, North Agronomy Farm) in 1999. Both sites were no-till production systems. Nitrogen rates (50, 100, 150 lb/a) were surface broadcast just after corn planting as either UAN, UAN + NBPT (AgrotaiN), or UCAN-21. A no-N treatment was included.

At Scandia (irrigated), N rates of 50, 100, 150, and 200 lb/a as dribble sidedressings either as UAN or UCAN-21 were evaluated. All treatments received 30 lb N/a as UCAN-21 in a 2x2 starter. A no-N check treatment was included.

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

Results

Grain yields were average to excellent in 1999. Visual responses to N were apparent shortly after emergence at the North Agronomy Farm but much less dramatic at Sandyland. Nitrogen rates up to 150 lb N/a significantly increased corn yields (Table 5). Nitrogen also consistently increased leaf N at both sites, but N rate had no effect on grain protein.

The UCAN-21 produced significantly higher corn grain yields and leaf N concentrations than both UAN and UAN + NBPT when broadcast on no-till corn. It is unlikely that the better performance of UCAN-21 was due to reduced N volatilization loss and, because both sites have near neutral pH's, a Ca response is also unlikely. Thus, the good performance of UCAN-21 is hard to explain.

At Scandia (Table 6), when 50 lb N/a was side-dressed, UCAN-21 outperformed UAN, but no significant differences ocurred between N sources at higher N. The 100 lb N/a sidedressing rate produced yields equivalent to those with higher N rates.

This work will be continued in 2000.

Table 5. Effects of nitrogen rates and sources on no-till corn, Scandia and Manhattan, KS, 1999.

		Sandyland Field, Irrigated						North Agronomy Farm, Dryland					
		V-6				Grain		V-6				Grain	
N Rate	N Source	Dry Wt.	N	N Uptake	Tassel N	Yield	N	Dry Wt.	N	N Uptake	Tassel N	Yield	N
lb/a		lb/a	%	lb/a	%	bu/a	%	lb/a	%	lb/a	%	bu/a	%
0	--	595	3.15	19	2.58	131	1.42	154	3.00	5	1.15	41	1.22
50	UAN	586	3.43	20	2.64	171	1.43	294	3.15	9	1.12	48	1.20
100	UAN	706	3.61	25	2.85	189	1.37	422	3.66	16	1.23	54	1.32
150	UAN	519	3.58	19	2.89	204	1.33	454	4.00	18	1.50	89	1.22
50	UAN + NBPT	682	3.35	23	2.78	186	1.31	269	3.30	9	1.19	51	1.23
100	UAN + NBPT	672	3.53	24	2.76	189	1.39	275	3.53	10	1.26	61	1.22
150	UAN + NBPT	620	3.56	22	2.82	170	1.51	410	4.07	17	1.53	84	1.21
50	UCAN-21	672	3.62	25	2.72	185	1.45	288	3.50	10	1.13	52	1.38
100	UCAN-21	495	3.42	17	2.87	190	1.33	288	3.65	11	1.26	80	1.18
150	UCAN-21	629	3.49	22	3.01	215	1.48	288	3.78	11	1.53	97	1.28
LSD (0.10)		170	0.19	NS	0.12	16	0.12	135	0.18	5	0.16	18	0.12
Mean Values:													
N	50	646	3.47	22	2.71	181	1.39	284	3.32	9	1.15	50	1.27
Rate	100	624	3.52	22	2.86	189	1.36	329	3.61	12	1.35	65	1.24
	150	589	3.54	21	2.90	197	1.44	384	3.95	15	1.68	90	1.24
LSD (0.10)		NS	NS	NS	0.07	9	NS	83	0.11	3	0.10	10	NS
N	UAN	603	3.54	21	2.79	188	1.37	390	3.60	14	1.28	64	1.25
Source	UAN + NBPT	658	3.48	23	2.79	182	1.40	318	3.63	12	1.33	65	1.22
	UCAN-21	599	3.51	21	2.87	197	1.42	288	3.64	11	1.57	76	1.28
LSD (0.10)		NS	NS	NS	0.07	9	NS	NS	NS	NS	0.10	10	NS

Table 6. Evaluation of calcium nitrate for irrigated corn production, Scandia, KS, 1999.

Treatment	Yield	Population	V6 Dry Weight
	bu/a	plants/a	lb/a
No N check	136	31234	478
UCAN-21 starter, no sidedress N	154	31654	756
UCAN-21 starter, 50 lb N UAN sidedress	172	31645	729
UCAN-21 starter, 100 lb N UAN sidedress	199	31640	773
UCAN-21 starter, 150 lb N UAN sidedress	199	31289	782
UCAN-21 starter, 200 lb N UAN sidedress	199	31644	755
UCAN-21 starter, 50 lb N UCAN-21 sidedress	189	31411	760
UCAN-21 starter, 100 lb N UCAN-21 sidedress	197	31279	741
UCAN-21 starter, 150 lb N UCAN-21 sidedress	197	31509	741
UCAN-21 starter, 200 lb N UCAN-21 sidedress	201	31619	740
UAN starter, 200 lb N UAN sidedress	195	31250	749
UAN starter, 200 lb N UCAN-21 sidedress	200	31591	773
LSD (0.05)	8	NS*	53

*Not significant at the 0.05 level of probability.

EFFECTS OF NITROGEN MANAGEMENT AND TILLAGE ON GRAIN SORGHUM

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

Summary

Since 1982, the responses of grain sorghum to tillage system, nitrogen (N) rate, N source, and N placement have been investigated. Until 1995, N sources and placements used were ammonium nitrate, broadcast and urea-ammonium nitrate solution, either broadcast or knifed, at rates of 0, 30, 60, 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 1999 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 average in 1999, but yields and grain protein were increased dramatically by N application.

Introduction

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

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

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 June 7, August 2, and October 11, respectively.

Results

Results are summarized in Table 7. Grain yield, flag leaf N, and grain protein were increased significantly by N application up to 120 lbs. Ammonium nitrate and AgrotaiN produced higher grain yields and grain protein levels 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. Eighteen-year average yields show no difference between no-till and conventional tillage on the silty clay loam soil at this site.

Table 7. Effects of nitrogen management and tillage on continuous grain sorghum, North Agronomy Farm, Manhattan, KS, 1999.

N Rate	N Source	Tillage	Leaf N	Grain Yield	Grain Protein
lb/a			%	bu/a	%
0	--	No-till	1.39	11	7.5
30	Am. nit.	No-till	1.73	51	6.5
60	Am. nit.	No-till	2.14	74	7.1
120	Am. nit.	No-till	2.69	68	9.3
30	Urea	No-till	1.82	27	7.1
60	Urea	No-till	2.13	55	6.8
120	Urea	No-till	2.40	72	7.9
30	AgrotaiN	No-till	1.57	32	7.1
60	AgrotaiN	No-till	1.87	75	6.7
120	AgrotaiN	No-till	2.53	89	8.7
0	--	Conventional	1.55	19	7.9
30	Am. nit.	Conventional	1.56	35	6.7
60	Am. nit.	Conventional	2.35	97	7.5
120	Am. nit.	Conventional	2.70	96	9.2
30	Urea	Conventional	1.76	50	6.5
60	Urea	Conventional	2.25	71	6.7
120	Urea	Conventional	2.58	102	8.5
30	AgrotaiN	Conventional	1.84	53	6.9
60	AgrotaiN	Conventional	2.40	67	6.6
120	AgrotaiN	Conventional	2.94	99	8.7
LSD (0.10)			0.29	28	0.9
Mean Values:					
N	30		1.71	41	6.8
Rate	60		2.19	73	6.9
	120		2.64	88	8.7
LSD (0.10)			0.12	13	0.4
N	Am. nit.		2.20	70	7.7
Source	Urea		2.24	63	7.3
	AgrotaiN		2.11	69	7.5
LSD (0.10)			NS	NS	NS
Tillage	No-till		2.10	60	7.5
	Conventional		2.27	69	7.5
LSD (0.10)			0.10	NS	NS

CHLORIDE FERTILIZATION FOR CORN AND GRAIN SORGHUM

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

Summary

Recent research in Kansas has shown that wheat often responds to chloride (Cl) fertilization. In some cases, Cl fertilization has slowed the progression of leaf diseases on wheat. In other cases, Cl responses occurred where soil Cl levels were low, indicating that some Kansas soils may be deficient in Cl. In light of consistent wheat response to Cl, work was continued in 1999 to evaluate Cl fertilization on dryland corn and grain sorghum. Results indicate that Cl fertilization often can increase corn and grain sorghum yields and leaf tissue Cl concentrations, particularly on soils testing less than 20 lb Cl/a. Yield responses also were most consistent when leaf Cl concentrations of the check treatments were below 0.10 - 0.15%.

Procedures

Chloride rates (0, 20, 40 lb/a) and sources (KCl, NaCl and $CaCl_2$) were evaluated on corn and grain sorghum at 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 1999 were average to excellent (Tables 8-10), and some significant 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 not significant in most cases. Chloride fertilization significantly increased leaf tissue Cl concentrations at all sites. All Cl sources performed similarly. Because of these positive results, this work will be continued in 2000.

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

Table 8. Effects of chloride fertilization on corn, northeast and central Kansas,1999.

Cl Rate	Cl Source	Brown Co. Yield	Brown Co. Tassel Cl	Marion Co. Yield	Marion Co. Tassel Cl
lb/a		bu/a	%	bu/a	%
0	--	123	0.16	94	0.15
20	KCl	124	0.29	106	0.18
40	KCl	129	0.40	107	0.55
20	NaCl	119	0.29	104	0.42
40	NaCl	134	0.46	108	0.59
20	$CaCl_2$	120	0.21	101	0.23
40	$CaCl_2$	127	0.32	96	0.32
LSD (0.10)		10	0.11	7	0.13
Mean Values:					
Cl	20	121	0.26	104	0.27
Rate	40	130	0.39	103	0.49
LSD (0.10)		6	0.05	NS	0.06
Cl	KCl	127	0.34	107	0.36
Source	NaCl	127	0.38	106	0.50
	$CaCl_2$	124	0.27	99	0.28
LSD (0.10)		NS	0.06	5	0.07
Soil test Cl, lb/a		19		14	

Table 9. Effects of chloride fertilization on grain sorghum, northeast and central Kansas, 1999.

Cl Rate	Cl Source	Brown Co. Yield	Brown Co. Boot Cl		Marion Co. Yield	Marion Co. Boot Cl
lb/a		bu/a	%		bu/a	%
0	--	93	0.15		98	0.13
20	KCl	98	0.28		109	0.36
40	KCl	108	0.49		111	0.51
20	NaCl	96	0.40		106	0.36
40	NaCl	104	0.55		107	0.47
20	$CaCl_2$	102	0.30		109	0.38
40	$CaCl_2$	95	0.44		105	0.49
LSD (0.10)		12	0.13		7	0.06
Mean Values:						
Cl	20	99	0.33		108	0.37
Rate	40	102	0.49		108	0.49
LSD (0.10)		NS	0.06		NS	0.03
Cl	KCl	103	0.38	0	110	0.43
Source	NaCl	100	0.47	7	107	0.42
	$CaCl_2$	99	0.37	7	107	0.44
LSD (0.10)		NS	0.08		NS	NS
Soil Test Cl (0-24 in.), lb/a		17			12	

Table 10. Effects of chloride fertilization on grain sorghum, south central and east central Kansas, 1999.

Cl Rate	Cl Source	Stafford Co. Yield	Stafford Co. Boot Cl	Osage Co. Yield	Osage Co. Boot Cl
lb/a		bu/a	%	bu/a	%
0	--	132	0.04	96	0.18
20	KCl	142	0.31	98	0.20
40	KCl	144	0.28	104	0.22
20	NaCl	146	0.25	109	0.23
40	NaCl	139	0.48	115	0.26
20	$CaCl_2$	144	0.21	96	0.23
40	$CaCl_2$	141	0.33	105	0.23
	LSD (0.10)	11	0.09	9	0.04
Mean Values:					
Cl	20	144	0.25	101	0.22
Rate	40	142	0.36	108	0.23
	LSD (0.10)	NS	0.05	6	NS
Cl	KCl	143	0.29	101	0.21
Source	NaCl	143	0.36	112	0.25
	$CaCl_2$	143	0.27	101	0.23
	LSD (0.10)	NS	0.07	6	0.02
Soil Test Cl, lb/a		21		31	

CORN YIELD RESPONSES AT SEVERAL LOCATIONS WITHIN A FIELD

A.J. DeJoia, J.P. Schmidt, R.K. Young and R.K. Taylor

Summary

Nitrogen rates to achieve maximum yield in1998 ranged from 50 to 180 lb/a depending on field site. The optimum rate was similar for all locations within a field, except where periodic flooding during the growing season was observed. Selecting sites within a field based on soil organic matter (OM) content did not appear to capture variability that would warrant a variable N application.

Introduction

With the advent of precision agriculture, producers have the ability to apply nitrogen (N) variably within a field. To do that, producers must have a basis for adjusting current whole-field N recommendations to more site-specific recommendations. Soil organic matter (OM) can contribute to the available N in the soil through mineralization. Variability in N mineralization may be sufficient to warrant variable application of N fertilizer. The objectives of this study were to determine N yield response in several areas of a field and to evaluate the potential for variable-rate N recommendations.

Procedures

Four center-pivot irrigated continuously cropped corn fields in south central Kansas were selected for this study. Each field was managed using the producer's current management practices, except for N application and grain harvest. Field sites had not received any manure additions for 3 years prior to the start of the experiment. The location, soil OM, and soil type for each site and year are described in Tables 11 and 12. Field plots were established at four field sites: Harvey Co. with four locations, Reno Co. and Barton Co. West each with three locations, and Barton Co. East with two locations in 1998. In 1999, new locations were selected within each field site. The Harvey and Reno Co. sites each had four locations, whereas both Barton Co. sites had only two locations. Locations were selected to represent the range in OM content within each field. Nitrogen treatments were ammonium nitrate broadcast at five rates (0, 75, 150, 225,and 300 lbs N/a) in 1998 and (0, 50, 100,150, 200 lbs N/a) in 1999, and all N was applied within 1 week of planting. The plots were 30 by 20 feet (eight 30-in rows) and were arranged in a randomized complete-block design with four replications.

Results

<u>1998</u>

At Harvey Co., yields ranged from 75 to 150 bu/a in the control plots, whereas yields at the 300 lb N/a rate differed by only 15 bu/a among locations. Yields at location 4 increased by 100 bu, whereas yields at the other locations only increased by 30-40 bushels as N rate increased (Fig.1a). The large difference in yield in the control plots and relatively small change in yield at the greater N rates resulted in a N by location interaction. Denitrification could have caused this interaction, because ponded water was observed at location 4 several times during the growing season. Maximum yields of 160 to 180 lb/a were achieved at locations 1, 3, and 4. Yields at Location 2 did not reach a plateau regardless of the N rate.

The Reno Co. or Barton Co. fields showed no yield responses to N treatments. However, a location effect did occur in each of these fields. Yield was greatest at location 3 at Reno Co. with an average of 183 bu/a, and yields at location 2 averaged 166 bu/a (Fig. 1b). Average yield at location 3 was 167 bu/a, and location 2 averaged 136 bu/a at the Barton Co. West field (Fig. 1c). A 25-bu yield difference occurred between the two locations at Barton Co. East, with location 1 having the greater yield (Fig. 1d).

1999

At Harvey Co., a location by treatment interaction was detected again. The greatest yield increase occurred at location 4, from 70 to 165 bu/a (Fig. 2a). The greatest yield increase at any other location was only 68 bu/a among the N treatments. At location 4, ponded water was observed during parts of the growing season, thus indicating the potential for denitrification.

At Reno Co., yield differences among locations were detected. Yield was smallest at location 1 with an average of 102 bu/a, whereas yields at all other locations averaged above 167 bu/a (Fig. 2b). Nitrogen treatments also affected yield; the average difference between the control and 200 lb N/a treatment was 55 bu/a. Location effects at Barton Co. West were observed, with the average yield at location 1 being 9 bu/a greater than that at location 2 (Fig. 2c). No location or treatment effects were detected at the Barton Co. East field (Fig 2d).

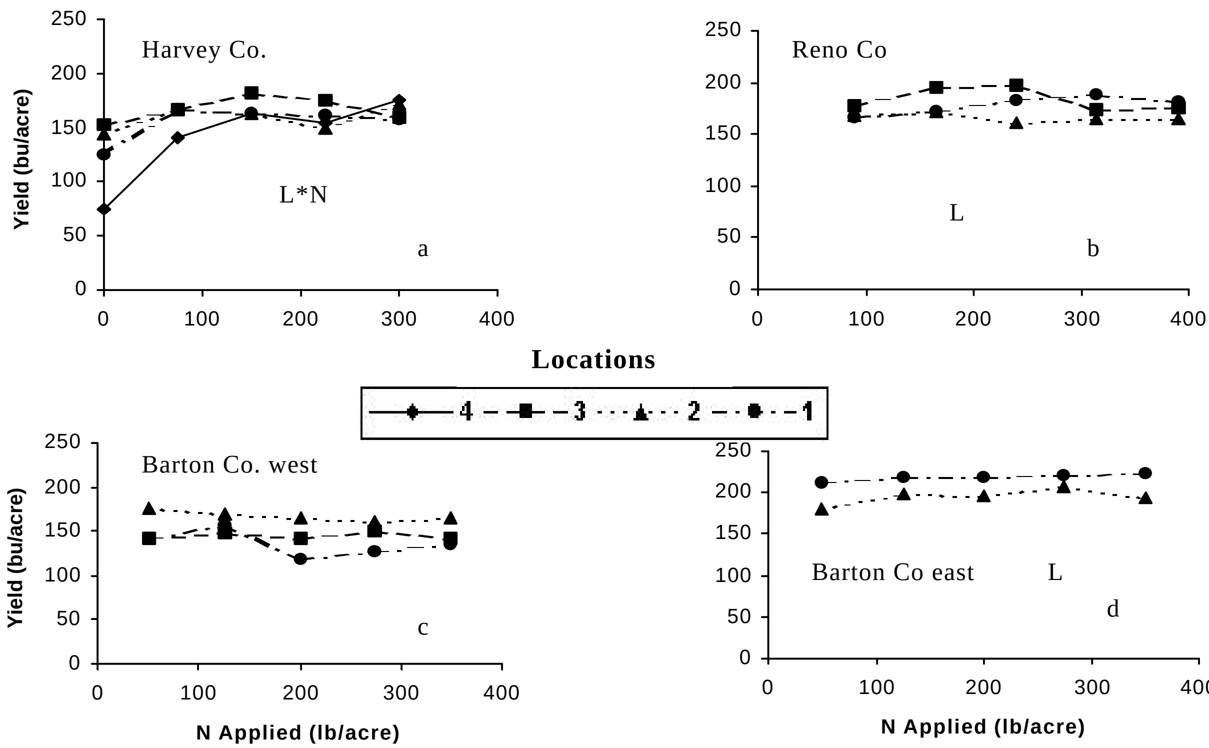

Fig 1: Yield vs Applied Nitrogen for four field sites in 1998. L, N, and L*N indicate significant Location, treatment and Location by treatment effect, respectively. Organic matter content is in increasing order with Location 1 having the lowest OM content.

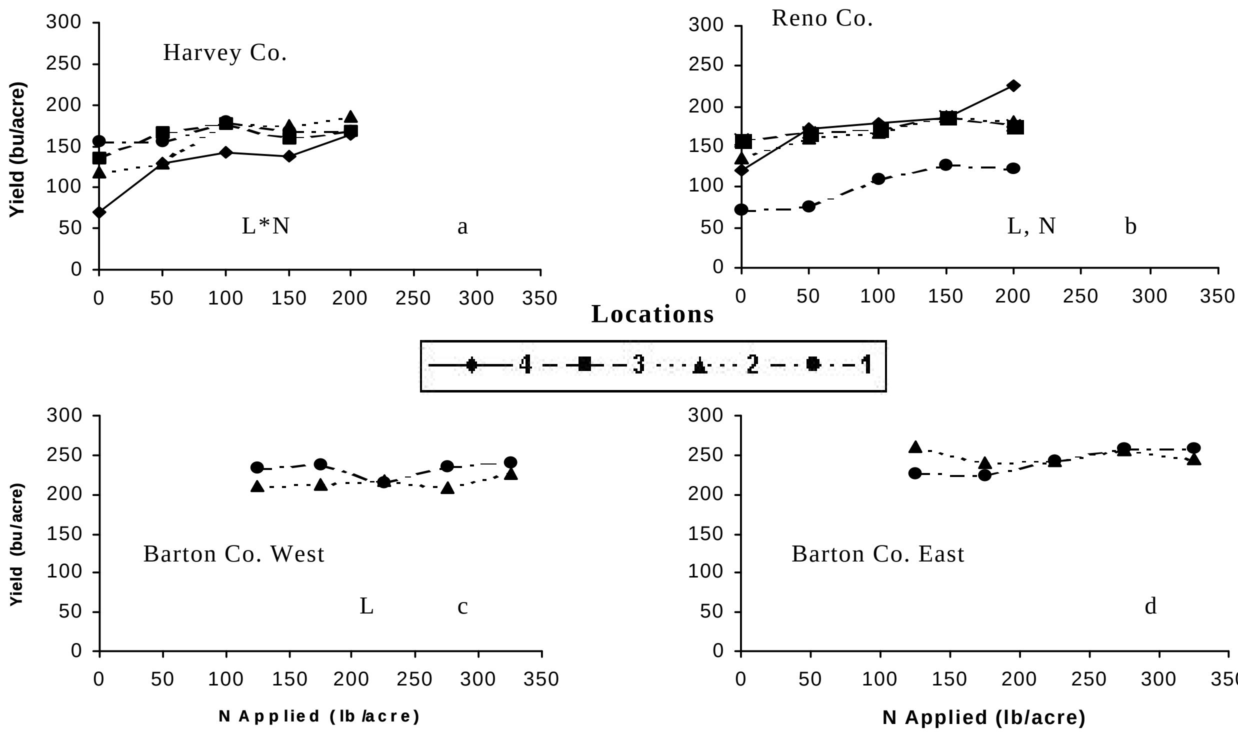

Fig 2: Yield vs Applied Nitrogen for four field sites in 1999. L, N, and L*N indicate significant Location, treatment and Location by treatment effect, respectively. Organic matter content is in increasing order with Location 1 having the lowest OM content.

Table 11. Soil description for 1998 locations in Kansas.

Field Site	Location	Soil Series	Soil Texture	Soil Taxonomic Group	% OM
Harvey					
	4	Ladysmith	Silty Clay Loam	Fine, smectitic, mesic Udertic Argiustolls	3.3
	3	Crete	Silt Loam	Fine, smectitic, mesic Pachic Argiustolls	2.7
	2	Crete	Silt Loam	Fine, smectitic, mesic Pachic Argiustolls	2.1
	1	Crete	Silt Loam	Fine, smectitic, mesic Pachic Argiustolls	2.1
Reno					
	3	Shellabarger	Fine Sandy Loam	Fine-loamy, mixed, superactive, mesic Udic Argiustolls	1.8
	2	Farnum	Loam	Fine-loamy, mixed, superactive, mesic, Pachic Argiustolls	1.7
	1	Shellabarger	Fine Sandy Loam	Fine-loamy, mixed, superactive, mesic Udic Argiustolls	1.2
Barton (West)					
	3	Pratt	Fine Sand	Sandy, mixed, mesic Lamellic Haplustalfs	1.5
	2	Pratt	Fine Sand	Sandy, mixed, mesic Lamellic Haplustalfs	1.0
	1	Pratt	Fine Sand	Sandy, mixed, mesic Lamellic Haplustalfs	0.8
Barton (East)					
	2	Pratt	Fine Sand	Sandy, mixed, mesic Lamellic Haplustalfs	2.5
	1	Pratt	Fine Sand	Sandy, mixed, mesic Lamellic Haplustalfs	1.4

Table 12. Soil description for 1999 locations in Kansas.

Field Site	Location	Soil Series	Soil Texture	Soil Taxonomic Group	% OM
Harvey					
	4	Crete	Silt Loam	Fine, smectitic, mesic Pachic Argiustolls	2.6
	3	Crete	Silt Loam	Fine, smectitic, mesic Pachic Argiustolls	2.2
	2	Crete	Silt Loam	Fine, smectitic, mesic Pachic Argiustolls	2.1
	1	Crete	Silt Loam	Fine, smectitic, mesic Pachic Argiustolls	2.1
Reno					
	4	Albion	Sandy Loam	Course-loamy, mixed superactive, mesic Argiustolls	1.8
	3	Farnum	Loam	Fine-loamy, mixed, superactive, mesic, Pachic Argiustolls	1.5
	2	Albion	Sandy Loam	Course-loamy, mixed superactive, mesic Argiustolls	1.4
	1	Shellabarger	Fine Sandy Loam	Fine-loamy, mixed, superactive, mesic Udic Argiusolls	0.6
Barton (West)					
	2	Pratt	Fine Sand	Sandy, mixed, mesic Lamellic Haplustalfs	1.7
	1	Pratt	Fine Sand	Sandy, mixed, mesic Lamellic Haplustalfs	0.8
Barton (East)					
	2	Pratt	Fine Sand	Sandy, mixed, mesic Lamellic Haplustalfs	2.7
	1	Pratt	Fine Sand	Sandy, mixed, mesic Lamellic Haplustalfs	1.8

SITE-SPECIFIC NITROGEN MANAGEMENT IN IRRIGATED CORN

R.K. Young, J.P. Schmidt, A.J. DeJoia, and R.K. Taylor

Summary

The current, predominant practice for nitrogen (N) management is to apply a uniform N fertilizer application across the field. This practice can be an economic risk to producers, if high-yielding areas are underfertilized, and an environmental risk, if low-yielding areas are overfertilized. Variable-rate fertilizer application can reduce these risks. In 1998, soil and plant tissue N levels were well above the critical levels for each growth stage, indicating that N was nonlimiting. Forty grid units were selected for sampling based on the 20 high and 20 low N use efficiency (NUE) values calculated from the previous 2 years of grain yield and N rate application. In these fields, significantly higher grain yields were obtained with less N applied from the high NUE grid units than from the low NUE grid units. Results from this study indicate that site-specific technologies can be used to evaluate current N recommendations and to modify them accordingly to minimize economic and environmental risks.

Introduction

The high potential for groundwater contamination from nitrates is a concern in the Arkansas River Valley in the central and south central portions of Kansas. This potential risk is a consequence of high rates of inorganic N fertilizers being applied to irrigated cropland. Because of the increasing acreage of continuous irrigated corn in this area of the state, total N fertilizer application has increased. This phenomenon accompanied by sandy soils and high water tables (10-50 ft) increases the threat of nitrates leaching out of the crop root zone and into the groundwater. As a result, the practice of variable-rate N application is being evaluated as a method to improve NUE and, thus, reduce potentially leachable nitrogen.

Procedures

Each field (140 acres) of four sites of continuous corn under center-pivot irrigation was divided into ¾ acre grid units (180 ft x 180 ft). Uniform and variable-rate N treatments were assigned randomly to 6-unit blocks creating 12 blocks for each treatment (Fig. 3). Composite samples of soil N (0-12 in) and plant tissue N were collected at V8, V12, and R1 growth stages from within 20 ft of the sampling point (midpoint of grid unit) from 40 grid units selected based on the 20 highest and 20 lowest NUE ratings calculated for each grid unit.

NUE = Grain Yield (bu/a) / N Rate (lb/a)

Postharvest soil N for each grid unit was measured from one 0-4 ft core collected at the sampling point. Average grain yield for each grid unit was determined using a yield monitor.

Results

The following results are based on two sites. At both sites, soil and plant tissue N levels were not significantly different for each growth stage between the 20 high NUE units and the 20 low NUE units (Tables 13 & 14). At the Barton Co. site, grain yield was significantly higher for the 20 high NUE units than the 20 low NUE units for all 3 years (Table 15). In addition, the 20 high NUE units achieved greater yields with less total N applied. At the Reno Co. site, grain yield was significantly greater for the 20 high NUE units than the 20 low NUE units for 1997 and 1999. Like the other site, greater yields with less total N applied was achieved for the 20 high NUE units compared to the low NUE units (Table 16). Preplant soil N and organic matter levels were significantly higher for the 20 high NUE units at both sites. These additional N credits decreased the N rate recommendation for each grid unit. At the Barton Co. site, the 20 high NUE grid units received variable-rate N application

treatments, whereas the 20 low received 14 uniform and 6 variable N application treatments. At the Reno Co. site, the 20 high NUE grid units received 17 uniform and 3 variable N application treatments, whereas the 20 low received 3 uniform and 17 variable N application treatments.

Table 13. Soil and plant tissue nutrient contents for high and low NUE units, Barton Co., KS, 1998.

NUE	Plant Stage	Soil N	Leaf Tissue	Soil OM	Soil P	Preplant Soil N
		mg/kg	% N	%	mg/kg	mg/kg
High 20	V-8	38.49	3.60	2.31	47.9	31.25
	V-12	53.63	3.00			
	R-1	24.14	2.56			
Low 20	V-8	32.35	3.71	1.45	23.5	22.88
	V-12	51.89	2.89			
	R-1	23.90	2.60			

Table 14. Soil and plant tissue nutrient contents for high and low NUE units, Reno Co., KS, 1998.

NUE	Plant Stage	Soil N	Leaf Tissue	Soil OM	Soil P	Preplant Soil N
		mg/kg	% N	%	mg/kg	mg/kg
High 20	V-8	12.98	3.47	1.33	22.35	10.23
	V-12	27.12	2.95			
	R-1	27.54	2.76			
Low 20	V-8	13.39	3.26	1.09	29.9	7.78
	V-12	18.03	2.87			
	R-1	27.43	2.71			

Table 15. Grain yield and N rate for high and low NUE units, Barton Co., Kansas, 1996-98.

	1996		1997		1998	
NUE	N Rate	Grain Yield	N Rate	Grain Yield	N Rate	Grain Yield
	lb/a	bu/a	lb/a	bu/a	lb/a	bu/a
High 20	184	205	197	178	226	185
Low 20	219	185	238	131	242	169

Table 16. Grain yield and N rate for high and low NUE units, Reno Co., Kansas, 1997-99.

	1997		1998		1999	
NUE	N Rate	Grain Yield	N Rate	Grain Yield	N Rate	Grain Yield
	lb/a	bu/a	lb/a	bu/a	lb/a	bu/a
High 20	178	168	220	165	225	147
Low 20	230	139	227	159	231	130

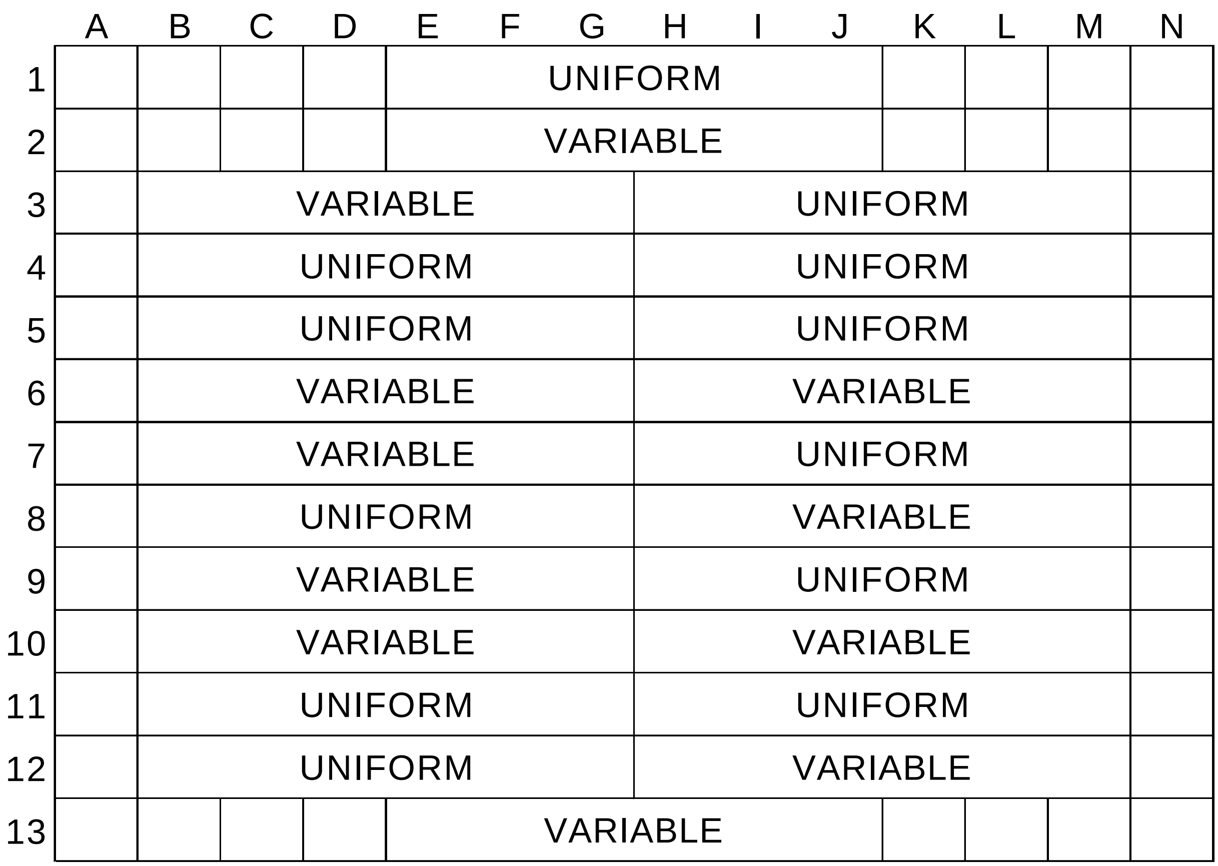

Figure 3. Nitrogen rate treatment design, Barton Co., KS.

CORN YIELD RESPONSE TO IN-ROW PLACEMENT OF IRON SULFATE

C.B. Godsey, J.P. Schmidt, A.J. Schlegel, R.K. Taylor, and C.R. Thompson

Summary

Iron deficiency in soils is a common problem facing many producers in western Kansas. In this study, 72 lbs/a iron sulfate ($FeSO_4$) monohydrate placed with the seed at planting increased average corn yields at five sites in western Kansas. These had been identified as sites that exhibit Fe deficiency symptoms (chlorosis). Although the average yield was higher, the response to Fe was not consistent among sites.

Introduction

Many soils in SW Kansas are known to be Fe deficient. Iron deficiency symptoms are displayed in grain sorghum, corn, and soybeans grown in the area. Previous research in western Nebraska has indicated that Fe-deficiency problems can be corrected by the addition of $FeSO_4$ monohydrate in the seed row. The objective of this project was to determine the correct application rate of $FeSO_4$ monohydrate for corn in SW Kansas and to evaluate the potential for targeted application using precision farming technologies.

Procedures

Five irrigated cornfields in SW Kansas were identified for Fe-deficiency symptoms. A problematic area, known to display Fe chlorosis, within each field was identified. Five different treatments included four rates of $FeSO_4$ monohydrate (0, 24, 48, and 72 lb per product acre) and one foliar application replicated four times in a randomized complete block design. The $FeSO_4$ monohydrate was applied through insecticide boxes on the planter and placed in the seed slot with the seed. The foliar Fe application was applied at about the V4 growth stage. Each plot was four rows wide (30 in rows) and 30 ft long. Forty feet of rows in each plot were hand harvested to determine yield.

Results

Averaging the yield response from all five sites in 1999 showed a significant treatment effect (Table 17). All Fe treatments had a greater average yield than the control. Specifically, the 24 lb and 72 lb rates of $FeSO_4$ monohydrate increased 14 and 15 bu/a, respectively, compared to the control treatment. At individual sites, the only significant treatment difference occurred at the Finney County site. Here, yield from the 72 lb rate of $FeSO_4$ monohydrate averaged 25 bushels greater than yield from the control treatment. In Scott County, average yields for the $FeSO_4$ treatments were numerically greater than yields of the control by 7-10 bu/a, though not statistically different. Similarly, fields NW 33 and SE 14 in Stevens County did not show significant treatment differences, but all average yields for the Fe treatments were numerically greater than yields for the control. The remaining site in Stevens County, field SW 29, did not display any notable trends. Although yields with Fe treatment appeared greater than the control yields at all sites, within-plot variability of Fe chlorosis masked treatment effects, so significant effects were difficult to determine. This sort of variability is typical and contributes to the difficulty in developing an appropriate remedy for Fe-deficient soils.

In addition to small plot experiments, aerial photographs of bare soil and photographs at various growth stages along with soil tests will be used to target Fe applications throughout four of these fields in 2000.

Table 17. Corn yield results from small-plot studies with iron sulfate, southwestern, KS, 1999.

Treatment	Finney County	Scott County	Stevens County NW 33	Stevens County SE 14	Stevens County SW 29	Average
	- - - - - - -	- - - - - - -	- - - - - - - bu/a	- - - - - - -	- - - - - - -	
Control	155	189	85	177	168	155
24 lb/ac FeSO4	168	200	110	195	174	169
48 lb/ac FeSO4	149	200	99	194	152	159
72 lb/ac FeSO4	180	196	106	204	162	170
Foliar	160	183	99	197	187	165
LSD (0.10)	20	NS*	NS*	NS*	NS*	10

*not significant for individual field

MANAGEMENT OF PHOSPHORUS-STRATIFIED SOILS IN SOUTHEASTERN KANSAS: A THREE-YEAR SUMMARY

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Summary

A 3-year study was conducted on three sites in Bourbon County, Kansas to investigate the effect of stratification of available P in the surface soil on crop growth within normal cropping sequences. We determined the effect of physical redistribution of P by using three methods of seed bed preparation - moldboard plowing (PL), conventional (CT), and no-tillage (NT) (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 one corn site, results showed that conventional and plowed treatments had higher grain yields than the no-till treatment. At this site, the addition of P, regardless of the placement, also increased grain yield as compared to the no P check. At the other corn site, no significant yield differences were observed for either tillage or P placement. At the grain sorghum site, a significant interaction between tillage and P placement affected for grain yield. Phosphorus application as a starter or knifed increased grain yields for the no-till treatments, P application as a 2 x 2 placed starter decreased grain yields (as compared to the check) on conventional tillage, and P application had little effect on the yields of plowed treatments. Wheat yields were highest in the plots that were plowed the previous spring and lowest following no-tillage. Soybean yields were not affected significantly by tillage or fertilizer placement.

Introduction

In southeast Kansas, available soil phosphorus (P) by the Bray1-P method is frequently more than twice as high in the 0-5 cm layer as in the 5-10 cm layer. Reduced tillage methods of seedbed preparation and broadcast P application have caused the buildup of available P at the surface and a depletion of available P deeper in the profile. The effects of tillage and P fertilizer placement on early-season dry matter accumulation by crops and yield are unknown. Studies were initiated in Bourbon County, Kansas to determine tillage and P placement effects on: (1) P distribution in the surface 12 inches; (2) early-season dry matter and P uptake; and (3) and grain yields of corn, sorghum, soybean, and wheat. The study was conducted within the cooperators' cropping sequences.

Procedures

Soil at the Bruner location is classified as a Parsons silt loam; the George and Wilson sites both have Catoosa silt loams. These sites were selected because soil test P was much higher in the top 3 in. of the profile than in the 3 to 6-in. layer. 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 and no-till planting of the no-till plots for the second-year soybean and third-year corn at the Bruner and Wilson sites. No-till methods were used for all plots for the second year wheat at the George site, and the wheat was winter grazed. The plowed and conventional tilled strips were disked prior to planting corn at the George site in the third year. Soil samples were collected before the first year's tillage operation and after the first and second years' harvests. These samples were analyzed for Bray1-P at depths of 0-2, 2-4, 4-6, 6-9, and 9-12 in. 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 placed deep (5 to 6 inches), and 40 lbs P_2O_5/a broadcast. In the first and third years, the corn and sorghum were sampled by taking whole plants at the V6 stage and leaf samples at tassel/boot. 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

The results shown are 3-year summaries for the three sites. Plowing effectively mixed the soil, as shown by the change in soil test P to a depth of 6 in. at the Bruner and Wilson sites and to a depth of 9 in. at the George site (Table 18). Deep and 2x2 starter placed P fertilizer significantly increased 2-year average corn yields in the conventional tillage system, but P placement did not affect corn yields in the no-tilled or plowed systems at the George site (Fig. 4). Grain sorghum on plowed and no-tilled treatments consistently responded to deep and 2x2 starter placed P (Fig. 5). Soybean and wheat yields were not affected by P placement, but wheat planted after corn on plowed plots produced significantly higher yields than when following conventional or no-till plots (Tables 19 and 20). At the Bruner site, early-season dry matter and P uptake were highest in the plowed treatments that had P applied as a 2x2 starter. Corn grain yield at this site was not significantly different for any tillage or P placement (Fig. 6). In general, early-season dry matter and P accumulation were highest in the plowed treatments and lowest in the no-till treatments. The effect of P placement on final crop yield was not as great as we originally hypothesized for these locations.

Table 18. Bray1-P soil test results before and after tillage with depth for the George, Wilson, and Bruner sites, Bourbon County, KS.

		Before	After First Crop			After Second Crop		
	Depth	Tillage	NT	CT	PL	NT	CT	PL
	in		------------------------------ Bray1-P (ppm) ------------------------------					
George Site	0-2	27	20a*	20a	12b	20a	21a	13b
	2-4	16	15b	15a	10a	15a	13a	13a
	4-6	5	4b	6b	11a	5b	6b	10a
	6-9	4	3b	3b	5a	4b	4b	7a
	9-12	4	3a	3a	2a	3a	3a	6a
Wilson Site	0-2	17	18a	15ab	12b	15a	15a	12b
	2-4	12	12a	10a	9a	11a	10a	10a
	4-6	7	9a	7b	9a	8ab	7b	10a
	6-9	5	6a	6a	7a	7a	6a	7a
	9-12	4	5a	6a	5a	5a	5a	5a
Bruner Site	0-2	16	16a	14a	8b	13a	16a	11a
	2-4	11	9a	9a	9a	10a	9a	9a
	4-6	6	6a	7a	8a	5b	5b	7a
	6-9	4	4a	4a	5a	4a	4a	4a
	9-12	4	4a	5a	4a	3a	4a	3a

* Means within a row and year followed by the same letter are not significantly different (p=0.10).

Table 19. Soybean dry matter (DM) and tissue phosphorus content at V3 and grain yield for the Bruner and Wilson sites, Bourbon Co., KS.

		V3		
Location	Main Effects	DM	P	Grain Yield
Wilson Site	Tillage	lb/a	%	bu/a
	No-till	403b	0.35a	28a
	Conventional	491a	0.32a	27a
	Plow	494a	0.34a	27a
	P Placement			
	Check	451a	0.32b	28a
	Broadcast	476a	0.34a	28a
	Starter	464a	0.35a	26a
	Deep	459a	0.34a	27a
Bruner Site	Tillage			
	No-till	520b	0.35a	25a
	Conventional	709a	0.30b	25a
	Plow	752a	0.30b	24a
	P Placement			
	Check	673	0.29b	26a
	Broadcast	657	0.32a	24a
	Starter	655	0.33a	25a
	Deep	653	0.32a	24a

*Main plot and subplot means at the same location followed by the same letter are not significantly different (p=0.10).

Table 20. Wheat dry matter (DM) and tissue phosphorus content at early boot and grain yield for the George site, Bourbon Co., KS.

	Early Boot		
Main Effects	DM	P	Grain Yield
Tillage	lb/a	%	bu/a
No-till	6652b	0.19a	32b
Conventional	6844b	0.18a	35ab
Plow	8155a	0.18a	38a
P Placement			
Check	7507a	0.17b	36a
Broadcast	6844a	0.20a	37a
Deep	7299a	0.18b	32b

*Main plot and subplot means followed by the same letter are not significantly different (p=0.10).

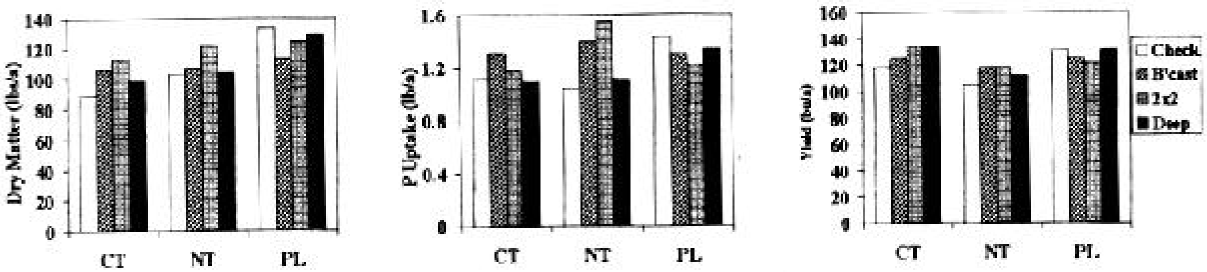

Figure 4. Two-year average early season corn dry matter and P uptake (V6) and grain yield for the George site, Bourbon County, KS.

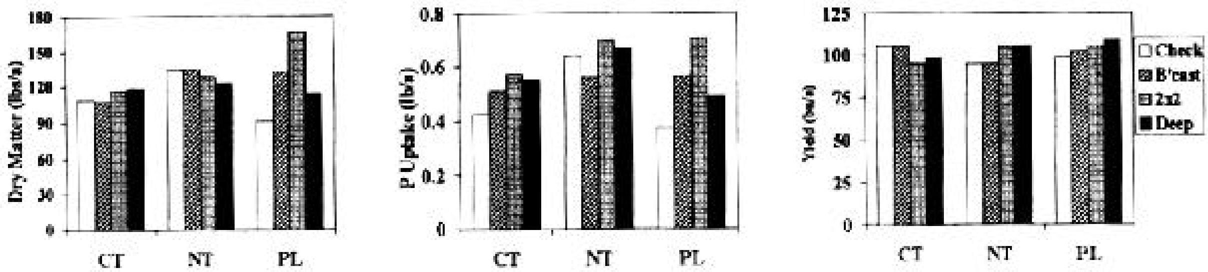

Figure 5. Two-year average early season grain sorghum dry matter and P uptake (V6) and grain yield for the Wilson site, Bourbon County, KS.

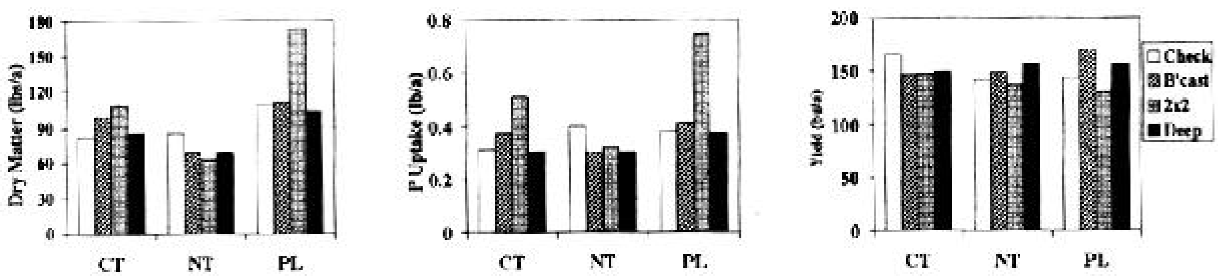

Figure 6. Early-season grain sorghum dry matter and P uptake (V6) and grain yield for the Bruner site, Bourbon County, KS, 1997.

EFFECTS OF NITROGEN SOURCE, RATE, AND APPLICATION TIME ON SOYBEAN

D.A. Whitney and W.B. Gordon

Summary

Nitrogen (N) application had no effect on 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 yield of soybean.

Procedures

The studies were located near the Irrigation Experiment Field near Scandia on a Crete silty clay loam soil and at the North Agronomy Farm at Manhattan on a Reading silt loam soil. The Scandia site was in corn in 1997, and the stalks were disked prior to soybean planting. The Scandia study was planted on June 2, and the N. Farm study was planted on June 7. Individual plots were four 30 in. rows by 30 ft long. Urea and PCU (43.5 and 42% N) were broadcast after planting and at the R-2 stage at rates of 50 and 100 lb/a of N. Leaf samples were taken from the planting-time application treatments at R-2 and all plots at the R-5.5 growth stage (data not shown). Grain yields were taken at maturity using a plot combine.

Results

Nitrogen application had no effect on soybean yield or on plant growth (Table 21). A qualitative visual inspection of root systems at R5.5 revealed reduced nodule density for N treatments. The foliar-applied CoRoN had no effect on yield.

Table 21. Effects of nitrogen source, rate, and application time on soybean near Scandia (irrigated) and at the North Agronomy Farm, Manhattan, KS.

N	N	Application	N. Farm				Scandia			
Rate	Source	Time	Grain Yield	Grain Protein	Leaf N	Nodule Rating	Grain Yield	Grain Protein	Leaf N	Nodule Rating
lb/a			bu/a	%	%		bu/a	%	%	
0	--	--	45.8	35.8	4.64	5	68.3	37.0	4.91	8
50	Urea	planting	43.7	35.6	4.90	-	67.1	36.3	4.79	7.5
100	Urea	planting	43.6	35.9	4.96	3	63.8	36.0	4.72	5
50	PCU 43.5	planting	44.9	36.2	4.78	-	67.1	36.3	4.61	6
100	PCU 43.5	planting	43.7	35.7	4.93	4	62.7	36.1	4.75	5.5
50	PCU 42	planting	43.8	36.1	4.94	-	63.8	36.0	4.85	7
100	PCU 42	planting	43.3	36.6	4.83	4	64.1	36.2	4.66	6
50	Urea	R-2	42.9	36.9		-	65.1	35.8		
100	Urea	R-2	46.6	37.3		6	69.7	36.0		
50	PCU 43.5	R-2	45.5	36.6		-	67.7	36.2		
100	PCU 43.5	R-2	45.8	37.5		-	65.1	36.3		
50	PCU 42	R-2	42.5	36.6		-	61.4	36.3		
100	PCU 42	R-2	42.9	36.5		-	66.8	36.3		
CoRoN @ 1.5 gal/a[1]		R-2	44.2	35.9		-	65.4	36.1		
CoRoN @ 3.0 gal/a		R-2	43.6	35.9		-	68.1	35.9		
LSD (.05)			NS				NS			

[1]CoRoN is a controlled-release liquid nitrogen manufactured by Helena Chemical.
Leaf sample at R-2, Nodule visual rating -1 (none) to 10 (best).

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CROP

Corn

Forage Grasses, Alfalfa

Grain Sorghum

Soybeans

Wheat

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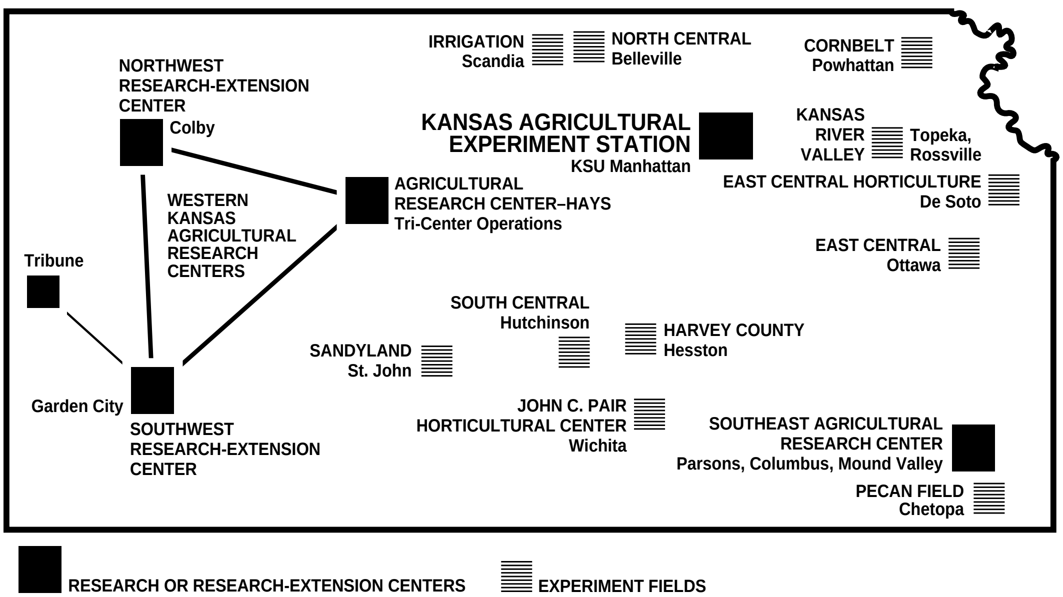

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