KANSAS FERTILIZER RESEARCH

2000

REPORT OF PROGRESS 868

Kansas State University
Agricultural Experiment Station
and Cooperative Extension Service

INTRODUCTION

The 2000 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.; Cargill, Inc.; Deere and Company; Enviro Products Corp.; Environmental Protection Agency; FMC Corporation; Farmland Industries, Inc.; Fluid Fertilizer Foundation; Foundation for Agronomic Research; 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; Pursell Technology, Inc., State Conservation Commission; Stockhausen, Inc.; The Sulphur Institute; USDA-ARS; and Wilfarm L.L.C.

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

Compiled by:
Ray E. Lamond
Extension Specialist
Soil Fertility and Management
Department of Agronomy
Kansas State University
Manhattan, KS 66506-5504

Requests for copies of this report should be directed to Ray E. Lamond, Department of Agronomy, Throckmorton Hall, Kansas State University, Manhattan, KS 66506-5504.

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

Contribution No. 01-247-S from the Kansas Agricultural Experiment Station.

TABLE OF CONTENTS

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

Precipitation Data (Inches)

1999	Manhattan	S.W. KS RES-EXT. CTR Tribune	S.E. KS AG. RES. CTR. Parsons	E. CEN EXP. FLD. Ottawa
August	2.49	1.85	0.48	0.00
September	3.82	1.62	4.26	8.43
October	0.09	1.45	0.88	0.85
November	2.16	0.09	1.20	1.79
December	0.79	0.14	4.04	2.43
Total 1999	37.36	21.38	41.84	37.92
Dept. Normal	4.08	5.72	3.33	-0.35
2000				
January	0.21	0.34	0.63	0.35
February	2.03	0.04	1.95	0.00
March	2.64	2.68	5.25	2.97
April	1.91	1.30	0.94	0.53
May	2.54	0.25	7.26	3.22
June	5.77	0.64	9.78	7.87
July	2.17	3.08	3.52	0.81
August	0.70	1.24	0.00	0.27
September	0.94	0.43	2.87	3.86

1999	N. CEN EXP. FLD. Belleville	KANSAS RV VALLEY EXP. FLD.	S. CEN. EXP. FLD. Hutchinson	AG. RES. CNTR. Hays
August	4.48	0.60	1.83	5.40
September	2.14	3.56	2.18	1.73
October	0.00	0.38	0.03	0.09
November	0.71	1.47	0.59	0.17
December	0.34	1.05	1.47	0.18
Total 1999	28.62	23.84	30.67	23.57
Dept. Normal	1.06	-10.80	3.36	1.74
2000				
January	0.18	0.19	1.21	0.28
February	1.68	1.89	2.91	0.77
March	3.11	2.60	7.22	4.25
April	1.82	0.63	0.84	1.84
May	1.06	1.80	2.67	2.76
June	2.80	4.62	3.40	1.31
July	1.49	1.36	6.23	6.18
August	1.86	1.45	0.00	0.27
September	1.17	1.62	2.60	0.69

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 winter wheat in Kansas.

Procedures

Studies were continued in 2000 at two sites (A and B) in Marion County and at the Sandyland Experiment Field.

Chloride rates (10, 20 lb/a) and sources [potassium chloride (KCl), calcium chloride ($CaCl_2$), sodium chloride (NaCl), and an experimental chloride material (Exp.)] 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 2000 were reduced somewhat by fairly dry conditions in late spring. Chloride fertilization significantly increased yields at two of three sites (Tables 1 and 2). The nonresponding site had a high (45 lb/a) soil Cl level, whereas both responsive sites had low soil Cl (9 lb/a). The application of 10 lb Cl/a was sufficient to achieve yield responses at both sites. Chloride sources performed similarly at all sites.

Chloride fertilization also significantly increased Cl concentrations in wheat leaf tissue at both responsive sites (Tables 1 and 2). The 20 lb/a rate resulted in significantly higher leaf Cl than the 10 lb/a rate at both responsive sites.

These results reaffirm earlier work showing 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, 2000.

		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	--	27	62	.08	49	61	.56
10	NaCl	31	61	.18	53	61	.56
20	NaCl	36	61	.25	48	61	.57
10	$CaCl_2$	32	61	.16	49	61	.54
20	$CaCl_2$	36	62	.24	53	60	.61
10	Exp	33	62	.16	53	62	.57
20	Exp	32	61	.26	53	62	.55
LSD (0.10)		5	NS	.04	NS	NS	NS
Mean Values:							
Cl	10	32	61	.17	51	62	.56
Rate	20	35	61	.25	51	61	.57
LSD (0.10)		NS	NS	.03	NS	NS	NS
Cl	NaCl	34	61	.21	50	61	.56
Source	$CaCl_2$	34	61	.20	51	61	.57
	Exp	32	61	.21	53	62	.56
LSD (0.10)		NS	NS	NS	NS	NS	NS
Soil Test Cl (0-24")		9			45		

Table 2. Effects of chloride rates and sources on wheat, Sandyland Experiment Field, St. John, KS, 2000.

Cl Rate	Cl Source	Yield	Test Weight	Leaf Cl
lb/a		bu/a	lb/bu	%
0	--	41	57	.07
10	KCl	51	58	.18
20	KCl	48	57	.30
10	NaCl	51	57	.19
20	NaCl	50	58	.27
10	$CaCl_2$	50	57	.17
20	$CaCl_2$	52	57	.25
10	Exp	50	57	.20
20	Exp	56	57	.27
LSD (0.10)		9	NS	.03
Mean Values:				
Cl	10	50	57	.19
Rate	20	51	57	.27
LSD (0.10)		NS	NS	.02
Cl	KCl	50	58	.24
Source	NaCl	50	57	.23
	$CaCl_2$	51	57	.21
	Exp	53	57	.23
LSD (0.10)		NS	NS	NS
Soil Test Cl (0-24")			9	

EFFECTS OF NITROGEN RATES AND SOURCES ON WHEAT

R.E. Lamond, C.J. Olsen, T.M. Maxwell, V.L. Martin, 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 2000 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 2000. UCAN-21, which is a mixture of liquid calcium nitrate and UAN, often produced higher forage and grain yields than UAN (urea - ammonium nitrate solution) over the course of this work, 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 (A and B) in Marion Co., two sites (A and B) in Saline Co., and at the Sandyland Field in 2000. 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.

Results

Forage and grain yields were good to excellent in 2000, although not as good as in 1998 or 1999. Visual responses to applied N were apparent within a few weeks after top-dressing. Site A in Marion Co. was affected by strawbreaker disease, which was worse in fertilized plots. Nitrogen fertilization increased wheat forage and grain yields at most sites (Tables 3, 4, and 5). The excellent response to N was due to relatively low residual soil N levels because of high yields in 1999. Nitrogen also consistently increased forage N and grain protein at most sites.

Nitrogen sources performed similarly at most sites in 2000, possibly because of significant rainfall shortly after fertilizer application. At the Sandyland Field, UCAN-21 produced higher forage yields, higher forage N concentrations, more N uptake, and higher grain protein than UAN. This site did not receive as much rain after fertilizer application.

Results from 3 years of work indicate that UCAN-21 is an excellent N source for top-dressing wheat and may outperform urea if conditions favor volatilization.

Table 3. Effects of nitrogen rates and sources on wheat, Marion Co., KS, 2000.

		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	--	10000	1.30	131	32	11.5	9840	1.07	104	43	11.2
30	UAN	10370	1.30	135	40	11.5	9270	1.18	110	39	12.0
60	UAN	8900	1.49	133	42	11.9	10950	1.48	157	52	11.6
90	UAN	12510	1.62	202	34	12.0	10540	1.64	174	58	12.3
30	UCAN-21	10500	1.36	145	44	11.8	8980	1.17	105	47	11.3
60	UCAN-21	10370	1.39	143	40	11.6	10540	1.20	127	56	11.3
90	UCAN-21	10780	1.57	171	43	12.1	11810	1.57	189	54	12.1
LSD (0.10)		NS	NS	NS	10	NS	NS	0.29	48	8	0.7
<u>Mean Values:</u>											
N	30	10440	1.33	140	42	11.7	9120	1.17	98	43	11.7
Rate	60	9640	1.44	138	41	11.8	10740	1.34	142	54	11.5
	90	11640	1.59	187	39	12.0	11170	1.60	181	56	12.2
LSD (0.10)		1640	0.22	37	NS	NS	1690	0.20	36	6	0.5
N	UAN	10590	1.47	157	39	11.8	10250	1.43	147	49	12.0
Source	UCAN-21	10550	1.44	153	42	11.8	10440	1.31	140	53	11.6
LSD (0.10)		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 4. Effects of nitrogen rates and sources on wheat, Saline Co., KS, 2000.

		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	--	1760	1.24	22	19	12.7	5540	1.19	65	50	9.4
30	UAN	3490	1.19	41	32	11.3	5860	1.28	75	57	9.2
60	UAN	3730	1.40	52	41	10.9	7750	1.37	106	63	9.3
90	UAN	5080	1.49	75	48	11.0	7910	1.66	125	63	9.8
30	UCAN-21	2830	1.27	36	28	11.1	5620	1.24	70	54	9.4
60	UCAN-21	4310	1.37	59	44	11.2	6800	1.44	95	58	9.4
90	UCAN-21	4260	1.59	66	50	11.5	6900	1.66	109	67	9.7
LSD (0.10)		1220	0.20	15	6	0.7	NS	0.23	35	9	NS
Mean Values:											
N	30	3160	1.23	39	30	11.2	5740	1.26	72	56	9.3
Rate	60	4020	1.39	55	42	11.0	7180	1.41	101	60	9.4
	90	4670	1.54	71	49	11.2	7160	1.66	117	65	9.8
LSD (0.10)		920	0.13	11	4	NS	NS	0.16	27	5	0.3
N	UAN	4100	1.36	56	40	11.1	7180	1.44	102	61	9.4
Source	UCAN-21	3800	1.41	54	41	11.3	6440	1.45	91	60	9.5
LSD (0.10)		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 5. Effects of nitrogen rates and sources on wheat, Sandyland Experiment Field, St. John, KS, 2000.

		Site A				
N	N	Forage			Grain	
Rate	Source	Yield	N	N Uptake	Yield	Prot.
lb/a		lb/a	%	lb/a	bu/a	%
0	--	7260	1.41	99	38	13.2
30	UAN	8900	1.51	132	49	13.4
60	UAN	10740	1.80	198	48	14.1
90	UAN	9920	1.71	168	43	15.7
30	UCAN-21	10660	1.72	191	43	14.8
60	UCAN-21	10910	1.79	200	43	15.6
90	UCAN-21	11560	1.76	204	42	15.8
LSD (0.10)		1960	0.21	61	7	1.2
Mean Values:						
N	30	9780	1.61	161	46	14.1
Rate	60	10830	1.80	199	45	14.8
	90	10740	1.74	186	42	15.7
LSD (0.10)		NS	0.14	NS	NS	0.8
N	UAN	9850	1.67	166	47	14.4
Source	UCAN-21	11040	1.76	198	43	15.4
LSD (0.10)		1180	NS	30	NS	.06

EFFECTS OF PREVIOUS CROP, SEEDING RATE, AND NITROGEN RATE ON NO-TILL WHEAT PRODUCTION

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

Summary

A study was initiated in the fall of 1997 to study the effects of previous crop, seeding rate, and nitrogen (N) rate on no-till wheat production. Wheat grain yields following soybeans in each year were roughly 25% higher than wheat yields following sorghum when averaged over seeding rate and N rate. However, at the highest seeding and N rates, the difference in yield between previous crops was minimal in 1998 and 1999, but a 12 bu/a difference in favor of soybean as the previous crop existed in 2000. In 1998 and 1999, significant yield increases occurred with higher seeding rates. In all 3 years, yields increased significantly with increasing N rates, but in no year was a significant previous crop by N rate interaction found. Our results from the 3-year study show that a N application rate of at least 80 lb/a and a seeding rate of at least 90 lb/a are needed after either sorghum or soybean.

Introduction

More and more wheat is being planted in eastern and central Kansas following fall harvest of corn, sorghum, or soybean. Only limited time exists for fertilization and seedbed preparation. With more farmers having the necessary drills, more wheat is being planted no-till, raising additional questions about seeding and N rates for these no-till systems. This research was initiated to study the effects of previous crop, seeding rate, and N rate for no-till wheat production.

Procedures

At the Agronomy Farm near Manhattan, grain sorghum and soybean were planted in the springs of 1997, 1998, and 1999 to establish the previous crop blocks for wheat planting in the fall. Good production practices were used to ensure optimum sorghum and soybean production. In all 3 years, the experiments were conducted on a Reading silt loam soil. Following fall harvest of the sorghum and soybean crops, wheat was planted into the residue using a no-till double-disk-opener plot drill with a 10 in. row spacing. Individual plots were 5 ft. wide by 20 ft. long. The study was a split-split plot design with previous crops as the first split and seeding rates as the second split. The variety 2137 was seeded on October 20, 1997, October 30, 1998, and October 25, 1999. The seeding rates were 60, 90, and 120 lb/a of seed in 1997 and 60, 90, 120, and 150 lb/a of seed in 1998 and 1999. On each seeding rate strip, three rates of N (40, 80, and 120 lb/a) were applied as ammonium nitrate. The N was broadcast in early spring each year. A no-N control was included. No starter or fall broadcast fertilizer was used because soil test results indicated adequate phosphorus (P) levels. A whole-plant sample was taken at heading from each plot, dried, and analyzed for N and P concentrations. Grain yields were taken at maturity by harvesting two center rows from each plot. A portion of the harvested grain was retained for moisture and protein determinations. Grain yields were adjusted to 14% moisture.

Results

The fall of 1999 was extremely dry at the Agronomy Farm, and wheat emergence was very slow. Visual observation in the fall did not reveal much growth or differences among seeding rates. An excellent response to N was evident in the spring on wheat after both previous crops. Statistical analysis of the yield data for 2000 showed responses to only the main effects of previous crop (34 bu/a for sorghum vs 43 bu/a for soybeans as the previous crop) and N rate (24, 39, 46, and 46 bu/a for 0, 40, 80, and 120 lb/a of N, respectively), Table 6. The main effect for seeding rate and all interactions were not significant. The lack of increased yield with increasing seeding rate was not expected, because seeding rate had a significant effect on yield in the previous 2 years.

Our original hypothesis was that N rate and seeding rate should be increased on wheat planted after grain sorghum compared to wheat following soybean. Our yield data show no year to have a significant previous crop by N rate interaction. An excellent response to N was obtained each year with a similar optimum rate for wheat following sorghum or soybean. This finding is in contrast to other studies and field observations suggesting that higher N rates are needed for optimum yields for wheat following sorghum than following soybean. Only in the first year of the study was the seeding rate by previous crop interaction significant, with a higher seeding rate needed on wheat following sorghum than soybean.

For the 2000 crop, grain protein and whole plant N concentration at heading showed a significant previous crop by N rate interaction. A greater response to N was found in grain protein and plant N for wheat following sorghum than soybean (Table 7). These results support our original hypothesis of the need for more N after sorghum.

Table 6. Effects of previous crop, nitrogen rate, and seeding rate on wheat yields for 3 years at the North Agronomy Farm, Manhattan, KS, 2000.

Crop	N	Seeding Rate after Sorghum, lb/a				Seeding Rate after Soybean, lb/a			
Year	Rate	60	90	120	150	60	90	120	150
	lb/a	- - - - - - - - bu/a - - - - - - - -				- - - - - - - - bu/a - - - - - - - -			
1998	0	27	41	35		53	48	56	
	40	41	52	50		50	60	62	
	80	46	53	57		58	55	67	
	120	48	56	58		57	59	57	
LSD (.05)		13							
1999	0	11	18	18	17	20	24	33	31
	40	9	32	33	32	27	38	35	37
	80	15	32	31	38	22	34	37	42
	120	18	30	27	39	19	30	42	34
LSD (.05)		17							
2000	0	25	15	21	23	23	24	29	29
	40	29	36	40	34	40	37	46	47
	80	42	38	42	46	50	44	56	50
	120	34	39	39	44	44	57	52	56
LSD (.05)		12							

Table 7. Mean grain protein and total plant nitrogen concentration for wheat following sorghum and soybean at four nitrogen rates, North Agronomy Farm, Manhattan, KS, 2000.

Previous Crop	N Rate	Grain Protein	Plant N
	lb/a	%	%
Sorghum	0	11.8	1.25
	40	11.1	1.65
	80	11.8	1.96
	120	12.9	2.17
Soybean	0	11.3	1.17
	40	10.8	1.32
	80	11.0	1.63
	120	11.6	1.85
LSD (.05)		0.5	0.15

Averaged over seeding rate.

EVALUATION OF POLYMER-COATED UREA AS A SEED-PLACED STARTER FERTILIZER FOR WHEAT PRODUCTION

D.A. Whitney, V.L. Martin, and L.D. Maddux

Summary

Polymer-coated urea (PCU) placed with the seed at nitrogen (N) rates as high as 35 lb/a did not cause germination damage, whereas urea caused substantial stand loss at this rate of N. These results are consistent with those from previous years showing that PCU prevented gemination injury. Because of the significant residual NO_3-N at both locations, only a small response to N was noted, thus presenting a critical evaluation of the starter fertilizer N rates.

Introduction

A considerable acreage of wheat is being planted following fall harvest of row crops, leaving little time for tillage and fertilizer application. This has sparked considerable interest in putting additional N over that normally applied in traditional starter fertilizers at planting to eliminate a second trip across the field. Putting N on with the drill at planting in direct seed-contact can be effective, but N rates with traditional N sources need to be limited to prevent germination damage. Urea is not recommended at any rate for direct seed-contact application because of potential damage. Polymer-coated urea products are available with a differential release rate of the urea. Pursell Technologies Inc. POLYON AG PCU has a reactive layer of coating that encapsulates the urea granule. Its applied thickness controls the urea release rate. Research in 1998 and 1999 with POLYON AG showed that the coating is effective in eliminating urea injury at rates as high as 60 lbs N/a in 10 in. drill rows. This research is a continuation of that work looking at starter N rate and source on nonirrigated wheat.

Procedures

Two wheat studies were initiated in the fall of 1999 at the Kansas River Valley Field near Rossville on a Eudora silt loam soil (coarse-silty, mixed, mesic Fluventic Hapludolls) and at the Sandyland Experiment Field near St. John on a Farnum fine sandy loam soil (Fine-loamy, mixed, thermic Pachich Argiutolls). The Kansas River Valley site was in corn in 1999, and the wheat was no-till planted into the corn residue. The Sandyland site was in wheat in 1999, and conventional seedbed preparation was used. 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 14 at the Kansas River Valley and on October 13 at the Sandyland Field. Starter fertilizer placed with the seed was either monoammonium phosphate (MAP, 11-52-0) alone at the rate of 5-24-0 per acre or MAP at 5-24-0 per acre with either urea (46-0-0) or POLYON AG (polymer-coated urea, 43% N) at rates to increase total starter N to 10, 20, 30, or 40 lb/a (see Tables 9 and 10 for treatments). Urea was used as a broadcast application to balance total N at 40 or 80 lb/a. Soil samples were taken at plot establishment at 0-6 in. and 6-24 in. increments. Results are shown in Table 8.

A whole-plant sample was taken at boot to early head emergence from each plot. The samples were oven dried at 65° C, ground, and analyzed for N and P concentrations. Grain yields were determined at maturity by harvesting the center rows from each plot. A sample of grain was retained for measurements of moisture and grain protein.

Results

Both locations had significant amounts of residual nitrate-N as shown by soil test results, which partially explains the smaller than expected response to N application. At both locations, grain yields were similar with 40 lb or 80 lb total N/a.

Excellent stands of wheat were obtained at both locations, except for the highest rates of urea with the seed. The 30-24-0 MAP/urea starter treatment was the lowest yielding plot at both locations (Tables

9 and 10). The 20-24-0 MAP/urea starter treatments also were low yielding at the Kansas River Valley site because of germination injury. Interestingly, the lowest rate of urea/MAP starter treatment had the highest yield at the Sandyland site, but was not significantly higher than several other PCU/MAP combinations. The 40-24-0 PCU/MAP treatment was at or near the top for yield at both locations.

At the Sandyland site, an excellent response in grain protein was found to N application, with the 80 lb/a N rates giving a greater protein increase than the 40 lb/a N rates. An excellent response to N application also was found for plant N concentration at heading. At the Kansas River Valley, no significant response in protein to N fertilization was found, and only a slight response to N application was noted for plant N concentration at late boot/early heading.

Table 8. Soil test results on samples taken prior to planting at Sandyland and Kansas River Valley Experiment Fields, KS, 1999.

Sample I.D.		pH	Lime Requirement	Bray P-1	Exchangeable K	Profile NO_3-N
			lb ECC/a	ppm	ppm	ppm
Kansas River Valley	0-6	5.2	3000	22	181	3.8
	6-24					12.4
Sandyland	0-6	5.5	500	34	109	13.5
	6-24					13.2

Table 9. Effects of direct seed-placed starter fertilizer rate and source on wheat yield, grain protein, and plant nitrogen concentration at heading at the Sandyland Experiment Field, St. John, KS, 2000.

Seed-Placed			B'cast**	Total	Grain		At Heading
N	P_2O_5	Source	N	N	Yield	Protein	Plant N
- - - lb/a - - -			lb/a	lb/a	bu/a	%	%
0	0	-	0		41.4	12.0	1.24
5	24	MAP	75 F	80	47.4	14.2	1.81
5	24	MAP	75 S	80	40.6	14.8	1.78
10	24	Urea/MAP	70 S	80	52.9	14.2	1.42
10	24	PCU/MAP	70 S	80	49.4	14.0	1.64
20	24	PCU/MAP	60 S	80	46.6	14.4	1.80
20	24	Urea/MAP	60 S	80	52.5	14.1	1.83
30	24	PCU/MAP	50 F	80	42.6	14.6	1.61
30	24	PCU/MAP	50 S	80	47.1	14.0	1.63
30	24	Urea/MAP	50 S	80	39.1	13.7	1.74
40	24	PCU/MAP	40 S	80	51.4	13.9	1.62
20	24	Urea/MAP	20 S	40	50.2	12.8	1.68
20	24	PCU/MAP	20 S	40	50.1	13.4	1.77
0	0	--	80 S	80	46.0	14.6	1.75
5	24	MAP	35 S	40	47.4	13.3	1.46
5	24	MAP	0	5	48.1	12.1	1.52
LSD (.05)					7.5	0.6	0.22

* MAP - monoammonium phosphate, 11-52-0, Urea 46-0-0 and PCU - POLYON AG polymer-coated urea, 43-0-0 from Pursell Technologies Inc.
** F - Broadcast N in fall and S - Broadcast N in spring

Table 10. Effects of direct seed-placed starter fertilizer rate and source on wheat yield, grain protein, and plant nitrogen concentration at heading at the Kansas River Valley Field, Rossville, KS, 2000.

Seed-Placed			B'cast**	Total	Grain		At Heading
N	P_2O_5	Source	N	N	Yield	Protein	Plant N
- - - lb/a - - -			lb/a	lb/a	bu/a	%	%
0	0	-	0		42.9	14.2	1.45
5	24	MAP	75 F	80	46.6	14.9	1.58
5	24	MAP	75 S	80	44.2	14.1	1.55
10	24	Urea/MAP	70 S	80	44.7	14.0	1.42
10	24	PCU/MAP	70 S	80	46.0	13.8	1.58
20	24	PCU/MAP	60 S	80	42.6	14.7	1.53
20	24	Urea/MAP	60 S	80	39.0	14.4	1.52
30	24	PCU/MAP	50 F	80	50.1	14.3	1.60
30	24	PCU/MAP	50 S	80	51.7	14.4	1.55
30	24	Urea/MAP	50 S	80	34.3	14.4	1.70
40	24	PCU/MAP	40 S	80	52.3	14.4	1.52
20	24	Urea/MAP	20 S	40	34.1	13.7	1.46
20	24	PCU/MAP	20 S	40	48.6	13.6	1.41
0	0	--	80 S	80	34.8	15.6	1.63
5	24	MAP	35 S	40	50.1	14.2	1.42
5	24	MAP	0	5	46.8	14.1	1.36
LSD (.05)					6.5	NS	0.20

* MAP - monoammonium phosphate, 11-52-0, Urea 46-0-0 and PCU - POLYON AG polymer-coated urea, 43-0-0 from Pursell Technologies Inc.
** F - Broadcast N in fall and S - Broadcast N in spring

CORRECTING SOIL pH VARIABILITY WITH SITE-SPECIFIC LIME APPLICATIONS

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

Summary

In south central Kansas, within-field soil pH may vary from less than 5.0 to greater than 7.0. However, the degree of variability within fields and between fields can be greatly different. In three fields, soil samples were taken and lime recommendations were determined in 1998, and the fields were resampled in 2000. Lime was applied randomly to half of each field using variable rate technology, and change in soil pH between 1998 and 2000 was evaluated. In two fields, lime recommendations varied greatly, and variable lime application decreased the range of pH values. On the third field, lime recommendations did not vary greatly, and variable lime application actually increased the range of pH values. This increase in pH range could be attributed to error in lime application, error in sampling, error in lime recommendation, or the small range in initial soil pH.

Introduction

In recent years, soil pH has dropped in south central Kansas, causing wheat yields to decline. Many producers initially did not recognize that low soil pH was the reason for yield reduction. Increasing amounts of fertilizer nitrogen (N) and phosphorus (P) often were applied in an effort to bring yields back to original levels. The extra N served to accentuate the soil acidity problem. Low soil pH and elevated soil aluminum (Al) levels were the real reasons for poor production. The additional N and P fertilizers were not efficiently used by the wheat crop, and the potential for P runoff increased. Some of this P fertilizer may have run off the fields and into surface waters, increasing the potential for eutrophication. Correction of the pH/Al problem by liming should allow for more efficient use of N and P and reduce the risk of P runoff. Liming is the most effective method of amending low soil pH, but lime quarries are some distance away from south central Kansas, so liming is sometimes cost prohibitive. Because much of the land is leased, many producers hesitate to invest in lime. This research was conducted to study the effects of variable-rate liming on changes in soil pH variability. If variable-rate lime application can be more effective and economic than a uniform application, producers may be more inclined to apply lime.

Procedures

Three field sites were established in south central Kansas. Soil sample points were chosen on 1-acre grids using a systematically unaligned procedure. Soil samples were collected in 1998, 1999, and 2000 from the same locations and analyzed for pH and buffered pH. Samples were composites of five cores taken at a 6-in. depth around a 5-ft. radius of a given point. Lime recommendations were determined from the 1998 soil samples, and an interpolated spread map was created using the inverse distance squared method. A uniform lime recommendation was determined by averaging the lime recommendations for all soil sample points in a given field and was evaluated to determine the amount of deviation from a site-specific recommendation. Each field was divided into 1.5-acre blocks, which were assigned randomly to have no lime applied or to be limed according to site-specific lime recommendation. Lime was applied in July 1998, using a spreader equipped with a GPS receiver. Lime was incorporated prior to planting. The rate of lime actually applied was determined for each sample point in a given field by averaging values of all lime applied within a 50-ft. radius around each soil-sample point.

Results

Fields 1 (Fig. 1) and 2 (Fig. 2) had widely varying lime recommendations. If the uniform rate of lime had been applied to these fields, 52% and 49% would have been misapplied by more than 1000 lb ECC/a, respectively. Only 23% of Field 3 (Fig. 3) would have been misapplied by more than 1000 lb ECC/a, if a uniform rate had been applied. In a field with widely varying lime recommendations, a uniform rate of lime could be detrimental in areas of high soil pH, potentially causing problems such as herbicide carryover and nutrient deficiencies. A uniform rate of lime also could be detrimental in areas of low pH, where under-application of lime potentially could cause decreased yields. Because the lime recommendations for Fields 1 and 2 varied more than the lime recommendation for Field 3, the potential for a site-specific lime application appears greater for Fields 1 and 2.

On all fields, the slope of relationship between lime recommended and lime applied differed significantly from 1.0. For all fields, more lime was applied than recommended to areas of low lime recommendation, and less lime was applied than recommended to areas of high lime recommendation (Figures 4-6).

Relationship between Final pH and Initial pH

The limed areas of Fields 1 and 2 (Figures 7 and 8) had slopes significantly different than the slopes for the areas of the field that did not receive lime. The slopes corresponding to the limed areas were closer to 0 than the slopes corresponding to the areas not receiving lime. In Fields 1 and 2, lime applications increased the lower pH values closer to the target pH of 6.8, which is used for the lime recommendations. Using variable-rate technology for lime application did not significantly change the slope of the relationship between final and initial pH values in Field 3 (Fig. 9). This could be attributed to error in lime application, error in sampling, error in lime recommendation, or the small range in initial soil pH.

With this type of site-specific data, a model can be constructed that could be used to predict final pH by knowing the initial pH and amount of lime actually applied. This model incorporates pH data from all three fields.

Final pH = 0.337+(0.996 x Initial pH) + (0.000125 x Lime Applied)
Mean Square Error 0.318 0.0553
0.0000133 r^2=0.71

This model has potential for producers considering a site-specific lime application, because it can be used to predict the lime application rate needed to bring an initial soil pH to a desired final soil pH. If a producer then collects soil samples and tests them for pH, those values can be inserted into the model along with a target pH, and a lime recommendation can be determined.

This research showed that soil pH variability is greater in some fields than others, and these high-variability fields would be better candidates for variable-rate liming than fields with low soil pH variability. Also, applying lime using variable-rate technology has potential to decrease the range in pH by increasing low soil pH without affecting areas of high soil pH. Finally, soil pH modeling holds promise as a management tool for variable-rate lime application.

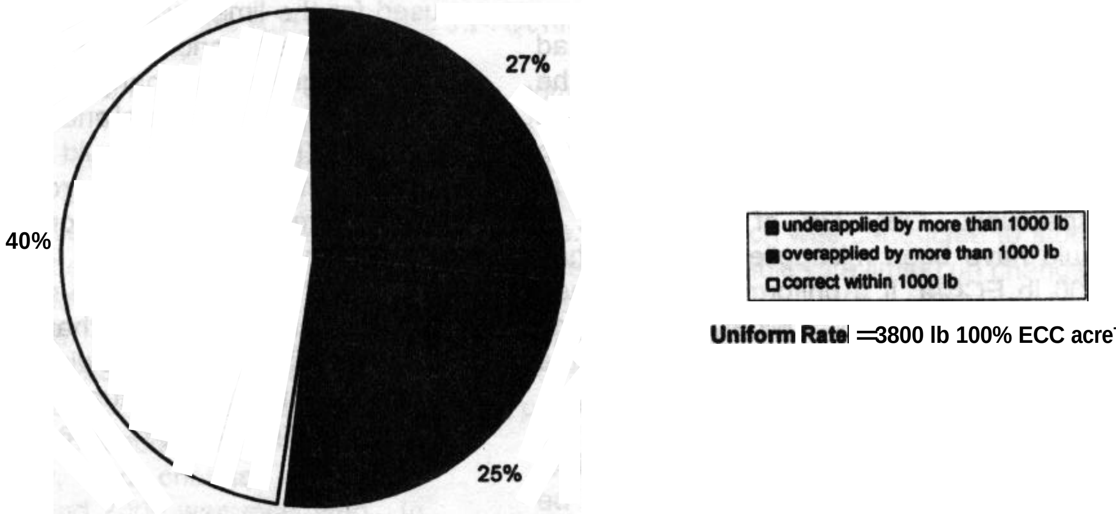


Figure 1. Deviation from a site-specific lime application for Field 1, south central Kansas.

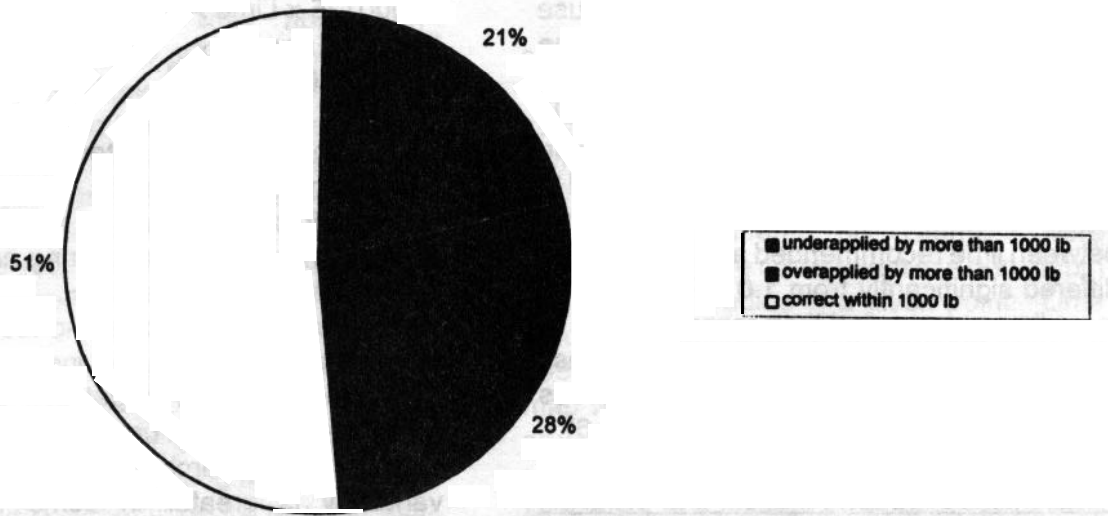


Figure 2. Deviation from a site-specific lime application for Field 2, south central Kansas.

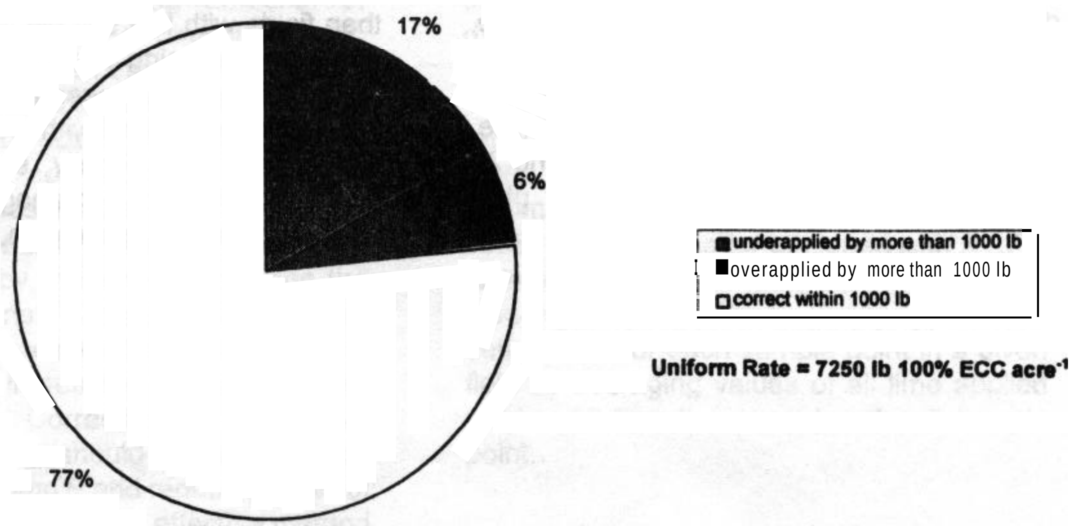


Figure 3. Deviation from a site-specific lime application for Field 3, south central Kansas.

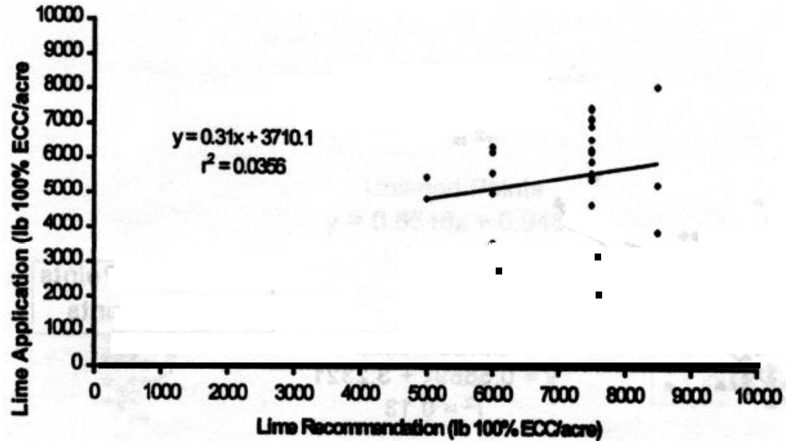


Figure 4. Lime applied as a function of lime recommended for Field 1, south central Kansas.

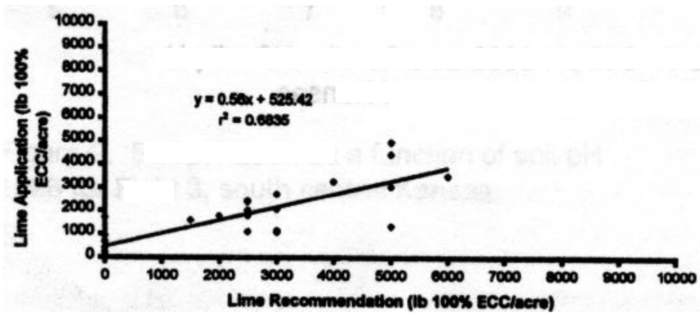


Figure 5. Lime applied as a function of lime recommended for Field 2, south central Kansas.

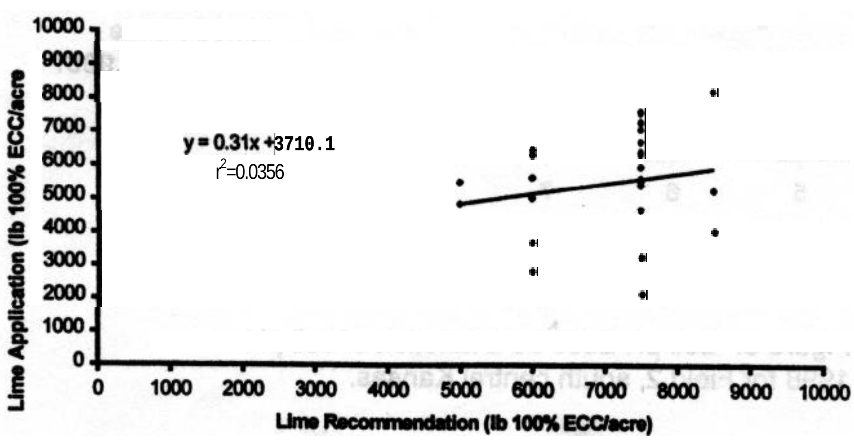


Figure 6. Lime applied as a function of lime recommended for Field 3, south central Kansas.

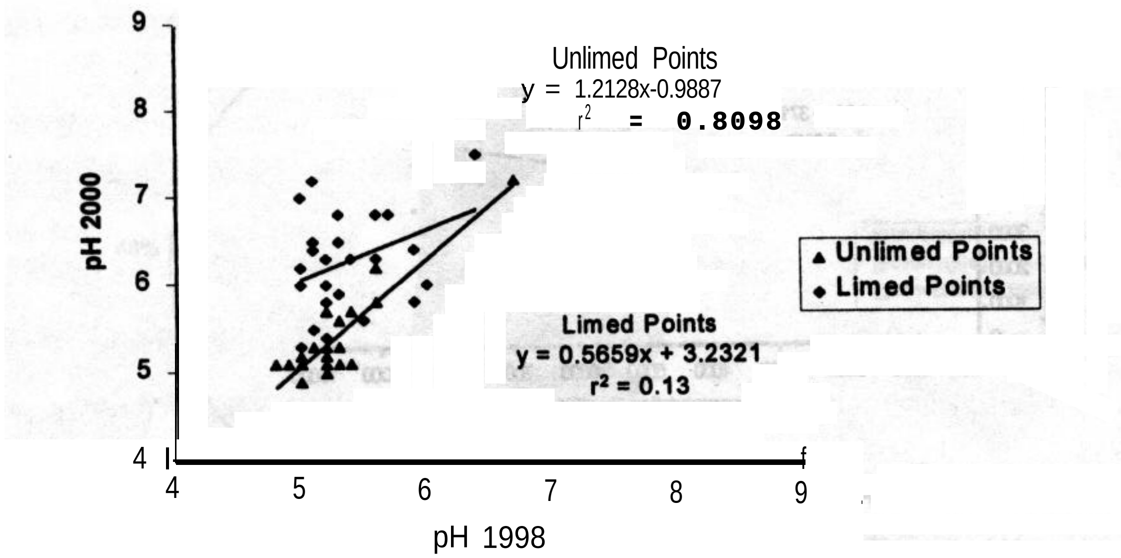


Figure 7. Soil pH 2000 as a function of soil pH 1998 for Field 1, south central Kansas.

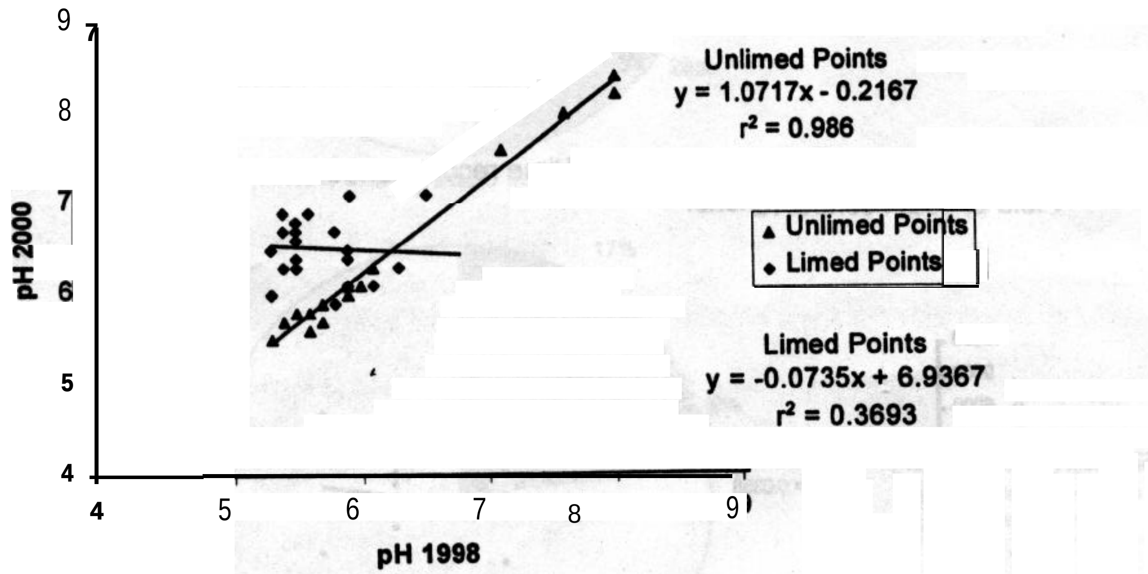


Figure 8, Soil pH 2000 as a function of soil pH 1998 for Field 2, south central

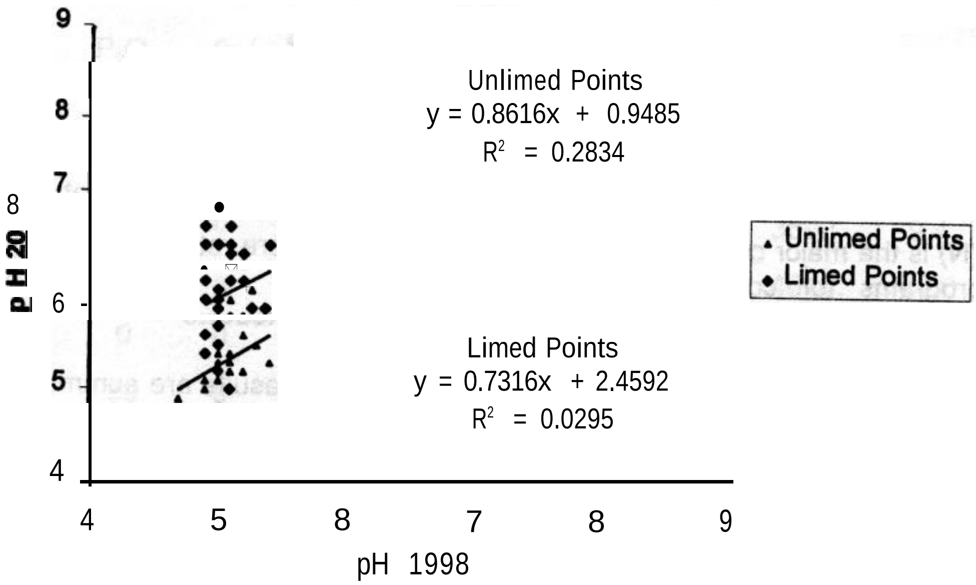


Figure 9. Soil pH 2000 as a function of soil 1998 for Field 3, south central Kansas.

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

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 2000 at two sites (A and B) in Miami County to evaluate N, P, and S. 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 2000 results are summarized in Table 1. Forage yields were average at both locations, and yields were increased by N application (Table 1). Nitrogen fertilization also significantly increased forage protein levels. Phosphorus fertilization increased brome forage yields at the site with low soil P (Site A), especially at the higher N rates. At the site with the medium soil P test (Site B), P fertilization effects on forage yields were nonsignificant.

The addition of S fertilizer produced higher yields at site B; the 20 lb S/a rate increased forage yields by nearly 900 lb/a. These results confirm earlier work indicating that bromegrass is a consistent responder to S fertilization. Producers who are managing bromegrass for maximum forage production should consider including S in their nutrient management plans. Results of this work over the past 4 years confirm that P is an essential part of bromegrass fertilization programs, especially when soil P tests are low. These studies will be continued in 2001.

Table 1. Fertility management on bromegrass, Miami Co., KS, 2000.

			Site A				Site B			
N	P_2O_5	S	Yield	Prot.	P	S	Yield	Prot.	P	S
	lb/a		lb/a	- - - - % - - - -			lb/a	- - - - % - - - -		
0	0	0	2220	7.8	.16		1430	8.5	.21	
40	0	0	4080	9.7	.14		3590	9.4	.22	
80	0	0	3580	10.0	.12		4840	10.0	.19	
120	0	0	4680	12.7	.14		5860	12.1	.20	
40	30	0	3260	8.6	.18		3640	9.4	.21	
80	30	0	4650	10.4	.17		4870	10.3	.22	
120	30	0	5200	12.7	.19		5650	11.8	.20	
80	30	20	4460	10.0	.15		5760	10.2	.21	
LSD (0.10)			590	1.9	.02		820	1.3	NS	
<u>Mean Values:</u>										
N	40		3670	9.1	.16		3610	9.4	.21	
Rate	80		4110	10.2	.14		4860	10.2	.20	
	120		4940	12.7	.16		5750	11.9	.20	
LSD (0.10)			400	1.5	NS		590	1.0	NS	
P_2O_5	0		4110	10.8	.13		4760	10.5	.20	
Rate	30		4370	10.6	.18		4720	10.5	.21	
LSD (0.10)			NS	NS	.02		NS	NS	NS	
Soil Test P, ppm			7				14			

SOIL FERTILITY RESEARCH
SOUTHWEST RESEARCH - EXTENSION CENTER

NITROGEN AND PHOSPHORUS FERTILIZATION OF IRRIGATED CORN AND GRAIN SORGHUM

A.J. Schlegel

Summary

Long-term research shows that phosphorus (P) and nitrogen (N) fertilizers must be applied to optimize production of irrigated corn and grain sorghum in western Kansas. In this study, N and P fertilization increased corn yields up to 90 bu/a. Averaged over the past 8 years, corn yields were increased more than 100 bu/a by N and P fertilization. Application of 160 lb N/a generally is sufficient to maximize corn yields. Phosphorus increased corn yields by 70 bu/a when applied with at least 120 lb N/a. Application of 40 lb P_2O_5/a has been adequate for corn until this year, when yields were increased by a higher P rate. Grain sorghum yields averaged over 8 years were increased 50 bu/a by N and 20 bu/a by P fertilization. Application of 80 lb N/a was sufficient to maximize yields in most years. Potassium (K) fertilization had no effect on sorghum yield.

Introduction

This study was initiated in 1961 to determine responses of continuous corn and grain sorghum grown under flood irrigation to nitrogen (N), phosphorus (P), and potassium (K) fertilization. The study is conducted on a Ulysses silt loam soil with an inherently high K content. No yield benefit to corn from K fertilization was observed in 30 years and soil K levels remained high, so the K treatment in the corn study was discontinued in 1992 and replaced with a higher P rate.

Procedures

Initial fertilizer treatments in 1961 to corn and grain sorghum in adjacent fields were N rates of 0, 40, 80, 120, 160, and 200 lb N/a without P and K; with 40 lb P_2O_5/a and without K; and with 40 lb P_2O_5/a and 40 lb K_2O/a. In 1992, the K variable for the corn study was replaced by a higher rate of P (80 lb P_2O_5/a). All fertilizers were broadcast by hand in the spring and incorporated prior to planting. The soil is a Ulysses silt loam. Corn hybrids Pioneer 3379 (1992-94), Pioneer 3225 (1995-97), Pioneer 3395IR (1998), and Pioneer 33A14 (2000) were planted at 32,000 seeds/a in late April or early May. The 1999 corn crop was lost to hail. Sorghum (Mycogen TE Y-75 from 1992-1996, Pioneer 8414 in 1997, and Pioneer 8505 from 1998-2000) was planted in late May or early June. Both studies were furrow irrigated to minimize water stress. The center two rows of each plot were machine harvested after physiological maturity. Grain yields were adjusted to 15.5% moisture for corn and 12.5% for sorghum.

Results

Corn yields in 2000 were higher than the long-term average (Table 1). Nitrogen and P fertilization increased corn yields by up to 90 bu/a. Grain yield in the control treatments was 131 bu/a, approximately twice as high as in any of the previous 7 years. Only 80 lb N/a was required to obtain near maximum yields compared to the long-term average of about 160 lb N/a. Hail severely damaged the corn in 1999, and the study was not harvested. This appears to have increased the amount of residual N for the 2000 crop. Corn yields were 10 bu/a greater with 80 than with 40 lb P_2O_5/a. This was the first year that yields were significantly higher with the higher P rate.

Grain sorghum yields in 2000 were similar to the long-term average (Table 2). Maximum sorghum yields were obtained with only 40 lb N/a when applied with P. Phosphorus increased yields by about 20 bu/a for all treatments receiving N, which was similar to the long-term average. Potassium fertilization had no effect on yield.

Table 1. Effects of nitrogen and phosphorus fertilizers on irrigated corn, Tribune, KS, 1992-2000.

		Grain Yield								
Nitrogen	P_2O_5	1992	1993	1994	1995	1996	1997	1998*	2000	Mean
- - - - lb/a - - - -		- -				bu/a -				
0	0	73	43	47	22	58	66	49	131	61
0	40	88	50	43	27	64	79	55	152	70
0	80	80	52	48	26	73	83	55	153	71
40	0	90	62	66	34	87	86	76	150	81
40	40	128	103	104	68	111	111	107	195	116
40	80	128	104	105	65	106	114	95	202	115
80	0	91	68	66	34	95	130	95	149	91
80	40	157	138	129	94	164	153	155	205	149
80	80	140	144	127	93	159	155	149	211	147
120	0	98	71	70	39	97	105	92	143	89
120	40	162	151	147	100	185	173	180	204	163
120	80	157	153	154	111	183	162	179	224	165
160	0	115	88	78	44	103	108	101	154	99
160	40	169	175	162	103	185	169	186	203	169
160	80	178	174	167	100	195	187	185	214	175
200	0	111	82	80	62	110	110	130	165	106
200	40	187	169	171	106	180	185	188	207	174
200	80	165	181	174	109	190	193	197	218	178
ANOVA										
N		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Linear		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Quadratic		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
P_2O_5		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Linear		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Quadratic		0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
N x P		0.013	0.001	0.001	0.001	0.001	0.001	0.001	0.008	0.001
MEANS										
Nitrogen, lb/a	0	80	48	46	25	65	76	53	145	67
	40	116	90	92	56	102	104	93	182	104
	80	129	116	107	74	139	146	133	188	129
	120	139	125	124	83	155	147	150	190	139
	160	154	146	136	82	161	155	157	190	147
	200	154	144	142	92	160	163	172	197	153
	LSD 0.05	14	7	13	7	10	12	11	10	5
P_2O_5, lb/a	0	96	69	68	39	92	101	91	149	88
	40	149	131	126	83	148	145	145	194	140
	80	141	135	129	84	151	149	143	204	142
	LSD 0.05	10	5	9	5	7	9	7	7	4

*Note: No yield data were obtained for 1999 because of hail damage.

Table 2. Effects of nitrogen, phosphorus, and potassium fertilizers on irrigated sorghum, Tribune, KS, 1992-2000.

N	P_2O_5	K_2O	Grain Yield 1992	1993	1994*	1996	1997	1998	1999	2000	Mean
- - - - lb/a - - - -			- - - - bu/a - - - -								
0	0	0	27	46	64	74	81	77	74	77	65
0	40	0	28	42	82	77	75	77	85	87	69
0	40	40	35	37	78	79	83	76	84	83	69
40	0	0	46	69	76	74	104	91	83	88	79
40	40	0	72	97	113	100	114	118	117	116	106
40	40	40	72	92	112	101	121	114	114	114	105
80	0	0	68	91	96	73	100	111	94	97	92
80	40	0	85	105	123	103	121	125	113	116	112
80	40	40	85	118	131	103	130	130	123	120	118
120	0	0	56	77	91	79	91	102	76	82	82
120	40	0	87	120	131	94	124	125	102	116	113
120	40	40	90	117	133	99	128	128	105	118	115
160	0	0	62	93	105	85	118	118	100	96	97
160	40	0	92	122	137	92	116	131	116	118	116
160	40	40	88	123	125	91	119	124	107	115	112
200	0	0	80	107	114	86	107	121	113	104	105
200	40	0	91	127	133	109	126	133	110	114	118
200	40	40	103	123	130	95	115	130	120	120	118
ANOVA											
Nitrogen			0.001	0.001	0.001	0.003	0.001	0.001	0.001	0.001	0.001
Linear			0.001	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001
Quadratic			0.001	0.001	0.001	0.116	0.001	0.001	0.227	0.001	0.001
P-K			0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Zero P vs. P			0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
P vs. P-K			0.431	0.888	0.734	0.727	0.436	0.649	0.741	0.803	0.858
N x P-K			0.420	0.006	0.797	0.185	0.045	0.186	0.482	0.061	0.035
MEANS											
Nitrogen											
0 lb/a			30	42	75	77	80	76	81	82	67
40			64	86	100	92	113	108	105	106	97
80			80	104	117	93	117	122	110	111	107
120			78	105	118	91	114	118	95	105	103
160			81	113	122	89	118	124	108	110	108
200			91	119	126	97	116	128	115	113	113
LSD 0.05			10	10	14	9	10	8	13	7	7
P_2O_5-K_2O											
0-0 lb/a			56	81	91	79	100	103	90	91	86
40-0			76	102	120	96	113	118	107	111	106
40-40			79	102	118	95	116	117	109	112	106
LSD 0.05			7	7	10	7	7	6	9	5	5

*Note: No yield data were obtained for 1995 because of early freeze damage.

IMPACT OF ANIMAL WASTES ON IRRIGATED CORN

A.J. Schlegel and H.D. Bond

Summary

The potential for animal wastes to recycle nutrients, build soil quality, and increase crop productivity is well established. A concern with land application of animal wastes is that excessive applications may damage the environment. This study evaluates established best management practices for land application of animal wastes on crop productivity and soil properties. Swine wastes (effluent water from a lagoon) and cattle wastes (solid manure from a beef feedlot) were applied at rates to meet corn requirements for phosphorus (P) and nitrogen (N) (established best management practices), along with a rate to supply double the N requirement. Other treatments were N fertilizer (60, 120, and 180 lb N/a) and an untreated control. Corn yields in 2000 were increased by application of animal wastes and N fertilizer. However, the type of waste or application rate had little effect on yield.

Introduction

The potential for animal wastes to recycle nutrients, build soil quality, and increase crop productivity is well established. A growing concern is that changes in livestock production systems (larger and more concentrated operations) may create environmental problems because of excessive amounts of animal wastes in localized areas. Specific concerns are surface runoff of P, which can cause eutrophication (overenrichment) of surface waters, and leaching of NO_3-N through the soil, which might contaminate groundwater. This study was initiated to evaluate best management practices for utilization of animal wastes for irrigated crop production.

Procedures

This study was initiated in 1999 to determine the effect of land application of animal wastes on crop production and soil properties. The two most common animal wastes in western Kansas were evaluated; solid cattle manure from a commercial beef feedlot and effluent water from a lagoon on a commercial swine facility. The rate of waste application was based on the amount needed to meet the estimated crop P requirement, crop N requirement, or twice the N requirement (Table 1). The Kansas Department of Agriculture Nutrient Utilization Plan Form was used to calculate animal waste application rates. Expected corn yield was 180 bu/a. Soil test P and N values were determined from samples taken in the fall of 1999.

Residual soil N in the N-based treatments was 77 lb/a for the cattle manure and 136 lb/a for the swine effluent. The 2XN treatments were twice the calculated rates for the 1XN treatments. The allowable P application rate for the P-based treatments was 105 lb P_2O_5/a, because soil test P was less than 150 ppm Mehlich-3 P. Nutrient values used for the animal wastes were 17.5 lb available N and 25.6 lb available P_2O_5/ton of cattle manure and 6.1 lb available N and 1.4 lb available P_2O_5/1000 gal of swine effluent.

Other nutrient treatments were three rates of N fertilizer (60, 120, and 180 lb N/a) along with an untreated control. Treatments in 2000 were applied in the early spring and incorporated prior to planting of corn. The experimental design was a randomized complete block with four replications. The study was established in border basins to facilitate effluent application and irrigation. Plot size was 12 rows wide by 45 ft. long. All plots were irrigated to minimize water stress. The soil is a Ulysses silt loam. Corn (Pioneer Brand 34D34) was planted on April 25 at 33,000 seeds/a. Ear leaf samples were collected at silking and analyzed for N and P contents. The center four rows of each plot were machine harvested on September 19, and yields were adjusted to 15.5% moisture.

Results

Grain yields were increased by application of animal wastes and commercial fertilizer in 2000 compared to the untreated control (Table 2). The type of animal waste or rate of application had little effect on corn yield. Nitrogen content of the ear leaf tended to be higher from application of animal wastes than N fertilizer, although no differences occurred between manure type or application rate. Leaf P content was higher from applications of cattle manure than of swine effluent. No yield measurements were taken in 1999 because of severe hail damage. The study will be continued in 2001 to evaluate the multiyear impact of repeated animal waste applications.

Table 1. Application rates of animal wastes, Tribune, KS, 2000.

Application Basis*	Cattle Manure	Swine Effluent
	ton/a	gal/a
P Requirement	4.1	75,000
N Requirement	6.6	9,400
2XN Requirement	13.2	18,800

* The nutrient values used for the calculations were 17.5 lb available N and 25.6 lb available P_2O_5 per ton of cattle manure and 6.1 lb available N and 1.4 lb available P_2O_5 per 1000 gallon of swine effluent.

Table 2. Effects of animal wastes and nitrogen fertilizer on irrigated corn, Tribune, KS, 2000.

Nutrient Source	Rate*	Leaf N	Leaf P	Grain Yield
		- - - - - - - %	- - - - - - -	bu/a
Cattle Manure	P	2.59	0.29	197
	N	2.64	0.29	195
	2XN	2.52	0.29	195
Swine Effluent	P	2.56	0.27	189
	N	2.61	0.26	184
	2XN	2.62	0.27	181
N Fertilizer	60	2.25	0.24	178
	120	2.63	0.27	186
	180	2.46	0.26	184
Control	0	2.35	0.25	158
LSD 0.05		0.21	0.02	22

* Rate of animal wastes are calculated based on meeting P requirement, N requirement, or twice the N requirement of the crop. The N fertilizer rates are in lb N/a.

SOIL FERTILITY RESEARCH
AGRICULTURAL RESEARCH CENTER-HAYS

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

C.A. Thompson

Summary

Increasing evidence shows positive effects of Stockosorb materials on crop production. However, their usage does not guarantee a 100% crop response. In fact, unless certain guidelines are followed, their use can result in economic loss. The most consistent response occurred when 1 to 2 lb/a Stockosorb AGRO F was blended with liquid fertilizer and applied in a band with the seed at planting. This method of application resulted in a uniform band of the material in the seed row. The micro-environment created with this banding process allowed plant roots to grow into the hydrated gel and extract water-soluble nutrients as needed. The cross-linked polyacrylamide was metered out through a 1/16-inch ID plastic tube with a ground-driven pump at 2.5 to 3 mph, instead of spray nozzles with an orifice. If greater ground speeds are desired, use of a 1/8-inch ID tube may be necessary in order to keep psi within the metering system at reasonable levels. A critical step was adding the AGRO F material directly into the total volume of liquid fertilizer and not into a premix tank. Water can be added only after AGRO F has been mixed into the liquid fertilizer. A premix test should be performed to determine the compatibility of the mixture before mixing into a large tank. Also, a small area of 20 to 40 acres should be tested first before expanding to the producer's entire acreage.

Introduction

Products similar to the polyacrylamides used in baby diapers to absorb urine were used in this study. The cross-linked polymer Stockosorb AGRO was a dry material and was applied as such. Stockosorb AGRO F was a fine dry material that was blended and stayed in suspension with liquid fertilizers.

Once in the soil, both of these products absorbed water and water-soluble nutrients to form hydrated gels. Plant roots can grow into these hydrated gels and extract the nutrients.

The cooperation of off-station farmers in this study is greatly appreciated.

Procedures

Research sites were located on- and off-station (farmer's fields in surrounding counties) in conventional crop rotations. The scientist, using special research equipment, applied materials and performed planting and harvest procedures. Stockosorb materials were supplied by Stockhausen, Inc. They were banded with the seed at planting using a special cone/spinner mechanism that metered the prepackaged dry material in a very precise manner. Dry Stockosorb AGRO was combined either with coarse sand or the dry fertilizer treatment. The Stockosorb AGRO flowed better in the distribution tubes when combined with some type of coarse material.

Liquid materials (28-0-0 and 10-34-0) were applied with a John Blue ground-driven pump. When Stockosorb AGRO F was blended with liquid fertilizer, replications were separated with a 40 foot turnaround area. This allowed each liquid treatment to be applied in all replications before changing to the next treatment. Stockosorb AGRO F was mixed with the total amount of liquid fertilizer needed for each treatment in all replications. Water was added to this mixture to bring the total volume up to 20 gal/a. Liquid products were metered out through a 1/16-inch ID tube. No orifices were used because they tended to plug easily. Liquid pressure inside the tubes ranged from 30 to 45 psi. The plastic tubes went through metal tubing, the last 4 inches of which were angled back 30 degrees to eliminate mud buildup around the seed opening.

All on- and off-station sites were located on silt loam or silty clay loam soils. The predominate soil type was Harney silt loam. A modified 8-row grain drill was used to plant both wheat and sorghum in a 12-inch row spacing. The wheat variety Jagger was used in all wheat studies, Presto triticale in the small grain forage study, DeKalb DK36 (medium-early maturing) in the grain sorghum studies, and Canex forage sorghum in the summer hay and silage studies. Winter wheat was seeded at 60 lb/a, winter triticale at 75 lb/a, grain sorghum at 90,000 seeds/a (superthick sorghum), and forage sorghum at 20 lb/a. Treatments were replicated four times. Six rows from the center of each 8-row plot were harvested for grain with a Massey MF-8 plot combine equipped with a 72-inch header. A Dickey-John grain analysis computer was used to measure test weight. Plant height and visual rating notes were taken at harvest. Data were analyzed with the statistical software package SAS. ANOVA was used to determine treatment differences.

Results

Small Grains

Stockosorb AGRO Rate x Starter Fertilizer

Three sites on the KSU Agricultural Research Center-Hays were used to compare five Stockosorb AGRO rates with and without starter fertilizer (Table 1) on winter wheat. Significant yield increases from the use of starter fertilizer were measured at all three sites. Where Stockosorb AGRO was applied alone, only Site #3 responded to the lowest 1 lb/a rate (0.09 probability). A modest average yield increase (2.8 bu/a) was measured from the use of Stockosorb AGRO alone. However, when starter fertilizer was blended with Stockosorb AGRO, significant yield increases over starter fertilizer alone were measured on all three sites. This synergistic effect of the two products blended together is noteworthy.

The net return from the same three sites is shown in Table 2. Only the 1 lb/a Stockosorb AGRO rate applied alone on winter wheat in Site #3 gave a significant net return. Only Site #2 gave a positive net return from the combination of Stockosorb AGRO and starter fertilizer. Average net returns from Stockosorb AGRO rates over 2 lb/a started to decline on all three sites. Thus, on these three sites, applying more than 2 lb/a on these silt loam soils did not pay.

Comparison of Dry and Liquid Stockosorbs

Six off-station sites on farmers' fields (Table 3) were used to compare dry Stockosorb AGRO (with and without liquid starter fertilizer) with Stockosorb AGRO F (blended in liquid starter fertilizer). Each site exhibited modest to significant response to liquid starter fertilizer. Responses to the two Stockosorb products were realized only when they were combined with liquid starter fertilizer. This synergistic effect was noted on all six sites, and yields were consistently superior with Stockosorb AGRO F than with Stockosorb AGRO. Applying more than 2 lb/a of either product had little effect on yields.

On all six sites (Table 4), net return declined with each increment of Stockosorb AGRO applied alone. Liquid fertilizer applied alone returned only $4.14/a more than the control when averaged over the six sites. Only the Rooks County site had a greater net return when Stockosorb AGRO + liquid fertilizer were used in combination. However, five of six sites had greater net returns when Stockosorb AGRO F + liquid fertilizer were blended together. Applying more than 2 lb/a Stockosorb F with liquid fertilizer did not pay.

Stockosorb AGRO Rate and Placement on Presto Triticale

Comparisons of broadcast and banded Stockosorb AGRO rate are shown in Table 5 for hay at the boot stage and for grain. The entire study received 25+25+0 banded with the seed using ammonium nitrate (34-0-0) and 18-46-0. Although yields did not differ greatly between the two application methods, net return was significantly better when the Stockosorb AGRO was banded with the seed. When 1 lb/a Stockosorb AGRO was placed in a half-inch band with the seed, this was equivalent to broadcasting 24 lb/a on the surface. This is the reason for the 1:24 ratio of banded to broadcast. A positive net return was not realized from broadcast Stockosorb AGRO, because input costs were too high. Banded Stockosorb AGRO at low rates seemed to be cost effective for triticale hay and grain production.

Summer Crops

Stockosorb AGRO Rate x Nitrogen Fertilizer

Yield results of banding five Stockosorb AGRO rates (with and without N) with the sorghum seed at planting are shown in Table 6. Results at the droughty site in Ness County also were confounded by a heavy grass infestation that lowered yields and caused extensive variability. In each of the five sites, sorghum responded better to Stockosorb AGRO combined with N fertilizer. This finding was also very apparent when data from the five sites were averaged. Results showed a synergistic effect when Stockosorb AGRO was combined with N fertilizer.

With one exception, Stockosorb AGRO applied alone resulted in less return than the control (Table 7). However, for the combination with N fertilizer averaged over the five sites, a positive net income was realized with rates up to 3 lb/a Stockosorb AGRO. When averaged over five sites, the 2 lb/a Stockosorb AGRO rate combined with N returned over $10.00/a more than N alone.

Comparison of Dry and Liquid Stockosorbs

The yield effects of Stockosorb AGRO and Stockosorb AGRO F are compared in Table 8. Stockosorb AGRO was applied as a dry material alone and with liquid fertilizer. The Stockosorb AGRO F that was blended with liquid fertilizer several days prior to usage stayed in suspension throughout the banding process at seeding time. Some sites had a high LSD, indicating extensive variability. This was caused partly by the two droughty periods that occurred during the growing season.

The yield responses (Table 8) to Stockosorb AGRO applied alone, regardless of rate, were insignificant. When both polymers were applied with liquid fertilizer, higher yields were realized with Stockosorb AGRO F than with Stockosorb AGRO. It was very difficult to apply the low rates of the dry Stockosorb AGRO in a uniform manner in the banding operation. However, Stockosorb AGRO F was applied evenly when banded at seeding time. This even application of the liquid form may account for the consistent higher yields over Stockosorb AGRO. For both materials, Stockosorb rates had to be at least 1 lb/a or higher.

The net returns of the dry and liquid Stockosorb materials are shown in Table 9. Stockosorb AGRO applied alone failed to result in a significant positive net return at any of the five sites. Liquid fertilizer applied alone or in combination with each of the Stockosorb products resulted in a positive net return when Stockosorb rates were 1 lb/a or higher. The general economic trend favored Stockosorb AGRO F (liquid form) over Stockosorb AGRO (dry). The greatest net return was from the Stockosorb AGRO F applied with liquid fertilizer.

Stockosorb AGRO Rate and Placement on Forage Sorghum

Stockosorb AGRO was compared in two placement methods, broadcast and incorporated, and banded with the forage sorghum seed (Table 10). When 1 lb/a Stockosorb AGRO was placed in a half-inch band with the seed, this was equivalent to broadcasting 24 lb/a on the surface. For hay and silage at both sites, polymer placement had no effect on plant height or yield.

No positive net return occurred with broadcast Stockosorb AGRO because of high input costs. However, when the polymer was banded, net return was greater with each additional pound of Stockosorb AGRO applied. It should be pointed out that broadcast N and banded N were applied on the entire site. Quite likely, a positive synergistic effect occurred when fertilizer N and Stockosorb AGRO were banded together. The return on investment was very high with the banded method.

Table 1. Three-site summary of 2000 winter wheat yields as affected by Stockosorb AGRO applied with and without starter fertilizer and placed in a band with the seed at planting under dryland conditions, KSU Agricultural Research Center–Hays, KS.

Stockosorb AGRO Rate w/Seed	Starter Fertilizer w/Seed[1]	Yield Site #1	Yield Site #2	Yield Site #3	Yield Three-Site Average
lb/a		---	--- bu/a ---	---	---
0	No	34.3	34.0	37.0	35.1
1	No	34.3	34.5	45.1	37.9
2	No	34.4	35.3	45.5	38.4
3	No	34.5	36.2	45.7	38.8
6	No	34.6	36.4	45.8	38.9
12	No	34.8	37.3	45.6	39.2
0	Yes	37.9	43.1	48.5	43.2
1	Yes	38.8	48.9	49.2	45.6
2	Yes	39.7	55.1	51.3	48.7
3	Yes	40.6	56.4	51.8	49.6
6	Yes	40.7	56.6	52.7	50.0
12	Yes	40.9	56.6	53.0	50.2
LSD ($P<.05$)					
Stockosorb Rate		1.6	1.9	2.2	2.4
Starter Fertilizer		3.3	4.4	3.8	3.6
Stockosorb X Starter		2.1	2.7	NS	2.1
P Values					
Stockosorb Rate		<0.01	<0.01	<0.01	<0.01
Starter Fertilizer		0.01	0.01	0.01	<0.01
Stockosorb X Starter		0.02	<0.01	0.09	<0.01

[1] 25+25+0 starter fertilizer using a blend of 18-46-0 and ammonium nitrate (34-0-0).

Table 2. Three-site summary of net return from 2000 winter wheat as affected by Stockosorb AGRO applied with and without starter fertilizer and placed in a band with the seed at planting under dryland conditions, KSU Agricultural Research Center–Hays, KS.

Stockosorb AGRO Rate w/Seed	Starter Fertilizer w/Seed[2]	Net Return[1]			
		Site #1	Site #2	Site #3	Three-Site Average
lb/a		$/a			
0	No	85.75	84.94	92.44	87.71
1	No	81.63	82.25	108.69	90.86
2	No	79.00	81.31	106.63	88.98
3	No	76.13	80.44	104.31	86.96
6	No	67.44	72.00	95.50	78.31
12	No	49.88	56.13	77.06	61.02
0	Yes	81.06	94.06	107.50	94.21
1	Yes	79.25	104.44	105.31	96.33
2	Yes	78.44	117.06	107.56	101.02
3	Yes	77.63	117.19	105.81	100.21
6	Yes	69.06	108.69	98.88	92.21
12	Yes	51.56	90.81	81.69	74.69
LSD (P<.05)					
Stockosorb Rate		1.56	4.82	5.60	2.37
Starter Fertilizer		NS	11.04	NS	3.96
Stockosorb X Starter		2.80	6.80	NS	3.58
P Values					
Stockosorb Rate		<0.01	<0.01	<0.01	<0.01
Starter Fertilizer		0.87	0.01	0.30	<0.01
Stockosorb X Starter		0.02	<0.01	0.09	<0.01

[1] Wheat @ $2.50/bu; Stockosorb @ $3.00/lb; starter fertilizer at $12.75/a; banded application @ $1.00/a.

[2] 25+25+0 starter fertilizer using 18-46-0 and ammonium nitrate (34-0-0).

Table 3. Six-site summary of 2000 winter wheat yields as affected by liquid and dry Stockosorb applied with and without liquid fertilizer and 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	Yield Barton County	Ness County	Osborne County	Rooks County	Russell County	Trego County	Six-Site Average
	----------	----------	----------	bu/a	----------	----------	----------
Control	7.9	34.9	40.6	48.1	15.8	26.5	28.9
Stockosorb AGRO[1] @ ½ lb/a	9.0	36.1	44.1	44.6	15.3	27.0	29.3
Stockosorb AGRO @ 1 lb/a	9.0	36.2	44.2	43.8	15.4	26.9	29.2
Stockosorb AGRO @ 2 lb/a	9.6	36.8	44.4	44.1	15.4	28.2	29.7
Stockosorb AGRO @ 3 lb/a	9.9	36.8	44.1	44.4	15.8	28.0	29.8
Liquid Fertilizer[2]	15.9	39.9	52.6	54.7	20.6	32.9	36.1
Stockosorb AGRO F[3] @ ½ lb/a mixed w/liq fert	20.2	40.3	57.2	66.9	24.2	37.6	41.0
Stockosorb AGRO F @ 1 lb/a mixed w/liq fert	23.7	44.1	59.1	73.4	28.1	44.8	45.5
Stockosorb AGRO F @ 2 lb/a mixed w/liq fert	26.0	49.2	63.4	79.8	29.6	50.3	49.7
Stockosorb AGRO F @ 3 lb/a mixed w/liq fert	25.8	49.5	63.5	79.3	29.7	51.2	49.8
Stockosorb AGRO @ ½ lb/a + liq fert	19.2	39.9	53.5	58.9	22.2	34.4	38.0
Stockosorb AGRO @ 1lb/a + liq fert	20.2	40.2	55.4	60.0	23.5	35.5	39.1
Stockosorb AGRO @ 2 lb/a + liq fert	20.8	41.5	56.0	64.0	25.2	39.0	41.1
Stockosorb AGRO @ 3 lb/a + liq fert	21.0	42.9	56.4	64.4	25.2	38.8	41.4
LSD (P<.05)	2.9	3.1	4.2	3.7	6.7	8.2	2.2
P Values	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

[1] Stockosorb AGRO is a crystal form of the cross-linked polymer. This material was mixed directly with the seed and applied as a dry material in the row.

[2] 25+25+0 liquid fertilizer using 10-34-0 and 28-0-0 metered through a ground-driven John Blue pump.

[3] Stockosorb AGRO F is a powder form of the cross-linked polymer. This material was mixed directly with the liquid fertilizer and applied as a liquid in the seed row.

Table 4. Six-site summary of net return of 2000 winter wheat as affected by liquid and dry Stockosorb applied with and without liquid fertilizer and 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	Net Return[1] Barton County	 Ness County	 Osborne County	 Rooks County	 Russell County	 Trego County	 Six-Site Average
	----------	----------	----------	$/a	----------	----------	----------
Control	19.85	87.31	101.38	120.13	39.42	66.19	72.36
Stockosorb AGRO @ ½ lb/a	20.06	87.63	107.63	109.00	35.67	64.94	70.82
Stockosorb AGRO @ 1 lb/a	18.44	86.50	106.50	105.50	34.58	63.19	69.12
Stockosorb AGRO @ 2 lb/a	16.86	84.88	103.94	103.25	31.58	63.38	67.31
Stockosorb AGRO @ 3 lb/a	14.63	81.88	100.19	101.06	29.50	60.00	64.92
Liquid Fertilizer	26.00	86.00	117.75	123.06	37.67	68.50	76.50
Stockosorb AGRO F @ ½ lb/a mixed w/liq fert	35.31	85.38	127.63	151.86	45.17	78.75	87.35
Stockosorb AGRO F @ 1 lb/a mixed w/liq fert	42.44	93.44	131.06	166.69	53.42	95.19	97.04
Stockosorb AGRO F @ 2 lb/a mixed w/liq fert	45.13	103.13	138.69	179.75	54.17	106.00	104.48
Stockosorb AGRO F @ 3 lb/a mixed w/liq fert	41.63	100.94	135.88	175.44	51.58	105.31	101.81
Stockosorb AGRO @ ½ lb/a + liq fert	31.69	83.50	117.50	131.00	39.25	69.69	78.81
Stockosorb AGRO @ 1lb/a + liq fert	32.63	82.69	120.63	132.31	40.92	70.94	80.02
Stockosorb AGRO @ 2 lb/a + liq fert	31.31	83.06	119.13	139.38	42.17	76.69	81.96
Stockosorb AGRO @ 3 lb/a + liq fert	28.69	83.50	117.25	137.13	39.17	73.13	79.81
LSD (P<.05)	7.36	7.77	10.59	9.33	NS	20.43	5.46
P Values	<0.01	<0.01	<0.01	<0.01	0.10	<0.01	<0.01

[1] Wheat @ $2.50/bu; Stockosorb @ $3.00/lb; liquid fertilizer @ $12.75; banded application @ $1.00/a.

Table 5. Forage and grain results of 2000 winter triticale as affected by Stockosorb AGRO applied preplant broadcast and incorporated and banded with seed at planting (Sept 15) on an Armo loam soil, Fort Hays State University farm, Hays, KS.

Stockosorb Rate	 Placement Method	Forage – Boot Stage Plant Height	 Dry Matter %	 Dry Matter Yield	 Net Return from Stocksorb[3]	 Growth Rating[2] Dec.	 Growth Rating[2] April	Grain[1] Yield	 Net Return from Stockosorb[3]	 Test Weight	 Plant Height	 Growth Rating[2] July
lb/a		inch		lb/a	$/a			lb/a	$/a	lb/bu	inch	
0		26	26.4	9157	0.00	5.8	6.5	2927	0.00	48.7	34	6.5
24	Broadcast	26	26.4	9724	-55.43	6.5	7.5	3088	-68.59	48.6	35	7.2
48	Broadcast	27	26.1	10565	-98.41	7.0	8.2	3305	-131.92	48.8	35	7.5
72	Broadcast	28	27.3	11322	-144.29	7.0	8.2	3564	-193.57	48.6	36	7.8
0		26	29.7	9203	0.00	5.5	6.5	2911	0.00	48.6	34	6.5
1	Banded	26	27.0	9722	13.91	6.2	7.2	3189	7.13	49.0	35	7.5
2	Banded	28	28.5	10524	38.56	6.5	7.8	3407	12.85	49.0	35	7.8
3	Banded	29	27.5	11516	69.80	7.2	8.5	3852	27.64	48.8	37	8.2
LSD. (P<.05)												
Stockosorb Rate		0.5	NS	507	17.49	0.5	0.4	211	8.44	NS	1	0.6
Placement		0.7	0.4	NS	21.98	NS	NS	NS	5.39	NS	NS	0.3
Stockosorb X Place		NS	1.4	NS	19.29	NS	NS	NS	5.85	NS	1	NS

[1] Variety planted: Presto; grain harvest was July 6, 2000. A uniform application of 25+25+0 was banded applied with seed 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 6. Five-site summary of yields from 2000 grain sorghum as affected by Stockosorb AGRO applied with and without nitrogen fertilizer and placed in a band with the seed at planting under dryland conditions in five counties near the KSU Agricultural Research Center–Hays, KS.

Stockosorb AGRO Rate w/Seed	Nitrogen Fertilizer w/Seed[1]	Yield Barton County	Ellis County	Ness County	Osborne County	Rush County	Five-Site Average
lb/a		bu/a					
0	0	57.3	49.6	25.5	65.4	64.0	52.4
1	0	54.8	51.9	25.2	66.6	69.0	53.5
2	0	54.2	54.3	25.0	68.5	70.6	54.5
3	0	54.4	54.5	25.3	67.2	65.4	53.4
6	0	53.9	54.0	24.3	68.1	67.8	53.6
12	0	54.2	55.3	22.4	67.6	70.7	54.0
0	25	69.1	65.0	35.8	75.2	78.8	64.8
1	25	74.7	65.6	38.3	77.4	84.5	68.1
2	25	81.9	73.5	44.8	81.0	93.2	74.9
3	25	81.0	71.6	46.7	81.5	91.8	74.5
6	25	79.9	72.4	46.1	83.4	93.3	75.0
12	25	79.4	73.6	48.3	84.6	94.5	76.1
LSD (P<.05)							
Stockosorb Rate		NS	NS	NS	NS	NS	3.3
Nitrogen Fertilizer		2.5	7.9	11.1	4.5	4.2	2.0
Stockosorb X Nitrogen		6.3	NS	5.4	NS	NS	3.3
P Values							
		0.51	0.06	0.47	0.64	0.35	<0.01
Stockosorb Rate							
Nitrogen Fertilizer		<0.01	0.01	0.01	<0.01	<0.01	<0.01
Stockosorb X Nitrogen		0.01	0.96	<0.01	0.57	0.40	<0.01

[1] 25+0+0 nitrogen fertilizer using ammonium nitrate (34-0-0).

Table 7. Five-site summary of net return from 2000 grain sorghum as affected by Stockosorb AGRO applied with and without nitrogen fertilizer and placed in a band with the seed at planting under dryland conditions in five counties near the KSU Agricultural Research Center–Hays, KS.

Stockosorb AGRO Rate w/Seed	Nitrogen Rate w/Seed	Net Return[1] Barton County	Ellis County	Ness County	Osborne County	Rush County	Five-Site Average
lb/a	lb N/a	$/a					
0	0	94.59	81.80	42.08	107.91	105.60	86.40
1	0	86.46	81.64	37.58	105.89	109.85	84.29
2	0	82.43	82.60	34.30	105.99	109.41	82.94
3	0	79.68	79.97	31.79	100.88	97.91	78.05
6	0	69.98	70.10	21.14	93.32	92.87	69.48
12	0	52.43	54.20	-0.08	74.58	79.70	52.17
0	25	105.52	98.75	50.53	115.50	121.60	98.38
1	25	111.76	96.78	51.74	116.13	127.97	100.88
2	25	120.64	106.78	59.42	119.20	139.24	109.06
3	25	116.20	100.56	59.56	116.94	133.93	105.44
6	25	105.30	93.04	49.61	111.11	127.49	97.31
12	25	86.55	76.94	35.24	95.05	111.47	81.05
LSD (P<.05)							
Stockosorb Rate		9.82	8.87	11.16	13.68	NS	5.40
Nitrogen Fertilizer		4.10	13.10	18.37	7.48	6.95	3.36
Stockosorb X Nitrogen		10.35	NS	8.92	NS	NS	5.48
P Values							
		<0.01	<0.01	<0.01	<0.01	0.08	<0.01
Stockosorb Rate							
Nitrogen Fertilizer		<0.01	0.02	0.03	0.01	<0.01	<0.01
Stockosorb X Nitrogen		0.01	0.95	<0.01	0.51	0.37	<0.01

[1] Grain sorghum @ $1.65 bu/ Stockosorb @ $3.00/lb; nitrogen fertilizer (am. nitrate) at $7.50/a; banded application @ $1.00/a.

Table 8. Five-site summary of 2000 grain sorghum yields as affected by liquid and dry Stockosorb applied with and without liquid fertilizer and placed in a band with the seed at planting in five counties near the KSU Agricultural Research Center–Hays, KS.

Treatments Banded in Furrow w/Seed	Yield Barton County	Ellis County	Ness County	Rooks County	Rush County	Five-Site Average
	------------------------------ bu/a ------------------------------					
Control	58.2	51.0	23.0	45.2	55.8	46.6
Stockosorb AGRO[1] @ ½ lb/a	60.6	54.8	22.1	46.7	62.9	49.4
Stockosorb AGRO @ 1 lb/a	59.8	52.4	23.4	48.0	63.5	49.4
Stockosorb AGRO @ 2 lb/a	61.3	51.0	24.0	49.5	61.6	49.5
Stockosorb AGRO @ 3 lb/a	55.8	53.5	23.9	46.1	56.1	47.1
Liquid Fertilizer[2]	66.1	65.7	29.9	58.9	74.2	59.0
Stockosorb AGRO F[3] @ ½ lb/a mixed w/liq fert	66.0	65.3	32.4	59.2	74.4	59.5
Stockosorb AGRO F @ 1 lb/a mixed w/liq fert	76.2	72.9	34.3	60.7	77.1	64.2
Stockosorb AGRO F @ 2 lb/a mixed w/liq fert	89.9	85.0	42.6	79.4	95.2	78.4
Stockosorb AGRO F @ 3 lb/a mixed w/liq fert	88.2	91.5	41.4	79.4	94.3	79.0
Stockosorb AGRO @ ½ lb/a + liq fert	66.3	61.3	30.4	54.6	73.1	57.1
Stockosorb AGRO @ 1 lb/a + liq fert	71.3	70.6	34.4	65.0	76.8	63.6
Stockosorb AGRO @ 2 lb/a + liq fert	79.0	81.3	37.6	69.4	79.0	69.2
Stockosorb AGRO @ 3 lb/a + liq fert	80.8	79.9	38.2	70.6	81.9	70.3
LSD (P<.05)	9.0	10.6	7.1	8.1	12.3	3.8
P Values	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

[1] Stockosorb AGRO is a crystal form of the cross-linked polymer. This material was mixed directly with the seed and applied as dry material in the row.

[2] 25+25+0 liquid fertilizer using 10-34-0 and 28-0-0 metered through a ground-driven John Blue pump.

[3] Stockosorb AGRO F is a powder form of the cross-linked polymer. This material was mixed directly with the liquid fertilizer and applied as liquid in the seed row.

Table 9. Five-site summary of net return of 2000 grain sorghum as affected by liquid and dry Stockosorb applied with and without liquid fertilizer and placed in a band with the seed at planting in five counties near the KSU Agricultural Research Center–Hays, KS.

Treatments Banded in Furrow w/Seed	Net Return[1] Barton County	Ellis County	Ness County	Rooks County	Rush County	Five-Site Average
	$/a					
Control	95.98	84.11	37.95	74.62	92.16	76.97
Stockosorb AGRO @ ½ lb/a	97.38	87.92	34.01	74.56	101.29	79.04
Stockosorb AGRO @ 1 lb/a	94.65	82.54	34.66	75.24	100.78	77.58
Stockosorb AGRO @ 2 lb/a	94.13	77.11	32.60	74.64	94.60	74.62
Stockosorb AGRO @ 3 lb/a	82.15	78.24	29.44	66.07	82.59	67.69
Liquid Fertilizer	95.34	94.70	35.59	83.48	108.76	83.58
Stockosorb AGRO F @ ½ lb/a mixed w/liq fert	93.68	92.46	38.25	82.47	107.51	82.88
Stockosorb AGRO F @ 1 lb/a mixed w/liq fert	108.88	103.58	39.89	83.37	110.39	89.23
Stockosorb AGRO F @ 2 lb/a mixed w/liq fert	128.50	120.50	50.50	111.30	137.33	109.64
Stockosorb AGRO F @ 3 lb/a mixed w/liq fert	122.80	128.23	45.56	108.26	132.85	107.55
Stockosorb AGRO @ ½ lb/a + liq fert	93.11	84.90	33.87	73.92	104.28	78.03
Stockosorb AGRO @ 1 lb/a + liq fert	99.85	98.70	39.10	89.42	108.89	87.20
Stockosorb AGRO @ 2 lb/a + liq fert	109.48	113.44	41.25	93.68	109.52	93.48
Stockosorb AGRO @ 3 lb/a + liq fert	109.47	108.05	39.20	92.70	111.43	92.18
LSD (P<.05)	14.91	17.55	11.72	13.30	20.23	6.31
P Values	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

[1] Grain sorghum @ $1.65/bu; Stockosorb @ $3.00/lb; liquid fertilizer @ $12.75; banded application @ $1.00/a.

Table 10. Hay and silage results of 2000 Canex forage sorghum as affected by Stockosorb AGRO applied preplant broadcast and incorporated and banded with the seed at planting (site #1 and site #2 – June 7) on a Harney silt loam soil, KSU Agricultural Research Center–Hays, KS.[1]

Stockosorb		Site #1[2]						Site #2[2]					
		Hay - Boot Stage			Silage - Soft Dough			Hay - Boot Stage			Silage - Soft Dough		
Rat	Placement Method	Plant Height	Yield	Net Return	Plant Height	Yield	Net Return	Plant Height	Yield	Net Return	Plant Height	Yield	Net Return
lb/a			ton/a	$/a		ton/a	$/a		ton/a	$/a		ton/a	$/a
0		76	4.9	221	90	15.4	231	75	5.0	227	89	17.6	263
24	Broadcast	78	5.4	167	93	16.3	169	78	5.7	181	93	19.2	213
48	Broadcast	82	6.3	136	94	18.2	125	79	5.9	120	95	20.3	157
72	Broadcast	83	6.6	79	97	22.2	114	82	6.5	75	97	22.9	124
0		77	5.1	228	89	14.4	211	76	5.2	233	89	17.4	261
1	Banded	78	5.5	245	92	16.7	241	78	5.6	248	92	19.1	287
2	Banded	81	6.2	274	94	17.6	258	80	6.2	272	95	20.8	305
3	Banded	82	6.5	284	97	23.4	341	82	6.6	288	97	22.9	334
LSD (P<.05)													
Stockosorb Rate		2	0.5	21	2	1.2	18	1	0.3	14	3	1.9	NS
Placement		NS	NS	29	NS	NS	39	NS	NS	28	NS	NS	26
Stockosorb X Place		NS	NS	26	NS	NS	32	NS	NS	18	NS	NS	17

[1] A uniform application of 20 lb N w/seed at planting plus 60+0+0 was applied broadcast and incorporated on all treatments.

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

SOIL FERTILITY RESEARCH
SOUTHEAST AGRICULTURAL RESEARCH CENTER

EFFECTS OF TIMING OF LIMITED-AMOUNT IRRIGATION AND NITROGEN RATE ON SWEET CORN PLANTED ON TWO DATES

D.W. Sweeney and C.W. Marr

Summary

In 1999, irrigation increased the number of harvestable ears by more than 25%. Planting at the earlier date resulted in 70% more ears than planting at the later date. Applying more than 40 lb/a of nitrogen increased fresh weight of individual ears.

Introduction

Field corn responds to irrigation, and timing of water deficits can affect yield components. Sweet corn is considered as a possible, value-added, alternative crop for producers. Even though large irrigation sources, such as aquifers, are lacking in southeastern Kansas, supplemental irrigation could be supplied from the substantial number of small lakes and ponds in the area. Literature is lacking on effects of irrigation management, nitrogen (N) rate, and planting date on the performance of sweet corn.

Procedures

The experiment was established on a Parsons silt loam in spring 1999 as a split-plot arrangement of a randomized complete block with three replications. The whole plots included four irrigation schemes: 1) no irrigation, 2) 2 in. at V12 (12-leaf stage), 3) 2 in. at R1 (silk stage), 4) 1 in. at both V12 and R1 and two planting dates (targets of late April and mid-May). The subplots consisted of three N rates of 40, 80, and 120 lb/a. Because of delays caused by unfavorable rainy conditions, plots were planted on May 11 and 27, 1999. Sweet corn from the first planting date was picked on July 21 and 27, and that from the second planting date was picked on August 2 and 6, 1999.

Results

The total number of harvestable ears was more than 20,000/a when sweet corn was planted at the earlier date, but was only 12,000/a from the later date (Table 1). On average, irrigation increased the number of harvestable ears by more than 25%, but no differences occurred among irrigation schemes. Nitrogen rate had no effect on ear number.

The effect of planting date was even greater on the total weight of the harvested ears (Table 1); planting at the earlier date more than doubled the total ear weight. This increase also was evident in the individual ear weight; individual ear weight from the early planting was more than 20% greater than that from the later planting. The effect of irrigation on total weight likely was a result of the effect on total number of ears, because individual ear weight was unaffected by irrigation. Although total ear weight was not affected by N rate, rates of 80 and 120 lb N/a resulted in greater individual ear weights than obtained with only 40 lb, and this effect was more pronounced for the second planting date (interaction data not shown).

Table 1. Effects of irrigation scheme and nitrogen rate on sweet corn planted at two dates, Southeast Agricultural Research Center, Parsons, KS, 1999.

Treatment	Total Ears	Total Fresh Weight	Individual Ear Weight
	no./a	ton/a	g/ear
Planting Date			
Date 1	20800	6.21	272
Date 2	12000	2.98	224
LSD (0.05)	2100	0.60	15
Irrigation Scheme			
None	13400	3.76	244
V12 (2")	17600	5.03	259
R1 (2")	16900	4.65	243
V12-R1 (1" at each)	17700	4.93	247
LSD (0.05)	2900	0.86	NS
N Rate, lb/a			
40	16300	4.40	239
80	16300	4.65	251
120	16700	4.73	254
LSD (0.05)	NS	NS	10

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

D.W. Sweeney

Summary

In 1999, overall grain sorghum yields were low with no differences between tillage systems. Adding nitrogen increased yields; knifed anhydrous ammonia generally resulted in greater yields than broadcast solid urea or urea-ammonia nitrate solution.

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.

Procedures

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

Results

In 1999, grain sorghum yields were low, averaging about 40 bu/a, because wet weather delayed planting (July 8). Under these conditions, yield was unaffected by tillage (Table 2). Adding N fertilizer increased grain sorghum yields by two to three times. In general, knifed anhydrous ammonia resulted in greater yields than broadcast solid urea or UAN liquid. However, in the no-tillage system, no significant differences occurred among those three N sources (interaction data not shown).

Table 2. Effects of tillage and nitrogen fertilization on yield of grain sorghum grown in rotation with soybean, Southeast Agricultural Research Center, Parsons, KS.

Treatment	1999 Yield	Avg. Yield 1983-1999
	-------------------- bu/a	--------------------
Tillage		
Conventional	41.6	66.9
Reduced	39.3	64.4
No Tillage	38.6	51.1
LSD (0.05)	NS	4.1
N Fertilization		
Check	20.8	36.4
Anhydrous NH_3	61.3	74.3
UAN Broadcast	39.0	65.1
Urea Broadcast	38.2	67.3
LSD (0.05)	6.5	3.4
T x N Interaction	0	NS

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

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

Summary

In 1999, short-season corn yield was unaffected by soil phosphorus (P) stratification or tillage. Knife placement of P fertilizer resulted in nearly 7 bu/a greater yield regardless of stratification or tillage.

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.

Procedures

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 and1999 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. However, wet weather delayed planting in 1999 until June 10.

Results

In 1999 at Site 2, corn yield averaged about 24 bu/a because of late planting and dry weather later in the growing season. Neither stratification nor tillage affected yields. Knife placement of fertilizer P resulted in nearly 7 bu/a greater yield than no P application, regardless of the presence of stratification or tillage selection.

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

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

D.W. Sweeney

Summary

In 1999, fertilization doubled yields, even though they were low. Applying all the nitrogen (N) in the spring increased yields in a reduced-tillage system, but N timing had no effect with no-tillage. Double-cropped soybean yields were less with no-tillage than with reduced-tillage but were unaffected by timing of the three fertilizers.

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-cropped 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-cropped 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-cropped soybean grown in reduced- and no-tillage systems.

Procedures

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 1999, fertilization doubled the 12 bu/a wheat yields obtained with no fertilizer (data not shown.) Applying all of the N in the spring resulted in greater wheat yields than all N applied in the fall in the reduced-tillage systems, whereas no difference occurred in wheat yields regardless of when N was applied in the no-tillage system (Fig. 1). Wheat yields were unaffected by the timing of P-K fertilization (data not shown). Double-cropped soybean yields were nearly 4 bu/a less with no-tillage than reduced tillage, but were unaffected by the timing of N-P-K fertilization applied to the wheat crop (data not shown).

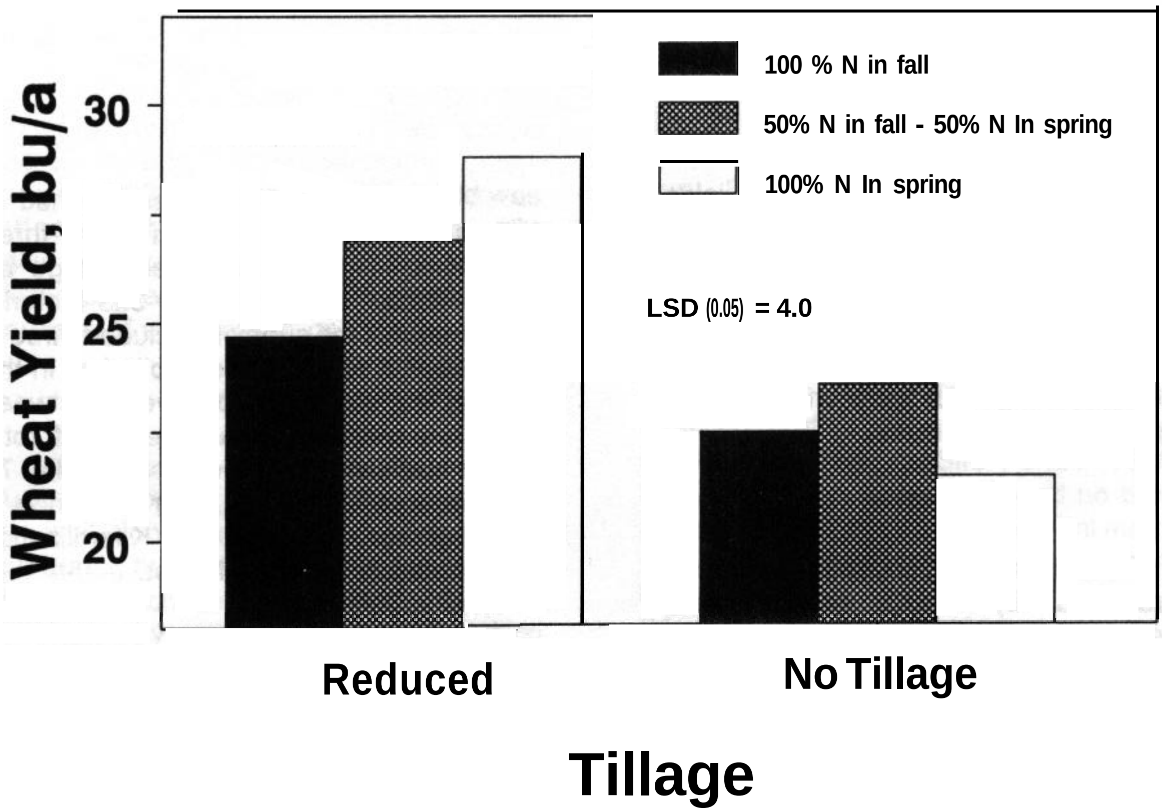


Figure 1. Effects of tillage and nitrogen fertilization timing on wheat yield in a continuous wheat-double-cropped soybean rotation, Southeast Agricultural Research Center, 1999

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

D.W. Sweeney

Summary

In 1999, overall soybean yields were low. Increasing soil phosphorus level increased yield by increasing the number of seeds per plant, but soil potassium level had no effect on soybean yield or yield components.

Introduction

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

Procedures

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

Results

In 1999, wet conditions during the early part of the growing season followed by dry conditions resulted in low overall yields of less than 14 bu/a (data not shown). Increasing soil test level from 5 ppm to over 10 ppm increased yield by about 20%. This was primarily due to an increased number of seeds per plant. Soil P levels did not affect population or seed weight. Soil test K levels had no effect on yield or yield components.

EFFICIENT NITROGEN MANAGEMENT FOR SEED AND RESIDUAL FORAGE PRODUCTION OF ENDOPHYTE-FREE TALL FESCUE

D.W. Sweeney and J.L. Moyer

Summary

Clean seed yield of endophyte-free tall fescue was greater with late fall application than with late winter application at the higher nitrogen (N) rates. Forage aftermath was increased with increasing N rates up to 150 lb/a and subsurface applications (knife or spoke) but was unaffected by N timing.

Introduction

Nitrogen fertilization is important for fescue and other cool-season grasses. However, management of nitrogen (N) for seed production is less defined, especially because endophyte-free tall fescue may need better management than infected stands. Nitrogen fertilizer placement has been shown to be important for forage yields, but data are lacking regarding the yield and quality of the aftermath remaining after seed harvest. The objective of this study is to determine the effect of timing, placement, and rate of N applied to endophyte-free tall fescue for seed and aftermath forage production.

Procedures

The experiment was established as a 2x3x5 factorial arrangement of a completely randomized block design with three replications. The two N timings were late fall (December 2, 1998) and late winter (February 24, 1999). The three placements for urea-ammonium nitrate solution were broadcast, spoke (approx. 3 in. deep), and knife (approx. 4 in. deep). The five N rates were 0, 50, 100, 150, and 200 lb/a. Each fall, all plots receive broadcast applications of 50 lb P_2O_5/a and 50 lb K_2O/a. Seed harvest was on June 11, 1999, and forage aftermath was harvested on June 14, 1999.

Results

In 1999, late fall application of N at rates up to 200 lb/a resulted in increased yield of clean seed (Fig. 2). This likely was caused by an increase in the number of panicles/sq m. With late winter application, yield increased with increasing rates to 100 lb N/a but decreased with higher N rates. Caryopsis (individual seed) weight and the number of seeds/panicle were unaffected by N management.

Production of forage aftermath was not affected by timing of N fertilization (data not shown). However, yield was increased by increasing N rates up to 150 lb/a but was not increased further by N applied at 200 lb/a (Fig. 3). Subsurface placement by either knife or spoke resulted in greater aftermath forage than broadcast N applications.

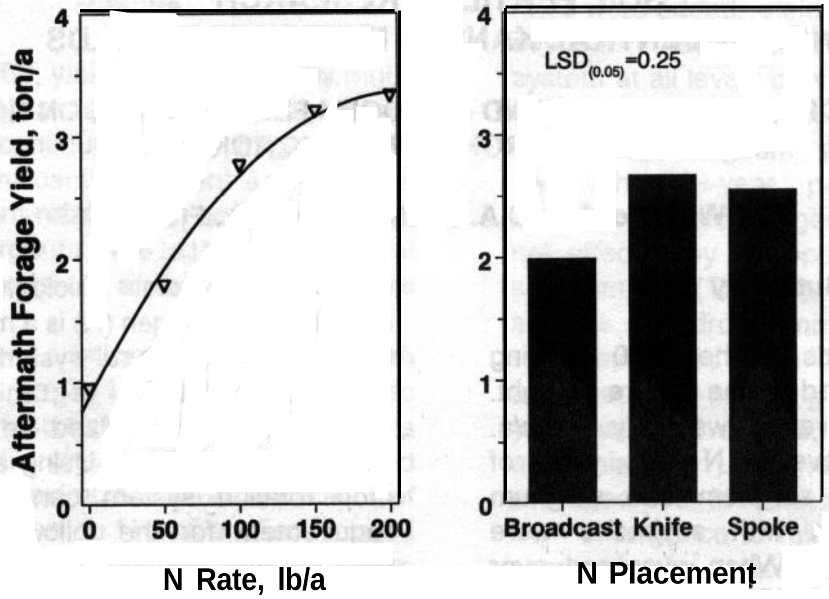


Figure 2. Effects of nitrogen timing and rate on clean seed yield and panicle count of endophyte-free tall fescue, Southeast Agricultural Research Center, 1999.

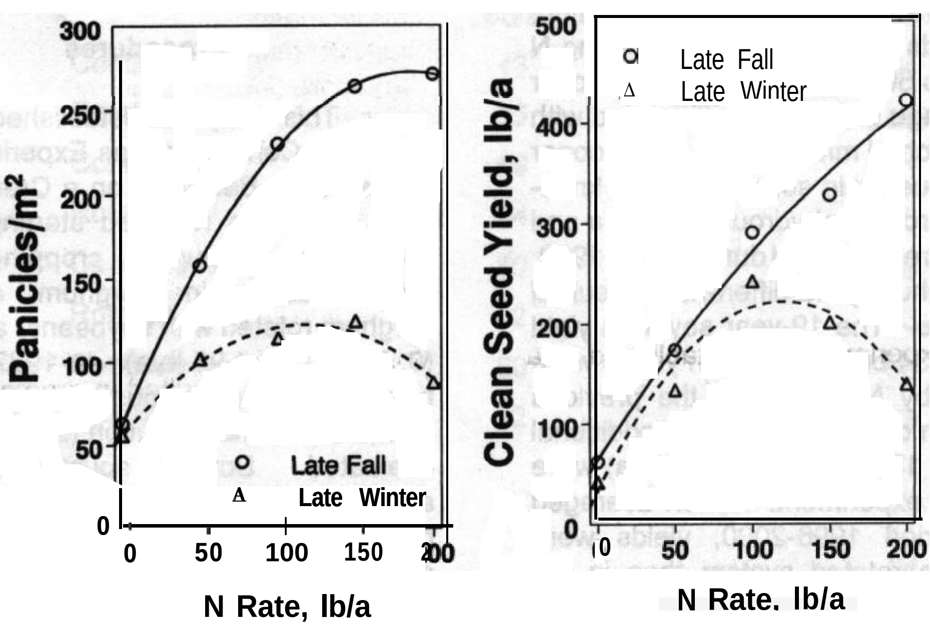


Figure 3. Effects of nitrogen rate and placement on yield of forage aftermath following seed harvest of endophyte-free tall fescue, Southeast Agricultural Research Center, 1999.

SOIL FERTILITY RESEARCH
NORTH CENTRAL KANSAS 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

Grain yields in the 2000 growing season were limited by the severe drought. The overall test average was only 62 bu/a. When averaged over all N rates, yields of continuous grain sorghum and sorghum grown in rotation with soybeans were statistically equal. 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 19-year soybean yield average was 34 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 1996-2000, 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 nitrogen (N) is a major source of N for plants in natural systems. Biological fixation through legume-*Rhizobium* associations is utilized extensively in agricultural systems. Using a legume in a crop rotation system can reduce the N requirement for the following nonlegume crop. Other benefits of legume rotations include breaking disease and insect cycles, helping weed control programs, and decreasing the toxic effects of crop residues. This study evaluates N rates for continuous grain sorghum and grain sorghum grown in annual rotation with soybeans in a no-tillage production system.

Procedures

This study was established in 1980 at the North Central Kansas Experiment Field, located near Belleville, on a Crete silt loam soil. Data are reported starting in 1982. Treatments included cropping system (continuous grain sorghum and grain sorghum rotated with soybeans) and N rates (0, 30, 60, and 90 lb/a). In 1982-1989, the two N sources anhydrous ammonia and urea-ammonium nitrate solution (28% UAN) were evaluated. Both N sources were knife applied in the middle of rows from the previous year's crop. After 1989, 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/ft 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 2000, yields were limited by much below-normal rainfall. When averaged over all N rates, continuous grain sorghum yield was not significantly different from yield of grain sorghum rotated with soybean. Yields of rotated sorghum were higher than those of continuous sorghum at the 0 and 30 lb/a N rates.

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 (Table 2). Addition of N alone did not make up yield losses in a continuous sorghum production system. Over the 19-year period (1982-2000), soybean yields averaged 34 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 midbloom, North Central Expt. Field, Belleville, KS.

N Rate	Cropping System	Grain Yield 1982-1995	Days to Midbloom 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, 1996-2000, North Central Experiment Field, Belleville, KS.

		Yield					
N Rate	Cropping System	1996	1997	1998	1999	2000	Avg.
		- - - - - - - - - - - - - - - - - - - bu/a - - - - - - - - - - - - - - - - - -					
0	Continuous	92	51	55	73	37	62
	Rotated	120	88	87	112	46	91
30	Continuous	110	71	75	95	40	78
	Rotated	137	108	115	119	62	96
60	Continuous	131	110	118	115	68	108
	Rotated	164	128	142	127	66	125
90	Continuous	143	121	126	125	69	117
	Rotated	163	141	144	126	68	128
120	Continuous	148	122	128	123	69	118
	Rotated	162	144	145	128	65	129
150	Continuous	148	120	127	123	69	117
	Rotated	162	143	145	129	65	129
180	Continuous	148	121	128	126	68	118
	Rotated	162	144	145	129	65	129
210	Continuous	148	122	128	126	66	118
	Rotated	162	145	145	129	64	129
<u>System Means</u>							
	Continuous	134	105	111	113	61	105
	Rotated	154	130	134	125	63	121
<u>N Rate Means</u>							
0		106	70	71	92	42	76
30		124	90	95	107	51	93
60		148	119	130	121	67	117
90		153	131	135	126	69	123
120		155	133	137	126	67	124
150		155	132	136	126	67	123
180		155	133	137	127	67	124
210		155	134	137	127	65	124
LSD(0.05)		8	6	6	6	8	

Table 3. Yield of soybeans grown in rotation with grain sorghum, 1982-2000, North Central Experiment Field, Belleville, KS.

Year	Yield	Year	Yield
	bu/a		bu/a
1982	38	1992	58
1983	15	1993	56
1984	20	1994	32
1985	28	1995	41
1986	48	1996	61
1987	48	1997	36
1988	18	1998	38
1989	25	1999	42
1990	30	2000	8
1991	12	Avg	34

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 phosphorus (P) was in the "high" range. Treatments consisted of tillage systems and starter fertilizer placement and composition. Tillage systems consisted of no-tillage and reduced-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 (2x2) and dribbled in a band on the soil surface 2 in. beside the seed row. Liquid starter fertilizer treatments consisted of nitrogen (N) and P_2O_5 combinations to provide 15, 30, and 45 lb N/a and 30 lb P_2O_5/a. Starter treatments containing either 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. Starter fertilizer containing 30 lb N and 30 lb P_2O_5/a decreased the number of days from emergence to mid-bloom by 9 days compared to the no-starter check treatment. Although dribble applications improved yields over those with the no-starter check, they were not as effective as 2x2 placement of starter fertilizer.

Introduction

Conservation-tillage production systems are being used by an increasing number of producers in the central Great Plains because of several inherent advantages. These include reduction of soil erosion losses, increased soil water use-efficiency, and improved soil quality. However, early-season plant growth can be poorer in reduced-tillage systems than in conventional systems. The large amount of surface residue present in a no-tillage system can reduce seed-zone temperatures. Lower than optimum soil temperature can reduce the rates of root growth and P uptake by plants. Starter fertilizers can be applied to place nutrient elements within the rooting zone of young seedlings for better availability, which will hasten maturity and avoid late-season damage by low temperatures. Some experiments that have evaluated crop responses to N and P starter fertilizers have demonstrated improved early growth and increased yield and attributed those responses to the P component of the combination. Other studies have indicated that N is the most critical element in the N-P starter on soils not low in P. Many producers do not favor 2x2 placement of starter fertilizer because of high initial cost of application equipment and problems associated with knife applications in high-residue situations. 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 reduced-tillage). The reduced-tillage treatment received one disking and harrowing operation in the spring 3 weeks prior to planting. Starter fertilizer either was placed 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 to provide 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 17, 2000. At the V6 stage of growth, 20 plants were selected randomly from the 1st or 4th row of each plot and analyzed for dry weight and N and P concentrations. At first bloom, 20 flag leaves/plot were harvested and analyzed for N and P concentrations. Plots were harvested on September 21, 2000.

Results

Although surface dribble-applied starter fertilizer increased grain yield compared to the no-starter check, yields were higher when fertilizer was placed 2x2 (Table 4). When averaged over tillage and starter combinations, yields were 8 bu/a greater when starter fertilizer was placed subsurface as compared to surface dribbled. Regardless of tillage system, the greatest yields occurred with 2x2 applications of starter fertilizer containing either 30 or 45 lb N/a with 30 lb P_2O_5/a. Starters with higher N rates also were most efficient in reducing the number of days from emergence to midbloom. The N alone or the P alone treatments did not yield as well as starters that contained both N and P. 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. All starter fertilizer treatments increased whole-plant dry matter at the V-6 stage over that with the no-starter check. Dribble placement was not quite as effective in increasing early-season dry matter as was 2x2 placement. The starters containing either 30 or 45 lb/a N with 30 lb/a P_2O_5 resulted in the greatest whole-plant dry matter accumulation at V-6. Early-season dry matter was greater in the reduced-tillage system than in the no-tillage blocks. Grain yield, days from emergence to mid-bloom, and V-6 stage whole-plant dry matter were not affected by tillage system.

Table 4. Effects of tillage system and starter fertilizer placement and composition on grain sorgh yield, number of days from emergence to midbloom, and whole-plant dry matter accumulation at the V-stage, North Central Experiment Field, Belleville, KS, 2000.

		Starter		Yield		Days to	V-6
Tillage	Placement	N	P_2O_5	2000	1999-2000	Midbloom	Dry Matter
		- - lb/a - -		- - - bu/a - - -			lb/a
Reduced		0	0	41	83	65	590
	2x2	0	30	52	92	59	700
		30	0	68	99	57	790
		15	30	70	106	57	820
		30	30	78	114	54	1080
		45	30	79	115	54	1078
	Dribble	0	30	46	90	61	688
		30	0	58	96	59	700
		15	30	61	98	59	782
		30	30	66	101	57	878
		45	30	72	104	56	910
No-Tillage		0	0	42	80	64	582
	2x2	0	30	51	98	58	710
		30	0	73	107	56	788
		15	30	73	109	57	828
		30	30	83	119	53	1089
		45	30	83	119	53	1095
	Dribble	0	30	45	90	61	690
		30	0	64	99	59	721
		15	30	65	98	59	788
		30	30	73	104	56	880
		45	30	78	106	56	892
<u>Tillage Means</u>	Reduced Till			65	102	57	843
	No-Till			69	105	57	848
	LSD(0.05)			NS		NS	NS
<u>Placement Means</u>	2x2			71	108	56	898
	Dribble			63	99	58	793
	LSD(0.05)			7		1	58
<u>Starter Means</u>	0-30			49	93	60	687
	30-0			66	101	58	750
	15-30			67	103	58	805
	30-30			75	110	55	982
	45-30			78	111	55	994
	LSD(0.05)			6		1	55

EFFECTS OF APPLICATION METHOD AND COMPOSITION OF STARTER FERTILIZER ON IRRIGATED RIDGE-TILLED CORN

W.B. Gordon

Summary

Field studies were conducted at the North Central Kansas Experiment Field, located near Scandia, on a Crete silt loam soil. The study consisted of four methods of starter fertilizer application (in-furrow with the seed, 2 in. to the side and 2 in. below the seed at planting, dribbled on the soil surface 2 in. to the side of the seed, and banded over the row on the soil surface) and five starter fertilizer combinations. The starters combined either 5, 15, 30, 45, or 60 lb/a N with 15 lb/a P_2O_5 and 5 lb/a K_2O. A no-starter check plot also was included in the experiment. Nitrogen rates were balanced so that all plots received 220 lb/a N, regardless of starter treatment. Starter fertilizer combinations were made using liquid 10-34-0 ammonium polyphosphate, 28% UAN, and potassium thiosulfate (KTS). When starter fertilizer was applied in-furrow with the seed, plant populations were reduced by over 7,500 plants/a compared with the other three application methods. Corn yield was 34 bu/a lower when starter fertilizer was applied in-furrow than when applied 2x2. Dribble application of starter fertilizer in a surface band 2 in. to the side of the seed row resulted in yields equal to 2x2-applied starter. Grain yield and V-6 dry matter were lower in the starter treatment that included only 5 lb N/a.

Introduction

Use of conservation tillage including ridge-tillage has increased greatly in recent years because of its effectiveness in conserving soil and water. In a ridge-tillage system, tillage at planting time is confined to a narrow strip on top of the ridge. The large amount of residue left on the soil surface can interfere with nutrient availability and crop uptake. Applications of liquid starter fertilizer have proven effective in enhancing nutrient uptake, even on soils that are not low in available nutrients. Many producers favor in-furrow or surface starter applications because of the low initial cost of planter-mounted equipment and problems associated with knives and colters in high-residue environments. However, injury can be severe when fertilizer containing N and K is placed in contact with seed. Also surface applications may not be effective in high-residue situations. The objective of this research was to determine corn response to starter combinations using four different application methods.

Procedures

Irrigated ridge-till trials were conducted at the North Central Kansas Experiment Field on a Crete silt loam soil. Soil pH was 6.2; organic matter was 2.4%; and Bray-1 P and exchangeable K were 40 and 420 ppm, respectively. The study consisted of four methods of starter fertilizer application (in-furrow with the seed, 2 in. to the side and 2 in. below the seed at planting, dribbled in a narrow band on the soil surface 2 in. to the side of the seed row, and banded over the row on the soil surface). In row-banding, fertilizer was sprayed on the soil surface in a 8 in. band over the seed row. Starters consisted of combinations that included either 5, 15, 30, 45, or 60 lb N/a with 15 lb P_2O_5/a and 5 lb K_2O/a. Nitrogen as 28% UAN was balanced so all plots received 220 lb/a, regardless of starter treatment. Starter fertilizer combinations were made using liquid 10-34-0, 28% UAN, and KTS. Planting was on April 12 at 30,000 seed/a. At the V-6 growth stage, plants were sampled, and dry weight was determined. Harvest was on September 18.

Results

When starter fertilizer was applied in-furrow with the seed, plant populations were reduced by over 7,500 plants/a when compared with the other application methods (Table 5). Corn yield was 34 bu/a lower when starter fertilizer was applied in-furrow with the seed than when applied 2 in. beside and 2 in. below the seed. Dribble application of starter fertilizer in a narrow surface band 2 in. to the side of the seed row resulted in yields equal to the 2x2 applied starter. In this year, surface band application was equal to sub-surface starter placement. The band over the row treatment resulted in yields greater than the in-furrow treatment but less than the 2x2 or surface band treatments. Grain yield and V-6 dry matter accumulation was lower in the starter treatment that only included 5 lb N/a.

Table 5. Effects of starter application method and composition on corn grain yield, plant population, and dry whole-plant dry matter at the V-6 stage, North Central Experiment Field, Scandia, KS, 2000.

Application method	Starter	Yield	Population	V-6 Dry Matter
	lb/a	bu/a	plants/a	lb/a
	Check 0-0-0	136.0	30,884	230
In-furrow	5-15-5	139.6	24,260	309
	15-15-5	156.5	23,142	321
	30-15-5	147.1	23,307	327
	45-15-5	147.8	23,197	326
	60-15-5	138.7	22,747	331
2x2	5-15-5	169.2	31,266	402
	15-15-5	171.7	30,729	403
	30-15-5	187.3	31,266	470
	45-15-5	184.8	30,976	549
	60-15-5	184.8	30,686	570
Dribble 2x	5-15-5	167.2	31,170	357
	15-15-5	175.0	31,655	429
	30-15-5	180.3	30,492	482
	45-15-5	181.9	30,392	446
	60-15-5	182.8	30,613	474
Row band	5-15-5	149.5	31,266	329
	15-15-5	154.4	31,557	345
	30-15-5	154.5	30,589	459
	45-15-5	165.1	30,492	456
	60-15-5	180.0	30,298	460
Method Means				
In-furrow		146.0	23,330	323
2x2		179.6	30,985	479
Dribble 2x		177.4	30,864	438
Row band		160.7	30,840	410
LSD (0.05)		10.9	840	32
Starter Means				
5-15-5		156.4	31,266	349
15-15-5		164.4	31,557	375
30-15-5		167.3	30,589	435
45-15-5		169.9	30,492	444
60-15-5		171.5	30,298	459
LSD (0.05)		10.2	849	33

EFFECTS OF NITROGEN RATES AND SOURCES ON RIDGE-TILLED IRRIGATED CORN

W.B. Gordon

Summary

The increased use of urea and urea-based fertilizers along with an increase in crops grown under no- or reduced-tillage practices may require changes in fertilizer management practices. Surface application of urea-based fertilizer risks the loss of some nitrogen (N) by volatilization of ammonia. Research suggests that calcium added to urea-based fertilizer can reduce ammonia losses and increase plant growth by increasing plant absorption of applied ammonium. This research was initiated in 1999 to evaluate an experimental N fertilizer, UCAN-21, applied in various starter and sidedress combinations in a ridge-tillage production system. UCAN-21 is a mixture of 2/3 UAN solution and 1/3 liquid calcium nitrate. Yields of corn were higher at the 50 and 100 lb/a N rate when UCAN-21 was dribbled on the soil surface than when the same rates of UAN were dribble applied. No differences occurred between UCAN-21 and UAN at the higher N rates. Corn yields were higher when UCAN-21 was used as a dribble-applied starter than when UAN alone was used.

Introduction

The most common liquid nitrogen source is the urea-ammonium nitrate solution (UAN) commonly sold in the midwest as a solution containing 28% nitrogen. Approximately half of the nitrogen in UAN is urea. Urea applied to soil reacts with water and the soil enzyme urease and is converted rapidly to ammonium. In this reaction, hydrogen ions are consumed, which causes the soil pH near the fertilizer to rise. If the pH rises above 7, a significant amount of ammonia can form in soil following urea application. When urea is surface applied, the formation of ammonia at the soil surface from urea hydrolysis may allow loss of N as ammonia. Research data suggest that calcium applied with a urea-based N fertilizer may limit N loss. The objective of this research was to compare an experimental N fertilizer (UCAN-21) that contains UAN and calcium nitrate to UAN alone.

Procedures

This experiment was conducted at the North Central Kansas Experiment Field, near Scandia, on a Crete silt loam site. The study was ridge-tilled and furrow irrigated. Treatments consisted of combinations of starters and sidedress N rates. Dribble sidedress applications of 50, 100, 150, and 200 lb N/a as UCAN-21 or UAN were evaluated. Additional treatments consisted of 50, 100, 150, and 200 lb N/a (UAN) subsurface knife applied. Starter treatment (30 lb N/a) consisted of UCAN-21 dribbled on the soil surface 2 in. to the side of the row. Additional treatments compared UCAN-21 as a dribbled starter to UAN alone as a starter with 200 lb/a N as a dribble sidedress application. A no-N check plot also was included. The study was planted on April 30 and harvested on September 18, 2000.

Results

Good responses to applied N were achieved in 2000. The no-N check yielded only 78 bu/a (Table 6). At the lower N rates (50 and 100 lb N/a), dribble application of UCAN-21 resulted in greater yields than UAN dribbled on the soil surface. With the lower N rates, UCAN-21 dribbled applied on the soil surface was as effective as subsurface knife-applied N. No differences were seen at the higher N rates. As a dribble-applied starter, UCAN-21 was slightly better than UAN.

Table 6. Evaluation of urea-ammonium nitrate plus calcium nitrate for irrigated, ridge-tilled corn production, North Central Experiment Field, Scandia, KS, 2000.

Starter	Sidedress	Rate	Method	Yield, bu/a
No N Check				78.3
UCAN-21	UAN	50	dribble	130.5
UCAN-21	UAN	100	dribble	139.9
UCAN-21	UAN	150	dribble	177.3
UCAN-21	UAN	200	dribble	176.3
UCAN-21	UCAN-21	50	dribble	147.2
UCAN-21	UCAN-21	100	dribble	149.7
UCAN-21	UCAN-21	150	dribble	174.5
UCAN-21	UCAN-21	200	dribble	176.5
UAN	UCAN-21	200	dribble	165.2
UAN	UCAN-21	200	dribble	160.5
UCAN-21	UAN	50	knife	132.3
UCAN-21	UAN	100	knife	149.5
UCAN-21	UAN	150	knife	178.8
UCAN-21	UAN	200	knife	178.4
N Rate Means (avg. over treatments) lb/a				
0				78
50				137
100				146
150				177
200				177

SOIL FERTILITY RESEARCH
HARVEY COUNTY EXPERIMENT FIELD

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

M.M. Claassen

Summary

Nitrogen response of sorghum grown in the third cycle of a wheat-vetch-sorghum rotation was compared with that of sorghum in a wheat-sorghum rotation at nitrogen (N) rates of 0 to 90 lb/a. Vetch was terminated by tillage (disking) or herbicides (no-till). Hairy vetch planted in October established 25% ground cover by the end of November and produced an average of 1.97 ton/a of dry matter by May. The average potential amount of N to be mineralized for use by the sorghum crop was 105 lb/a. Without N, leaf N levels were higher in sorghum following hairy vetch than in sorghum not following the cover crop. The apparent N contributions by vetch were equivalent to approximately 57 lb/a and more than120 lb/a of fertilizer N in no-till and disked plots, respectively. When averaged over N rates, yields of sorghum after disked vetch were 6.5 bu/a lower than either no-till sorghum after vetch or sorghum without a cover crop. Nitrogen rates of 60 and 90 lb/a significantly increased sorghum grain yield by 9.9 and 13.2 bu/a in the absence of a cover crop. However, no significant yield increase occurred with fertilizer N in sorghum after 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

Wheat-grain sorghum and wheat-hairy vetch-grain sorghum rotations were established on a Geary silt loam soil in1995. Hairy vetch was first planted as a winter cover crop after wheat on September 15 of that year. Sorghum was planted in the following June after termination of the vetch and application of fertilizer N rates of 30, 60, and 90 lb/a. A no-N plot was included. No-till winter wheat was planted in sorghum stubble shortly after harvest. The current data for 2000 represent the third cycle of the crop rotations.

Hairy vetch plots were no-till planted at 24 lb/a in 8-in. rows with a grain drill equipped with double-disk openers on October 8, 1999. One set of vetch plots was terminated by disking on May 8. 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 May 8, 2000. Nitrogen fertilizer treatments were broadcast as ammonium nitrate on May 24. 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 a rain delay at approximately 42,000 seeds/a on June 7, 2000. Weeds were controlled with a preemergence application of Dual II + AAtrex 90 DF (1 qt + 0.55 lb/a). Grain sorghum was combine harvested on September 26.

Results

September rains delayed planting of hairy vetch for several weeks. However, development of the crop resulted in an average ground cover of 25% by the end of November. Hairy vetch was beginning to bloom at the time of termination in May. Vetch dry matter yield averaged 1.97 ton/a, and N content was 2.67% (Table 1). The average potential amount of N to be mineralized for use by the sorghum crop was 105 lb/a.

Disking to terminate hairy vetch growth did not adversely affect soil moisture at the surface because of timely subsequent rains. Sorghum stands were relatively uniform across all treatments, with an average of 31,600 plants/a. Drought stress became progressively worse during August and September, when no meaningful rainfall occurred and temperatures were well above normal. Without N, leaf N levels were higher in sorghum following hairy vetch than in sorghum not following the cover crop. The apparent N contributions by vetch were equivalent to approximately 57 lb/a and >120 lb/a of fertilizer N in no-till and disked plots, respectively. Nitrogen rates increased leaf N up to 90 lb/a, most notably in sorghum without a cover crop and to a lesser extent in no-till sorghum after vetch. In sorghum after disked vetch, leaf N did not increase with the application of fertilizer N.

Grain sorghum maturity (days to half bloom) was delayed slightly by hairy vetch treatments. The number of heads per plant decreased slightly in sorghum after disked vetch in comparison with the other systems and showed no consistent response to fertilizer. When averaged over N rates, yields of sorghum after disked vetch were 6.5 bu/a lower than yields of either no-till sorghum after vetch or sorghum without a cover crop. In the absence of fertilizer N, sorghum after vetch produced yields not differing significantly from those of sorghum with no preceding cover crop. Nitrogen rates of 60 and 90 lb/a significantly increased sorghum grain yield by 9.9 and 13.2 bu/a in the absence of a cover crop. However, no yield increase occurred with fertilizer N in sorghum after vetch.

Table 1. Effects of hairy vetch cover crop, termination method, and nitrogen rate on grain sorghum after wheat, Harvey County Experiment Field, Hesston, KS, 2000.

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	--	--	76.1	57.2	29.7	63	1.4	2.36
	30	--	--	82.0	57.7	32.2	62	1.4	2.55
	60	--	--	86.0	58.4	31.3	63	1.4	2.75
	90	--	--	89.3	58.4	31.1	62	1.5	2.91
Vetch/Disk	0	2.19	109	73.8	57.8	30.8	64	1.4	3.12
	30	1.96	110	77.4	58.2	30.8	64	1.3	2.76
	60	2.05	104	79.9	58.5	32.8	64	1.3	2.95
	90	1.76	94	75.6	58.0	33.3	64	1.3	3.03
Vetch/No-till	0	2.26	116	82.2	58.0	31.2	64	1.5	2.72
	30	1.91	108	80.6	58.1	30.1	64	1.5	2.89
	60	1.84	98	85.5	58.5	32.6	64	1.4	2.85
	90	1.80	101	84.0	57.8	33.3	63	1.6	3.04
LSD .05		0.41	NS	9.5	0.82	NS	1.4	NS	0.19
LSD .10		NS	NS	----	----	NS	----	0.21	----
Means: Cover Crop/ Termination									
None		----	----	83.3	57.9	31.1	63	1.4	2.64
Vetch/Disk		1.99	104	76.7	58.1	31.9	64	1.3	2.96
Vetch/No-till		1.95	106	83.1	58.1	31.8	64	1.5	2.87
LSD .05		NS	NS	4.7	NS	NS	0.7	NS	0.10
LSD .10		NS	NS	----	NS	NS	----	0.10	----
N Rate									
0		2.23	112	77.3	57.7	30.6	64	1.4	2.73
30		1.94	109	80.0	58.0	31.0	63	1.4	2.73
60		1.94	101	83.8	58.5	32.2	64	1.4	2.85
90		1.78	98	83.0	58.0	32.6	63	1.5	2.99
LSD .05		0.29	NS	NS	0.47	NS	NS	NS	0.11
LSD .10		----	NS	4.6	----	NS	0.7	NS	----

[1] N applied as 34-0-0 on May 24, 2000.
[2] Oven dry weight and N content on May 8, 2000.
[3] Days from planting (June 7, 2000) 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 nitrogen (N) fertilizer rates of 0 to 90 lb/a. Residual effects of hairy vetch did not increase wheat whole-plant N or grain protein without N fertilizer or when averaged over all N rates. Nitrogen fertilizer at 90 lb/a increased plant N and grain protein levels, but not in comparison with the zero N rate at which yields were very low. Without N, wheat yields were not affected significantly by hairy vetch in the rotation. Averaged over N rates, hairy vetch in disk and no-till systems accounted for wheat yield increases of 2.6 and 4.1 bu/a. In wheat after sorghum without vetch, each 30 lb/a increment of fertilizer N significantly increased yield. In wheat after vetch-sorghum, yields reflected less response to the highest increment of fertilizer 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 N uptake and yield of wheat.

Procedures

Wheat-grain sorghum and wheat-hairy vetch-grain sorghum rotations were established on a Geary silt loam soil in1995. A second site was established 1 year later with the seeding of vetch in the fall. On this site, sorghum was grown in 1997 with or without the preceding cover crop and fertilized with N rates of 30, 60, or 90 lb/a. A no-N plot was included. Winter wheat was no-till planted into sorghum stubble in the fall of 1997. After wheat harvest, volunteer wheat and weeds were controlled with Roundup Ultra. In the second cycle of the rotation, hairy vetch plots were no-till planted at 31 lb/a in 8-in. rows 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 14. 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).

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, 1999. 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 on July 6, 1999. Weeds were controlled with preemergence application of Dual II + AAtrex 4L (1 qt + 0.5 pt/a). Grain sorghum was combine harvested on October 29. Fertilizer N treatments were broadcast as 34-0-0 on November 2, 1999, at rates equal to those applied to the prior sorghum crop. Variety 2137 winter wheat was no-till planted in 8-in. rows into sorghum stubble on the following day at 120 lb/a, and 32 lb/a of P_2O_5 fertilizer was banded in the furrow. Wheat was harvested on June 20.

Results

Hairy vetch terminated in mid-June, 1999, produced an average of 1.18 ton/a of dry matter, yielding 70 lb/a of N potentially available to the sorghum crop that followed (Table 2). However, vetch failed to increase sorghum leaf N concentration in the absence of N fertilizer and caused a yield loss of 8.3

bu/a when averaged over all N rates.

Without fertilizer N, the residual effect of hairy vetch did not increase wheat whole-plant N or grain protein. Also, vetch treatments averaged over N rates had no significant residual effects on wheat test weight, plant N, and grain protein. Nitrogen fertilizer at 90 lb/a versus 30 lb/a or 60 lb/a increased plant N and grain protein levels, but not in comparison with the no N, with which yields were very low.

Small numerical increases in wheat yields without fertilizer N following vetch versus no-vetch treatments were not significant. Averaged over N rates, hairy vetch in disk and no-till systems accounted for yield increases of 2.6 and 4.1 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 did not differ significantly between rates of 60 and 90 lb/a.

Table 2. Residual effects of hairy vetch cover crop, termination method, and nitrogen rate on no-till wheat after grain sorghum, Harvey County Experiment Field, Hesston, KS, 2000.

Cover Crop/ Termination[1]	N Rate[2]	Vetch Yield[3] Forage	Vetch Yield[3] N	Sorghum Yield 1999	Wheat Yield	Wheat Bushel Wt	Wheat Plant Ht	Wheat Plant N[4]	Wheat Grain Protein[5]
	lb/a	ton/a	lb	bu/a	bu/a	lb	in.	%	%
None	0	----	----	86.3	10.4	61.2	19	1.47	10.9
	30	----	----	90.2	24.8	61.2	25	1.14	9.8
	60	----	-----	99.1	41.3	60.9	30	1.19	9.4
	90	----	----	98.8	49.2	60.6	29	1.30	10.3
Vetch/Disk	0	0.90	55	86.8	13.0	61.1	20	1.39	10.1
	30	1.32	80	87.3	26.9	61.2	26	1.11	9.8
	60	1.26	70	88.1	45.8	60.9	29	1.25	9.8
	90	1.12	63	87.9	50.4	60.3	30	1.38	10.5
Vetch/No-till	0	1.50	92	72.8	18.5	61.9	23	1.34	11.0
	30	1.13	67	81.4	31.5	61.1	27	1.25	9.9
	60	1.26	71	91.6	43.6	61.1	29	1.20	9.8
	90	0.97	58	87.1	48.4	60.4	30	1.48	10.6
LSD .05		NS	NS	13.0	5.8	0.5	2.0	0.17	0.55
Means:									
Cover Crop/ Termination									
None									
Vetch/Disk		----	----	93.6	31.4	61.0	26	1.27	10.0
Vetch/No-till		1.15	67	87.5	34.0	60.9	26	1.28	10.1
LSD .05		1.21	72	83.2	35.5	61.1	27	1.32	10.3
		NS	NS	6.5	2.9	NS	1.0	NS	NS
N Rate									
0		1.20	73	82.0	14.0	61.4	20	1.40	10.7
30		1.22	74	86.3	27.7	61.1	26	1.16	9.9
60		1.26	71	92.9	43.6	61.0	29	1.21	9.7
90		1.04	60	91.3	49.3	60.4	30	1.39	10.5
LSD .05		NS	NS	7.5	3.4	0.3	1.1	0.10	0.32

[1] Hairy vetch planted in late October, 1998 replanted in February, and terminated in June, 1999.
[2] N applied as 34-0-0 on June 30, 1999 for sorghum and on November 1, 1999 for wheat.
[3] Oven dry weight and N content just prior to termination.
[4] Whole-plant N concentration at early heading
[5] Protein calculated as %N x 5.7.

SOIL FERTILITY RESEARCH
KANSAS RIVER VALLEY EXPERIMENT FIELD

MACRONUTRIENT FERTILITY ON AN IRRIGATED CORN-SOYBEAN ROTATION

L.D. Maddux

Summary

A corn-soybean cropping sequence was evaluated from 1983 through 2000 (9 years of corn; 9 years of soybeans) for the effects of nitrogen (N), phosphorus (P), and potassium (K) fertilization on the corn crop. All years showed a corn yield increase with increasing N rates up to 160 lbs/a. Previously applied N at 160 lbs/a also resulted in soybean yield increases of 4.0 to 5.4 bu/a in 4 of the 9 years. Corn and soybeans both showed yield responses to P, but corn showed a positive response in only 1 year, whereas soybeans had positive responses in 6 years. Potassium fertilization increased corn and soybean yields in 3 and 4 years, respectively. No response to starter was observed in corn in 1997 or soybeans in 1998.

Introduction

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

Procedures

The initial soil test in March, 1972 on this silt loam soil showed 47 lbs/a of available P and 312 lbs/a of exchangeable K in the top 6 in. of the soil profile. Rates of P were from 50 and 100 lbs P_2O_5/a from 1971 - 1975 and 30 and 60 lbs P_2O_5/a from 1976 - 1995. In 1997, the broadcast rates of P were not applied, and a starter of 120 lbs/a of 10-34-0 (12 lbs N/a + 41 lbs P_2O_5/a) was applied to all plots (1997 and 1998). Rates of K were 100 lbs K_2O/a from 1971 to 1975, 60 lbs K_2O/a from 1976 to 1995 and in 1999, and 150 lbs K_2O/a in 1997 and 1999. Rates of N included a factorial arrangement of 0, 40, and 160 lbs of preplant N/a (with single treatments of 80 and 240 lbs N/a). The 40 lbs/a N rate was changed to 120 lbs N/a in 1997 and 1999. The N, P, and K treatments were applied every year to soybeans from 1971 to 1982 and every other year (odd years) to corn from 1983 through 1995 and in 1999.

Corn hybrids planted were BoJac 603 - 1983, Pioneer 3377 - 1985, 1987, 1989; Jacques 7820 - 1991 and 1993; Mycogen 7250CB - 1995; and DeKalb 626 - 1997 and 1999. Soybeans planted were Douglas - 1984; Sherman - 1986, 1988, 1990, 1992, 1996, and 1997; Edison - 1994 and IA 3010 - 2000. Corn was planted in mid-April, and soybeans were planted in early to mid-May. Herbicides were applied preplant, incorporated each year. The plots were cultivated, furrowed, and furrow irrigated as needed. A plot combine was used for harvesting grain yields.

Results

Average corn and soybean yields for the 18-year period from 1983 through 2000 (9 years for each crop) are shown in Tables 1 and 2. A significant response to N fertilization by corn was obtained each year (Table 1). A good N response was obtained with 160 lbs N/a every year, and smaller, generally non-significant yield increases were observed with 240 lbs N/a. Corn yield in 1997 with 120 lbs N/a was equal to that with 160 lbs N/a and only 6 bu/a less in 1999. Corn yield showed a significant response to P fertilization only in 1985 and 1993 and to K fertilization in 1985, 1989, and 1993. No P response was observed in 1997, when starter fertilizer was applied to all plots, nor in 1999, the first year after 2 years of starter application.

Previously applied N of 160 lbs/a resulted in soybean yield increases of 4.0 to 5.4 bu/a (Table 2). Soybeans responded to P fertilization in 1984, 1986, 1990, 1992, 1994, and 2000 with yield increases ranging from 3.0 to 10.5 bu/a with 60 lbs P_2O_5/a. No P response was observed in 1998 when starter fertilizer was applied. However, a significant response was observed again in 2000, 2 years later. Potassium fertilization of soybeans resulted in yield increases in 1992, 1994, 1996, and 2000 that ranged from 2.9 to 5.8 bu/a.

These results indicate the importance of soil testing and maintaining a balanced fertility program.

Table 1. Effects of nitrogen, phosphorus, and potassium applications on corn yields in a corn-soybean cropping sequence, Kansas River Valley Experiment Field, Topeka, KS.

Fertilizer Applied[1]			Corn Yield								
N	P_2O_5[2]	K_2O	1983	1985	1987	1989	1991	1993	1995	1997	1999
-------------lbs/a-------------			-- bu/a --------------------------------------								
0	0	0	87	120	76	61	91	71	105	93	88
0	0	60/150	70	116	76	68	98	81	95	95	106
0	30	0	76	131	76	74	112	80	101	101	115
0	30	60/150	69	120	72	70	88	85	97	87	90
0	60	0	73	131	72	65	94	70	85	86	76
0	60	60/150	75	137	75	71	106	79	98	89	79
40/120	0	0	116	153	125	121	143	122	121	200	202
40/120	0	60/150	126	171	113	105	121	123	123	181	195
40/120	30	0	110	156	105	109	132	125	122	189	188
40/120	30	60/150	119	176	131	126	143	143	127	208	181
40/120	60	0	98	167	113	114	136	116	121	195	159
40/120	60	60/150	114	174	123	131	144	121	120	190	213
160	0	0	158	192	171	178	184	162	154	203	171
160	0	60/150	165	206	173	194	183	164	154	177	206
160	30	0	149	197	163	181	192	160	130	184	189
160	30	60/150	153	226	163	201	196	176	151	205	209
160	60	0	154	208	165	189	176	149	128	191	199
160	60	60/150	161	213	172	190	186	174	148	204	203
80	30	60/150	138	192	136	154	158	147	130	187	177
240	30	60/150	170	215	179	196	197	173	148	206	219
LSD(.05)			19	20	22	21	27	19	29	27	46
Nitrogen Means:											
0			75	126	74	68	98	78	97	92	92
40/120			114	166	118	118	136	125	122	194	190
160			157	207	168	189	186	164	144	194	196
LSD(.05)			8	9	9	9	11	8	13	19	19
Phosphorus Means:											
	0		120	160	122	121	137	121	125	158	161
	30		113	168	118	127	144	128	121	162	162
	60		113	172	120	127	140	118	117	159	155
LSD(.05)			NS	9	NS	NS	NS	8	NS	NS	NS
Potassium Means:											
		0	114	162	118	121	140	117	119	160	154
		60/150	117	171	122	128	141	127	124	159	165
LSD(.05)			NS	7	NS	7	NS	6	NS	NS	NS

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

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

Table 2. Effects of nitrogen, phosphorus, and potassium applications on soybean yields in a corn-soybean cropping sequence, Kansas River Valley Experiment Field, Topeka, KS.

Fertilizer Applied[1]			Soybean Yield								
N	P_2O_5[2]	K_2O	1984	1986	1988	1990	1992	1994	1996	1998	2000
-------------lbs/a-------------			--- bu/a ---								
0	0	0	68.8	56.0	66.5	54.9	63.5	68.6	69.0	63.2	48.1
0	0	60/150	70.4	56.9	66.3	57.3	66.1	66.8	75.7	63.0	54.4
0	30	0	69.3	59.4	64.2	61.7	76.0	77.4	75.3	63.6	53.6
0	30	60/150	69.4	61.4	68.6	62.5	69.9	80.7	76.3	63.7	58.1
0	60	0	69.6	60.5	68.1	61.9	75.1	77.8	74.0	60.8	53.4
0	60	60/150	72.6	63.3	75.1	63.1	76.1	79.4	76.2	62.8	57.8
40/120	0	0	68.7	58.1	71.1	61.3	60.0	71.5	73.1	65.0	51.6
40/120	0	60/150	67.3	62.1	66.0	62.7	67.0	75.8	73.1	62.8	57.6
40/120	30	0	67.6	61.4	64.6	59.4	69.5	71.7	72.7	60.2	53.3
40/120	30	60/150	71.8	64.4	75.7	63.9	74.2	81.0	78.3	69.0	61.6
40/120	60	0	73.0	64.5	75.5	62.7	71.3	76.5	72.3	63.7	50.8
40/120	60	60/150	71.9	61.7	69.9	64.6	74.3	81.1	76.5	63.0	60.2
160	0	0	67.8	60.3	75.0	62.2	65.1	74.1	77.2	63.9	55.1
160	0	60/150	70.6	60.5	74.2	61.9	67.7	74.8	80.6	63.8	57.0
160	30	0	70.4	59.4	75.7	60.9	69.2	80.5	77.7	60.3	53.4
160	30	60/150	67.2	63.5	74.4	69.3	80.7	80.3	80.9	63.0	59.5
160	60	0	73.6	62.9	67.8	66.0	76.1	80.8	72.2	63.1	59.6
160	60	60/150	71.0	63.6	73.9	66.5	79.7	84.5	80.5	66.5	64.9
80	30	60/150	71.1	63.7	70.2	65.7	73.0	77.9	78.8	66.3	63.9
240	30	60/150	72.1	62.0	69.7	66.2	70.4	82.2	79.3	65.8	60.7
LSD(.05)			NS	NS	NS	NS	9.6	6.9	NS	4.8	7.2
Nitrogen Means:											
0			70.0	59.6	68.1	60.2	71.1	75.1	74.4	62.9	54.2
40/120			70.0	62.1	70.5	62.5	69.4	76.3	74.3	64.0	55.9
160			70.1	61.7	73.5	64.5	73.1	79.2	78.2	63.5	58.2
LSD(.05)			NS	NS	3.9	3.4	NS	2.9	NS	NS	2.9
Phosphorus Means[2]:											
	0		68.9	59.0	69.9	60.1	64.9	71.9	74.8	63.6	54.0
	30		69.3	61.6	70.5	63.0	73.2	78.6	76.8	63.3	56.6
	60		71.9	62.7	71.7	64.2	75.4	80.0	75.3	63.3	57.8
LSD(.05)			2.4	2.9	NS	3.4	4.1	2.9	NS	NS	2.9
Potassium Means:											
		0	69.9	60.3	69.8	61.2	69.5	75.4	73.7	62.7	53.2
		60/150	70.2	61.9	71.6	63.5	72.9	78.3	77.5	64.2	59.0
LSD(.05)			NS	NS	NS	NS	3.3	2.4	2.8	NS	2.4

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

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

EFFECT OF PLACEMENT OF STARTER FERTILIZERS ON CORN

L.D. Maddux, D.A. Whitney, and S.A. Staggenborg

Summary

The effect of phosphorus (P) placement and source were evaluated at two sites in northeast Kansas. Most of the placement methods and both P sources were effective in increasing plant P concentration over with the 0 N, 0 P check at one site but not the other. Yields at both sites were higher than those of the 0 N, 0 P check with almost all treatments.

Introduction

Previous research has shown that starter fertilizers can increase corn yield. This research was designed to evaluate the effect of phosphorus (P) application and placement on the uptake of P by corn plants and corn yield. It was supported in part by a grant from Na-Churs Alpine Solutions and included their 6-24-6 fertilizer as a seed placement treatment.

Procedures

The study was conducted for 2 years on two sites: (1) Cornbelt Experiment Field near Powhattan on a dryland Grundy silty clay loam site previously cropped to soybeans with a pH of 6.5, an organic matter content of 3.2%, and a P test level of 6 ppm and (2) Kansas River Valley Experiment Field, Rossville Unit on an irrigated Sarpy fine sandy loam site previously cropped to grain sorghum with a pH of 6.7, an organic matter content of 1.2%, and a P test level of 12 ppm.

Nitrogen was applied at 120 lbs N/a at Powhattan and at 180 lbs N/a at Rossville using a urea ammonium nitrate solution (UAN). The 11 treatments included: (1) 0 N, 0 P check; (2) 0 P check with N; (3) 18-46-0 surface, broadcast, 40 lbs P_2O_5/a; (4 and 5) application in the seed row of 6-24-6 at 3 and 6 gpa (supplied by Na-Churs Alpine); (6 and 7) application in the seed row of 10-34-0 at 2 and 4 gpa (same P rate as the 6-24-6); (8) 10-34-0 at 7.6 gpa in a 2x2 placement (to supply 8.8-30-0); (9) 15-15-0 at 18 gpa in a 2 x2 placement (made with UAN and 10-34-0 to supply 30-30-0); (10) dual placement (mixture of UAN and 10-34-0 to supply the N-30-0); and (11) dual placement (N-30-0) + seed row placement of 6-24-6 at 3 gpa. In 2000, two additional treatments consisted of 10-34-0 dribbled over the top of the seed row at 6 and 8 gpa.

The N, surface, broadcast P, and dual-placement treatments were applied on May 3, 1999 and April 18, 2000 at Rossville and May 26, 1999 and April 14, 2000 at Powhattan. The starter treatments were applied at planting. Pioneer Brand 3335 (May 7, 1999) and Garst 8543IT (April 19, 2000) corns were planted at 30,000 sds/a in 30-inch rows at Rossville and Garst 8541IT (May 27, 1999) and Garst 8543IT (April 14, 2000) were planted at 26,000 sds/a in 30-inch rows at Powhattan. Whole-plant samples (5 plants) were taken at the 6-leaf stage of growth, and 10 leaves (opposite and below the ear leaf) were sampled at tasseling. These plant samples were analyzed for N and P. The plots were harvested using a plot combine on October 1, 1999 and September 19, 2000 at Rossville and October 28, 1999 and September 9, 2000 at Powhattan. Grain samples were collected and analyzed for N and P. Sample analyses for 2000 have not been completed at this writing.

Results

Phosphorus concentration of 6-leaf plant tissue was greatest in the two 2x2 treatments at Powhattan in 1999, but was significantly greater only compared to the concentration with the surface P application (Table 3). No significant differences in P content were observed in leaf tissue at tasseling or in the grain at harvest. At Rossville, the 0 N, 0 P treatment gave the highest P content at the 6-leaf stage of growth, probably because of a smaller plant size. However, by the tassel stage of growth, it had the lowest P content with only the 10-34-0, in the seed row, treatment resulting in a significantly higher P content. No differences between any other treatments were observed at the tassel stage of growth. Most of the treatments that received starter had higher P concentrations than that of the 0 N, 0 P check. However, so did the N, 0 P check.

All treatments at both locations in both years had significantly higher yields than the 0 N, 0 P check, except for the broadcast P at Powhattan in 1999 (Table 4). Dual placement of N and P was the highest yielding treatment at both sites in 1999, but the difference was significantly greater only compared to the 0 N, 0 P check because of the high variability at both sites.

Table 3. Effects of starter phosphorus placement and source on phosphorus contents of corn tissue and grain, northeast Kansas, 1999.

		6-Leaf P		Tassel Leaf P		Grain P	
Treatment[1]	Rate	Pow.	Ross.	Pow.	Ross.	Pow.	Ross.
		-------%-------		-------%-------		-------%-------	
0 N, 0 P	---	0.221	0.537	0.187	0.252	0.242	0.315
N, 0 P	---	0.213	0.456	0.132	0.290	0.210	0.272
Surface P Appl'n	40 lb/P_2O_5	0.201	0.464	0.199	0.277	0.256	0.323
6-24-6, w/Seed	3 gpa	0.232	0.407	0.199	0.293	0.235	0.362
6-24-6, w/Seed	6 gpa	0.233	0.391	0.203	0.268	0.238	0.341
10-34-0, w/Seed	2 gpa	0.231	0.447	0.203	0.294	0.224	0.291
10-34-0, w/Seed	4 gpa	0.237	0.407	0.197	0.312	0.207	0.309
10-34-0, 2x2	7.6 gpa[2]	0.254	0.434	0.199	0.294	0.239	0.271
15-15-0, 2x2	18 gpa[2]	0.259	0.420	0.188	0.296	0.228	0.357
N-30-0[3], Dual		0.207	0.426	0.203	0.270	0.232	0.313
N-30-0[3], Dual+Seed	3 gpa[3]	0.226	0.421	0.215	0.304	0.239	0.340
LSD(0.05)		0.031	0.072	NS	0.032	NS	NS

[1] N rates: 120 lbs N/a at Powhattan; 180 lbs N/a at Rossville; All treatments adjusted to same N.
[2] 7.6 gpa of 10-34-0 = 8.8-30-0; 18 gpa of 15-15-0 = 30-30-0 (i.e., 1:3 and 1:1 ratio N:P starters).
[3] 6-24-6 used at 3 gpa for seed treatment, 10-34-0 used with UAN to make the solution that was dual placed (N rate + 30 lbs P_2O_5).

Table 4. Effects of starter phosphorus placement and source on yield of corn, northeast Kansas, 1999 and 2000.

Treatment[1]	Rate	Powhattan 1999	Powhattan 2000	Rossville 1999	Rossville 2000
		- - - - - - - - - - - bu/a	- - - - - - - - - -		
0 N, 0 P	---	63	66	71	56
N, 0 P	---	87	103	149	132
Surface P Appl'n	40 lb/P_2O_5	83	107	164	128
6-24-6, w/Seed	3 gpa	97	104	189	133
6-24-6, w/Seed	6 gpa	98	110	169	149
10-34-0, w/Seed	2 gpa	99	97	167	134
10-34-0, w/Seed	4 gpa	96	113	167	135
10-34-0, 2x2	7.6 gpa[2]	93	110	169	136
15-15-0, 2x2	18 gpa[2]	90	112	150	123
N-30-0[3], Dual		106	104	199	118
N-30-0[3], Dual+Seed	3 gpa[3]	97	107	185	130
10-34-0, Dribble	6 gpa		114		139
10-34-0, Dribble	10 gpa		108		135
LSD(0.05)		21	15	46	26

[1] N rates: 120 lbs N/a at Powhattan; 180 lbs N/a at Rossville; All treatments adjusted to same N.
[2] 7.6 gpa of 10-34-0 = 8.8-30-0; 18 gpa of 15-15-0 = 30-30-0 (i.e., 1:3 and 1:1 ratio N:P starters).
[3] 6-24-6 used at 3 gpa for seed treatment, 10-34-0 used with UAN to make the solution that was dual placed (N rate + 30 lbs P_2O_5).

SOIL FERTILITY RESEARCH
EAST CENTRAL EXPERIMENT FIELD

EFFECTS OF LONG-TERM CROP RESIDUE HARVESTING AND FERTILIZER APPLICATION ON SOIL PROPERTIES AND CROP YIELD

K.A. Janssen and D.A. Whitney

Summary

Research was continued during 2000 to determine the effects of repeated harvesting of crop residues on crop yields and soil properties in a soybean-wheat-grain sorghum/corn rotation, fertilized with different levels of nitrogen (N), phosphorus (P), and potassium (K). The 2000 crop was the 20th year of this long-term study. The residue treatments (residue removed, normal residue incorporated, and 2X normal residue incorporated) caused no statistically significant differences in grain or residue yields in 2000. When averaged across all fertilizer treatments, corn grain yields were 82 bu/a with annual crop-residue harvesting, 81 bu/a with normal crop residue incorporated, and 80 bu/a with 2X normal crop-residue incorporated. In contrast, the fertilizer treatments (zero, low, normal, and high levels of N, P, and K) produced highly significant yield differences. Corn yield varied from 46 bu/a at the zero fertilizer rate to 106 bu/a at the highest level of fertilizer application. Soil test results show that soil properties are changing. Soil pH, soil exchangeable K, and soil organic matter are declining with crop-residue harvesting.

Introduction

Crop residues are being harvested increasingly as a source of raw materials for various nonagricultural uses. In Kansas, two companies currently are manufacturing wheatboard from wheat straw. In Iowa, over 50,000 tons of corn residue were harvested during the 97-98 crop year for ethanol production. In Minnesota, a company is planning to introduce BIOFIBER, a soy-based particle board. Other companies likely will join the market for the production of other bio-products (paper). All of this is in addition to the customary on-farm use of crop residues for livestock feed and bedding. These new uses are welcomed new sources of revenue for crop producers. However, they must be aware that crop residues also are needed for soil erosion protection and to replenish organic matter in the soil. Crop residue is the single most important source of carbon replenishment in soils.

Unfortunately, research data on the effects of crop residue harvesting on soil properties and crop yields are very limited, especially for long-term, continuous harvesting. From past observations, we know that grain producers have harvested crop residues for livestock feed for years with few noticeable side effects. However, harvesting crop residues for farm use generally has not been on a continuous basis from the same field. Also, some of the crop residues harvested may be returned as animal wastes. With non-agricultural uses, this generally would not be the situation, and repeat harvests would be more probable. Harvesting crop residues continually would remove larger amounts of plant nutrients and return less plant material to the soil. The effects of fertilizer management in offsetting these losses are not well understood.

This study was established to measure the effects of long-term harvesting of crop residues and the additions of various levels of crop residues on crop yields and soil properties in a soybean-wheat-grain sorghum/corn rotation, fertilized with variable rates of nitrogen (N), phosphorus (P) and potassium (K).

Procedures

This study was started in the fall of 1980. The residue treatments were: (1) crop residue harvested each year, (2) normal crop residue incorporated, and (3) twice (2X) normal crop residue incorporated (accomplished by adding and evenly spreading the crop residue from the residue-removal treatment). Superimposed over the residue treatments were four levels of fertilizer treatments: zero, low, normal, and high levels of N-P-K fertilizer (Table 1). The crops planted were soybean, wheat, and grain sorghum in a 3-year rotation. Corn was substituted for grain sorghum beginning in 1994. Grain yields and residue yields were measured each year, and soil samples (0 to 2-inch depth) were collected and analyzed after the 16th year to detect any changes in soil properties.

Results

Grain yields and residue yields for the last 10 years of this 20-year study are summarized in Tables 2 and 3. Except for 1987, the residue treatments caused no differences in grain or residue yields for any crop in any year since the study was initiated. In 1987, a year with hail, less residue was measured in the 2X normal residue incorporated treatment than with normal residue incorporated. This may have been the result of uneven hail damage rather than an effect of the residue treatments. Summed over all 20 years (1981-2000), grain and residue yields for all residue treatments differed by less than 2%. In contrast, the fertilizer treatments have produced large differences in grain and residue yields averaging 37% and 40%, respectively, for all years. Highest grain and residue yields were produced with the normal and high fertilizer treatments, and the lowest grain and residue yields with the zero and low fertilizer treatments.

Although no significant differences in grain and residue yields have resulted from the addition or removal of crop residue, soil properties have changed. The effects of the residue and fertilizer treatments on soil properties are shown in Table 4. Soil pH, exchangeable K, and soil organic matter have decreased with crop-residue harvesting. Effects on soil exchangeable K are most obvious. The harvesting of crop residue lowered exchangeable K in the soil by nearly 20%. This is because of the high K content in crop residue. Crop-residue harvesting decreased soil organic matter 9%. Doubling the crop residue increased soil organic matter by 12%. The fertilizer treatments caused the expected increases in N, P, and K. Soil pH decreased with fertilizer application. Available P, exchangeable K, and organic matter all increased with fertilizer application.

These data suggest that the occasional harvesting of crop residues is having little negative effect on grain or residue yields and should require no special changes in management practices, except possibly to keep a close watch on soil test K levels. However, long-term continuous harvesting of crop residues from the same field eventually could cause problems. This practice could cause further decreases in soil organic matter to a point where crop yields will be affected. The effects of crop-residue harvesting on soil properties and crop yields occur slowly and could take many years before stabilizing at a new level of equilibrium. With different soils and different environments, the time period for yield limitations to develop could be much different. This soil was initially quite high in organic matter and fertility. Soils with lower organic matter and lower fertility may be affected more quickly by crop-residue harvesting.

Table 1. Nitrogen, phosphorus, and potassium fertilizer treatments for crops in rotation, East Central Experiment Field, Ottawa, KS.

	Crop and Fertilizer Rate (N-P_2O_5-K_2O)		
Fertilizer Treatments	Soybean	Wheat	Grain Sorghum/Corn
		lbs/a	
Zero	0-0-0	0-0-0	0-0-0
Low	0-0-0	40-15-25	40-15-25
Normal	0-0-0	80-30-50	80-30-50
High	0-0-0	120-45-75	120-45-75

Table 2. Mean effects of crop residue and fertilizer treatments on grain yields, East Central Experiment Field, Ottawa, KS, 1991-2000.

Treatment	Wht '91	G.S. '92	Soy '93	Corn '94	Wht '95	Soy '96	Corn '97	Soy '98	Wht '99	Corn '00	20-yr total
						bu/a					
<u>Residue</u>											
Removed	34	128	21	104	21	42	89	47	25	82	1178
Normal	37	127	22	108	19	46	88	47	24	81	1190
2X Normal	39	130	21	107	17	48	82	46	22	80	1175
LSD 0.05	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	
<u>Fertilizer</u>											
Zero	26	120	19	89	12	43	46	44	17	46	982
Low	35	123	20	103	17	43	76	46	22	76	1146
Normal	41	135	22	114	22	47	99	47	26	96	1252
High	44	136	25	120	24	48	123	50	29	106	1343
LSD 0.05	2	7	2	5	2	2	9	2	2	7	

Table 3. Mean effects of crop residue and fertilizer treatments on residue yields, East Central Experiment Field, Ottawa, KS, 1991-2000.

Treatment	Wht '91	G.S. '92	Soy '93	Corn '94	Wht '95	Soy '96	Corn '97	Soy '98	Wht '99	Corn '00	20-yr total
						tons/a					
Residue											
Removed	0.92	1.80	0.38	1.63	1.22	0.48	1.46	1.00	0.63	2.85	27.40
Normal	1.00	1.85	0.39	1.73	1.22	0.52	1.49	1.03	0.59	2.74	27.78
2X Normal	1.04	1.92	0.39	1.56	1.24	0.54	1.39	1.03	0.51	2.72	27.74
LSD 0.05	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	
Fertilizer											
Zero	0.65	1.83	0.34	1.38	0.50	0.46	1.09	0.95	0.34	2.32	22.56
Low	0.93	1.74	0.35	1.46	1.02	0.52	1.35	0.97	0.49	2.79	26.54
Normal	1.10	1.95	0.40	1.91	1.71	0.53	1.57	1.07	0.68	2.88	29.60
High	1.27	1.90	0.45	1.81	1.67	0.54	1.78	1.08	0.80	3.09	31.48
LSD 0.05	0.11	0.17	0.03	0.26	0.16	0.04	0.19	0.06	0.08	0.33	

Table 4. Mean soil test values after 16 years of crop residue and fertilizer treatments, East Central Experiment Field, Ottawa, KS.

Treatment	Soil pH	Soil Available P	Soil Exchangeable K	Soil Organic Matter	Soil NO_3-N
		ppm	ppm	%	ppm
Residue					
Removed	6.0	29	163	3.0	33
Normal	6.1	30	201	3.3	27
2X Normal	6.2	37	249	3.7	21
LSD 0.05	0.1	2	20	0.2	NS
Fertilizer					
Zero	6.4	23	147	3.0	27
Low	6.2	26	177	3.3	26
Medium	6.0	36	236	3.5	30
High	5.8	42	259	3.5	26
LSD 0.05	0.1	3	22	0.2	NS

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

STARTER FERTILIZER MANAGEMENT FOR NO-TILL CORN PRODUCTION

B.J. Niehues, R.E. Lamond, and C.J. Olsen

Summary

Because of the interest in, and importance of, the use of starter fertilizers in no-till corn production systems, research was initiated to evaluate rates of nitrogen (N) in starter fertilizers placed in direct seed contact, dribbled over the row, or in a 2x2 configuration. The use of starter fertilizer containing N, phosphorus (P), and potassium (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-furrow did not increase yields and reduced plant populations. Current recommendations suggest that no more than 10 lb/a of N + K_2O should be placed in direct seed contact. Over-the-row applications did increase yields, and plant populations were not reduced compared to those with the in-furrow placement. Application of 30 to 120 lb N/a in a 2x2 starter band increased yields without affecting plant populations. Results indicate that either over-the-row or a 2x2 placement should be used if the starter fertilizer contains more than 10 lb/a of N. The addition of 10 lb sulfur/a in the starter fertilizer minimally increased yields this year.

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 contain small amounts of N. Because of the recognized potential inefficiency of surface-applied N in these heavy-residue production systems, interest has increased in applying more of the total N program in the starter fertilizer. However, 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 research was initiated to evaluate starter fertilizer management in a no-till production system, including placement and use of higher N rates.

Procedures

The study was conducted at the North Agronomy Farm (Manhattan, dryland) to evaluate direct seed contact, over the row, and 2x2 placements of starter fertilizer. In the direct seed contact and over-the-row studies, N rates were 10, 20, 40, and 50 lb N/a. In the 2x2 studies, N rates of 30, 60, 90, and 120 lb/a were evaluated in a starter fertilizer containing P and K placed 2 in. below and 2 in. to the side of the seed. Total N was balanced on all treatments at 150 lb/a, as broadcast ammonium nitrate. Corn was no-till planted on April 7.

Plant populations and V-6 dry matter yields were determined, and leaf samples were taken at V-6 and tassel stages to determine N, P, K, and sulfur (S) concentrations. Grain yields, grain moisture, and grain protein levels were determined.

Results

Grain yields were good to excellent in 2000 despite hot dry weather (Tables 1 and 2). The study was planted on April 7, and heat was not extreme during pollination. Soil test P and K levels were adequate in this field. The use of starter fertilizer either in direct seed contact, dribbled over the row, or in a 2x2 placement increased yields compared to broadcast N only (Tables 1-2). Increasing N rates with direct contact did not increase yields, and final stand counts were reduced significantly at the 40 and 50 lb N/a rates. Effects of too much N in direct seed contact are worse in dry seedbeds. Current recommendations suggest that no more than 10 lb/a of N plus K_2O should be placed in direct seed contact. A higher rate of N can be dribbled over the row without a risk of stand reduction, while still producing high yields.

With the 2x2 starter placement, applying either 30, 60, 90, or 120 lb N/a increased yields over the no-starter treatment. The 2x2 placement allows the flexibility of increasing N rates in a starter fertilizer without the risk of emergence problems encountered with in-furrow placement of starters. For the second year in a row, the inclusion of 10 lb S/a in the starter significantly increased early-season growth and grain yields. This work will be continued in 2001.

Table 1. Evaluation of starter fertilizer placed in direct seed contact on no-till dryland corn, North Agronomy Farm, Manhattan, KS, 2000.

B'cast	Starter Fertilizer				Plant	V-6					Tassel				Grain		
N[1]	N	P_2O_5	K_2O	Placement	Population	Dry Wt.	N	P	K	S	N	P	K	S	Moist.	Yield	Prot.
lb/a	- - lb/a - -				1000 plants/a	lb/a	- - - - - % - - - - -				- - - - - % - - - - -				%	bu/a	%
150	0	0	0	--	20.7	163	3.45	.32	3.32	.15	2.40	.26	1.82	.15	12.63	105	9.33
140	10	15	5	In-furrow	19.7	210	3.26	.34	3.43	.15	2.23	.26	1.83	.14	12.27	127	9.31
130	20	15	5	In-furrow	19.7	163	3.30	.32	3.55	.16	2.50	.29	1.85	.15	12.77	122	9.40
110	40	15	5	In-furrow	17.3	173	3.37	.33	3.62	.15	2.60	.28	1.80	.16	11.80	127	8.67
100	50	15	5	In-furrow	15.9	120	3.43	.31	3.44	.17	2.45	.29	1.87	.14	11.07	111	8.88
140	10	15	5	Over Row	20.2	209	3.54	.36	3.66	.16	2.49	.29	1.79	.15	12.13	133	9.10
130	20	15	5	Over Row	20.7	214	3.32	.30	3.71	.17	2.43	.28	1.90	.14	12.03	133	8.98
110	40	15	5	Over Row	19.2	173	3.57	.33	3.39	.16	2.39	.28	1.89	.14	12.03	126	9.08
100	50	15	5	Over Row	20.5	161	3.25	.30	3.50	.16	2.62	.29	1.87	.16	11.50	128	9.02
LSD(0.10)					2.8	NS	NS	NS	NS	NS	NS	NS	NS	NS	.75	21	NS
Mean Values:																	
Starter	10				20.0	209	3.40	.35	3.54	.16	2.36	.27	1.81	.15	12.20	130	9.20
N	20				20.2	189	3.31	.31	3.63	.17	2.47	.28	1.88	.15	12.53	127	9.19
	40				18.3	173	3.47	.33	3.51	.16	2.49	.28	1.85	.15	11.92	127	8.80
	50				18.2	141	3.34	.31	3.47	.17	2.54	.29	1.87	.15	11.28	119	8.95
LSD (0.10)					NS	38	NS	.03	NS	NS	NS	NS	NS	NS	.50	NS	NS
Placement	In-furrow				18.2	166	3.34	.33	3.51	.16	2.45	.28	1.84	.15	11.97	121	9.06
	Over Row				20.2	189	3.42	.32	3.57	.16	2.48	.28	1.86	.15	11.99	130	9.05
LSD (0.10)					1.5	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

[1] Broadcast N applied as ammonium nitrate after planting

Table 2. Evaluation of starter fertilizer placed 2x2 on no-till dryland corn, North Agronomy Farm, Manhattan, KS, 2000.

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	Moist.	Yield	Prot.
lb/a	- - - lb/a - - -				1000 plants/a	lb/a	- - - - - % - - - - -				- - - - - % - - - - -				%	bu/a	%
150	0	0	0	0	20.7	163	3.45	.32	3.32	.15	2.40	.26	1.82	.15	12.6	105	9.33
120	30	30	10	0	17.9	209	2.95	.31	3.51	.15	2.17	.28	1.98	.13	11.5	119	9.00
120	30	30	10	10	18.0	201	3.13	.34	3.87	.19	2.66	.32	1.91	.18	11.4	132	9.06
90	60	30	10	0	20.1	152	3.20	.30	3.61	.15	2.48	.30	1.91	.15	11.6	120	9.33
60	90	30	10	0	20.8	178	3.28	.29	3.42	.15	2.38	.30	1.81	.16	11.1	142	9.08
30	120	30	10	0	20.3	121	3.30	.27	3.54	17	2.46	.30	1.87	.16	11.4	128	9.73
LSD(0.10)					1.5	NS	0.27	.03	0.23	NS	NS	.03	NS	NS	1.25	15	NS

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

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 systems likely is due to nitrogen (N) loss by volatilization 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 continued in 2000 to evaluate experimental N fertilizers (UCAN-21 and CR-43) surface broadcast on no-till corn (Sandyland and Manhattan). UCAN-21 is a mixture of 2/3 urea-ammonium nitrate (UAN) solution and 1/3 liquid calcium nitrate. The CR-43 material is a polymer-coated urea. The polymer coating makes the urea a slow-release N source. Results indicate that UCAN-21 and CR-43 produced higher yields than UAN when surface broadcast on no-till corn.

Introduction

Urea-containing fertilizers are subject to N loss through volatilization when surface applied without incorporation, particularly if 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 2000 using no-till production systems. Nitrogen rates (50, 100, 150 lb/a) were surface broadcast just after corn planting as either UAN, CR-43, or UCAN-21. A no-N 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 in 2000 at the North Farm and below average at Sandyland. 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 3). Nitrogen also consistently increased leaf N and grain protein at both sites, but N rate had no effect on grain protein.

The UCAN-21 and CR-43 produced significantly higher corn grain yields than UAN at Sandyland. Similar trends were apparent at the North Farm. Both UCAN-21 and CR-43 would have less volatilization potential than UAN, and this may explain the yield differences noted.

This work will be continued in 2001.

Table 3. Effects of nitrogen rates and sources on no-till corn, Sandyland Field, St. John, and North Agronomy Farm, Manhattan, KS, 2000.

		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	Prot.	Dry Wt.	N	N Uptake	Tassel N	Yield	Prot.
lb/a		lb/a	%	lb/a	%	bu/a	%	lb/a	%	lb/a	%	bu/a	%
0	--	231	2.92	7	2.60	41	8.1	254	3.10	8	1.58	34	7.1
50	UAN	245	3.18	8	2.57	78	8.4	337	3.35	11	1.81	72	6.7
100	UAN	226	3.46	8	2.86	83	8.9	273	3.34	9	2.29	104	7.0
150	UAN	226	3.56	8	2.93	86	9.7	315	3.56	11	2.66	133	7.4
50	CR-43	293	3.37	10	2.79	86	8.9	215	2.79	6	2.03	83	6.8
100	CR-43	226	3.40	8	2.98	99	9.2	268	3.33	9	2.50	114	7.8
150	CR-43	216	3.41	7	2.97	94	10.0	291	3.37	10	2.49	132	8.3
50	UCAN-21	240	3.20	8	2.75	80	8.6	304	3.22	10	1.87	82	6.6
100	UCAN-21	182	3.24	6	2.87	91	8.8	184	3.57	7	2.37	109	7.3
150	UCAN-21	255	3.34	9	2.89	113	9.3	250	3.59	9	2.51	129	8.3
LSD (0.10)		NS	0.32	NS	0.14	17	0.6	NS	0.30	3	0.23	16	0.9
Mean Values:													
N	50	259	3.25	8	2.70	82	8.6	285	3.12	9	1.90	79	6.72
Rate	100	211	3.37	8	2.90	91	9.0	242	3.41	8	2.39	109	7.35
	150	232	3.44	7	2.93	97	9.7	285	3.50	10	2.55	131	8.00
LSD (0.10)		NS	NS	NS	0.08	9	0.1	NS	0.18	NS	0.14	9	0.4
N	UAN	232	3.40	8	2.78	82	9.0	308	3.42	10	2.25	103	7.05
Source	CR-43	245	3.39	8	2.91	93	9.4	258	3.16	8	2.34	110	7.63
	UCAN-21	226	3.26	7	2.83	95	8.9	246	3.46	8	2.25	106	7.40
LSD (0.10)		NS	NS	NS	0.08	9	0.1	NS	0.18	NS	NS	NS	0.4

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. In 2000, AgrotaiN was dropped as an N source and was replaced by CR-43, a polymer-coated, slow- release urea that may be less susceptible to volatilization. All N was surface broadcast. The tillage systems used were no-till or conventional. Results in 2000 indicate that conventional tillage performed better than no-till. The lower yields in no-till likely resulted from delayed early-season growth followed by very dry conditions. Nitrogen sources performed similarly in conventional tillage, but urea performed poorly in no-till. Ammonium nitrate outperformed urea in no-till, particularly at lower N rates. Apparently, N efficiency was reduced by volatilization losses from urea under no-till conditions. The V-6 leaf N concentrations indicates that CR-43 did exhibit slow-release characteristics. Yields were average in 2000, 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. In 2000, AgrotaiN was replaced by CR-43, a polymer-coated, slow-release urea.

Procedures

Three N sources at three rates each (30, 60, 120 lb N/a) were used. These were ammonium nitrate, urea, and CR-43. 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 of grain sorghum were done on May 10, July 24, and September 12, respectively.

Results

Results are summarized in Table 4. Grain yield, flag leaf N, and grain protein were increased significantly by N application up to 120 lbs. Ammonium nitrate 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. Conventional-tillage yields were better than no-till yields in 2000, probably because of delayed crop development in no-till followed by very dry conditions during grain fill. However, 19-year average yields show no difference between no-till and conventional tillage on the silty clay loam soil at this site.

Table 4. Effects of nitrogen management and tillage on continuous grain sorghum, North Agronomy Farm, Manhattan, KS, 2000.

N	N		V-6		Boot	Grain	
Rate	Source	Tillage	Dry Matter	N	N	Yield	Protein
lb/a			lb/a	%	%	bu/a	%
0	--	No-till	153	2.16	1.44	16	6.8
30	Am. nit.	No-till	358	3.07	1.50	49	6.2
60	Am. nit.	No-till	352	3.29	1.53	64	7.2
120	Am. nit.	No-till	307	3.51	2.10	82	10.8
30	Urea	No-till	179	3.24	1.39	42	7.0
60	Urea	No-till	281	3.00	1.59	59	6.7
120	Urea	No-till	320	3.52	2.05	84	8.0
30	CR-43	No-till	198	2.46	1.50	36	6.7
60	CR-43	No-till	224	2.85	1.67	59	7.8
120	CR-43	No-till	173	3.22	1.91	87	10.2
0	--	Conventional	186	2.56	1.55	27	7.1
30	Am. nit.	Conventional	391	2.54	1.57	46	6.7
60	Am. nit.	Conventional	634	3.04	1.90	91	7.7
120	Am. nit.	Conventional	467	3.24	2.23	88	10.8
30	Urea	Conventional	461	2.93	1.53	53	6.4
60	Urea	Conventional	723	3.24	1.91	89	8.0
120	Urea	Conventional	537	3.39	2.35	91	11.6
30	CR-43	Conventional	295	2.44	1.74	50	7.2
60	CR-43	Conventional	390	2.56	1.90	69	7.9
120	CR-43	Conventional	525	2.74	2.24	84	10.3
LSD (0.10)			120	0.35	0.19	14	0.7
Mean Values:							
N	30		313	2.78	1.54	46	6.7
Rate	60		434	3.00	1.75	72	7.5
	120		388	3.27	2.15	86	10.3
LSD (0.10)			51	0.15	0.08	6	0.2
N	Am. nit.		418	3.11	1.80	70	8.2
Source	Urea		417	3.22	1.80	70	7.9
	CR-43		301	2.71	1.83	64	8.4
LSD (0.10)			51	0.15	NS	NS	0.2
Tillage	No-till		266	3.13	1.69	63	7.8
	Conventional		492	2.90	1.93	74	8.5
LSD (0.10)			42	0.11	0.07	5	0.2

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 2000 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 in Brown and Marion counties. 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 2000 were average in Brown County and reduced by very dry conditions in Marion County. Yields and leaf tissue Cl concentrations are summarized in Tables 5 and 6 for corn and sorghum, respectively. Significant yield increases were noted at all sites, although not all Cl treatments produced significant yield increases. 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 2001.

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 5. Effects of chloride fertilization on corn, northeast and central Kansas, 2000.

Cl	Cl	Brown Co.		Marion Co.	
Rate	Source	Yield	Tassel Cl	Yield	Tassel Cl
lb/a		bu/a	%	bu/a	%
0	--	87	.19	38	.10
20	KCl	92	.26	42	.27
40	KCl	94	.28	47	.32
20	NaCl	95	.29	43	.30
40	NaCl	94	.33	46	.37
20	$CaCl_2$	90	.27	44	.27
40	$CaCl_2$	91	.31	43	.33
LSD (0.10)		6	.03	5	.04
Mean Values:					
Cl	20	93	.27	43	.28
Rate	40	93	.31	45	.34
LSD (0.10)		NS	.02	NS	.03
Cl	KCl	93	.27	45	.30
Source	NaCl	95	.31	45	.34
	$CaCl_2$	91	.29	43	.30
LSD (0.10)		NS	NS	NS	.03
Soil test Cl, lb/a		28		14	

Table 6. Effects of chloride fertilization on grain sorghum, northeast and central Kansas, 2000.

Cl Rate	Cl Source	Brown Co. Yield	Brown Co. Boot Cl	Marion Co. Yield
lb/a		bu/a	%	bu/a
0	--	87	.07	55
20	KCl	100	.19	67
40	KCl	100	.25	61
20	NaCl	93	.19	64
40	NaCl	91	.27	60
20	$CaCl_2$	93	.15	63
40	$CaCl_2$	98	.22	62
	LSD (0.10)	11	.02	5
Mean Values:				
Cl	20	95	.17	64
Rate	40	96	.25	61
	LSD (0.10)	NS	.01	3
Cl	KCl	100	.22	64
Source	NaCl	92	.23	62
	$CaCl_2$	96	.19	62
	LSD (0.10)	8	.02	NS
	Soil Test Cl (0-24 in.), lb/a	9		9

DETERMINING OPTIMAL NITROGEN RATE FOR IRRIGATED CORN

R.J. Gehl, J.P. Schmidt, and R.K. Taylor

Summary

Refining current nitrogen (N) recommendations will be important for obtaining maximum corn yields, while reducing economic and environmental risks. In this study, maximum yields were achieved in small-plot studies at N rates ranging from 50 to 200 lb/a, depending on the field site. Further analysis of data collected in this study will be completed to determine large-scale effects of applied N rates on corn yield.

Introduction

Variability in yields at a field scale can complicate determination of the appropriate N rate for obtaining maximum yields when a regional N recommendation is used. Previous research has indicated a potential for reaching yield goals when N is applied at rates below the recommended level at sites in south central Kansas. The current research was initiated to determine the N rate needed to obtain maximum corn grain yields at selected sites in south central Kansas and to evaluate the potential for variable-rate N recommendations.

Procedures

Small-plot locations were identified in each of three center-pivot irrigated corn fields in Harvey, Pawnee, and Reno counties in south central Kansas. Field sites in Harvey and Pawnee counties are under continuous corn management, whereas the site in Reno Co. is in a corn-soybean rotation. Nitrogen treatments were ammonium nitrate broadcasted at six rates (50, 100, 150, 200, and 300 lbs N/a) and applied within 2 weeks of emergence. A no-N check was included. Plots were 30 by 20 ft (eight 30-in. rows) and were arranged in a randomized complete-block design with four replications. At the Reno Co. location, an additional 56 lbs N/a were applied by fertigation of 32-0-0.

Soil samples were taken in each treatment at 0-12 and 12-24 in. depths at approximately the V-6 growth stage. Sub-samples were taken between and within the rows. Leaf tissue samples also were taken at the V-6 growth stage. The most recently mature leaf of 10 plants in the second and seventh rows of each plot was collected for analysis of N concentration. Grain yield was determined by hand harvesting 20 feet of each of the center two rows of each plot and was adjusted to15.5% moisture content.

In addition to the small-plot research, two strips 180 ft wide and the length of each field received +50 and -50 lbs N/a relative to the whole-field average N rate. Yield data from these strips and the remaining area of the fields were collected using yield monitors attached to the producers' combines. Yield averages in each of these strips will be compared to yields in adjacent 180 ft strips that received the whole-field average N rate.

Results

Treatment differences in grain yield were observed at Harvey and Pawnee counties (Table 7). A linear increase in yield of 80 bu/a with increased N rate from 0 to 200 lbs/a was observed at the Harvey Co. site. Results from the Pawnee Co. site indicated a quadratic treatment effect. At this site, 50 lb N/a provided the highest yield (186 bu/a), whereas 300 lb N/a resulted in the lowest yield (145 bu/a). No statistical yield difference was observed at the Reno Co. site. These results may have been affected by the previous soybean crop and the additional 56 lbs N/a applied through the pivot.

A significant increase in leaf N concentration as a function of N rate was observed at each location (Table 8). A quadratic treatment effect was apparent at the Reno Co. site only. A linear plateau relationship was observed between leaf tissue % N and yield (linear relationship below 3.12% N) at the Harvey Co. site, but not at either of the other two sites. Leaf tissue N at the Reno and Pawnee Co. sites was above 3.2% regardless of treatment, indicating that % N probably was not yield-limiting for any N treatment. Similar comparisons will be performed on soil N content sampled at V-6.

Results of this study indicate that response to N varied depending on field location, and lower N rates limited yield at only one of the locations. Yield at the Harvey Co. site responded linearly to N rate, and the maximum yield was obtained at 200 lbs N/a. The Pawnee Co. site reached maximum yield at 50 lb N/a, and a quadratic yield by treatment relationship was observed. A yield response to N at the Reno Co. site was not observed, likely because of management factors.

Table 7. Corn grain yield response to nitrogen treatments, south central Kansas, 2000.†

Treatment	Harvey Co.	Pawnee Co.	Reno Co.
lbs N/a	bu/a		
0	90	152	216
50	107	186	220
100	145	183	218
150	159	173	223
200	170	161	213
300	162	145	214
Contrast			
Linear	*		NS
Quadratic		*	NS

† Treatment by location interaction was observed among field sites, * Significant at the 0.10 probability level

Table 8. Percent nitrogen in leaf tissue sampled at V-6, south central Kansas, 2000 †

Treatment	Harvey Co.	Pawnee Co.	Reno Co.
lbs N/a	% N		
0	2.34	3.49	3.35
50	2.49	3.60	3.70
100	2.93	3.85	3.70
150	3.01	3.90	3.82
200	3.35	3.94	3.86
300	3.31	4.03	3.90
Contrast			
Linear	*	*	*
Quadratic			*

† Treatment by location interaction was observed among field sites, * Significant at the 0.10 probability level

CONTROLLED-RELEASE NITROGEN FERTILIZER IN STARTER FOR SORGHUM PRODUCTION

D.A. Whitney, W.B. Gordon, and A.J. Schlegel

Summary

No-till planting systems have generated interest methods that allow total fertilizer application when planting to eliminate trips across the field. Previous research also has shown increasing the nitrogen (N) in starter fertilizer has been beneficial for no-till sorghum. Putting N and/or potassium (K) in direct seed contact, especially urea, may cause seedling injury, so products that slow N release such as polymer-coated urea, may be effective. At the North Central Experiment Field location, polymer-coated urea at rates of 24 and 54 lb N/a added to a monoammonium phosphate (MAP) as a direct seed-applied starter increased yields over MAP alone or MAP plus uncoated urea. However, significant stand reductions occurred when N from polymer- coated urea exceeded 24 lb N/a.

Introduction

No-till planting of row crops has generated considerable interest in use of starter fertilizer. However, planters equipped with separate coulter/knifes to place the fertilizer to the side and below the seed are not common in 12-row and larger planters, raising questions about putting fertilizer in the seed furrow as an alternative. Research at the North Central Experiment Field also has shown a bigger response to 30-30-0 starter placed to the side and below the seed compared to a 10-30-0 starter similarly placed. Fertilizer rate and source must be limited when placed in direct seed contact to avoid germination injury. This is especially true for N and K. Polymer-coated fertilizers for slow release of N have been found to reduce that germination injury problem.

This research was initiated to study the effects on germination and production of grain sorghum of applying a controlled-release urea in direct seed contact.

Procedures

Studies were initiated at the North Central Experiment Field near Belleville on a Crete silt loam soil (fine, montmorillonitic, mesic Pachic Argiustolls) and at the Southwest Research-Extension Center near Tribune on a Colby silt loam (fine-silty, mixed (calcareous), mesic Ustic Torriorthents). Both locations were in wheat in 1999, and sorghum was no-till planted into the wheat stubble. A soil sample was taken from each site prior to planting, and the results are as follows:

	NC Field	Tribune
pH	5.7	7.9
Lime Req. ECC, lb/a	2000	–
Bray-1 P, ppm	51	10
Exch. K, ppm	572	–
Org Mat, %	–	1.7
DTPA Fe, ppm	–	7

The NC location was planted on May 17 to Pioneer var. 8505 at 65,000 seeds/a, and the Tribune location was planted on May 25 to Pioneer var. 8505 at 33,000 seeds/a. Individual plots were 4 rows wide (30 in. spacing) by 30 ft long at NC and 40 ft long at Tribune. Starter fertilizer was applied at both locations in direct seed contact using 11-52-0 at 58 lb/a (a 6-30-0 starter rate) as the base of the mix for all starter treatments. Treatments with additional N in the starter were formulated using a controlled-release polymer-coated urea, Type II (CR-43) from Agrium or urea as the additional N. The broadcast N was applied as either urea or the CR-43. Stand counts were taken at each location shortly after emergence. Because of extremely dry weather at Tribune, no additional data could be collected there. At the NC location, leaf samples were taken at late boot to early heading and analyzed for N and P concentrations. Grain yields were determined at maturity and corrected to 14%

moisture for reporting yield. A grain sample was retained and analyzed for protein concentration.

Results

The 2000 growing season at both locations was extremely dry with less than half the normal growing season precipitation. At both locations, surface soil moisture was good at planting because of the wheat residue cover, but no rainfall coupled with above-normal temperatures during sorghum emergence put considerable stress on seedling emergence. At the Tribune location, tremendous variability occurred in stands, with less than 10% emergence on several treatments, but no significant treatment effects were found (Table 9). Continued dry weather through the remainder of the growing season resulted in no grain yield at this location. At the North Central location, stands were reduced significantly as the rate of N applied with the seed increased, except for the highest rate of N (120-30-0), which caused only a moderate stand reduction for no apparent reason . The 30-30-0 urea/MAP starter resulted in a much greater stand reduction than did the 30-30-0 CR-43/MAP starter, suggesting that the controlled-release polymer coating on the urea was partially effective in reducing germination injury.

Grain yields at the North Central Field were increased significantly by the 30-30-0, 60-30-0, and 120-30-0 CR-43/MAP starters compared to no starter or MAP alone. The tremendous stand reduction associated with the 30-30-0 urea/MAP and 90-30-0 CR-43/MAP starter treatments resulted in the lowest absolute yields of any treatments in the study but not significantly lower than the no-starter check. The yield increase from more N in the starter is consistent with previous research at the North Central Field where a 2x2-placed band of a 30-30-0 starter rate was significantly better than the traditional 10-30-0 starter. The N concentration in leaf samples at boot to early heading also was increased by increasing the N rate in the starter.

Our results suggest that in a no-till sorghum system, increasing the N in the starter can increase yield compared to a traditional starter or no starter. However, germination injury can occur, if the starter is placed in direct seed contact. The polymer-coated urea for controlled N release used in this study was helpful in reducing injury but not totally effective. Other coating thicknesses/release rates need to be investigated for providing more protection against seedling injury, while releasing adequate N for optimum plant growth.

Table 9. Effects of starter rate and nitrogen source on plant populations at Tribune, KS and plant population, grain yield, and plant nitrogen and phosphorus concentrations of no-till sorghum, North Central Experiment Field, Belleville, KS, 2000.

					Tribune	North Central Field				
Starter (w/seed)			B'cast		Plant	Plant	Grain		Boot Stage (leaf)	
N	P_2O_5	Sources	N	Source	Stand	Stand	Yield	Protein	N	P
lb/a			lb/a		plts/a	plts/a	bu/a	%	- % -	
0	0	--	0	--	2,700	43,600	77.6		2.83	.25
30	30	CR-43/MAP	0	--	1,600	39,200	90.0		2.96	.25
60	30	CR-43/MAP	0	--	2,900	10,400	102.8		3.06	.24
90	30	CR-43/MAP	0	--	4,600	7,000	64.0		3.20	.24
120	30	CR-43/MAP	0	--	2,600	34,200	104.0		3.03	.25
30	30	CR-43/MAP	60	--	2,500	31,400	95.2		2.99	.25
30	30	Urea/MAP	60	--	2,300	7,000	70.2		3.04	.26
6	30	MAP	54	Urea	1,800	40,100	78.9		2.88	.24
6	30	MAP	54	CR-43	3,000	38,300	74.9		2.90	.24
6	30	MAP	84	Urea	3,200	36,700	75.8		2.86	.23
6	30	MAP	84	CR-43	3,200	38,300	78.4		2.82	.23
6	30	MAP	114	Urea	2,000	38,300	85.2		2.90	.25
6	30	MAP	114	CR-43	1,500	40,100	84.4		2.88	.23
0	0	--	90	Urea	2,000	45,300	84.1		2.96	.25
LSD (.05)					NS	5,200	22.4		0.21	NS

CR-43 - controlled-release polymer-coated urea, 43% N from Agrium

SEED-ROW APPLICATION OF IRON SULFATE TO CORRECT IRON DEFICIENCY IN CORN

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

Summary

Iron deficient-soil is a common problem facing many producers in western Kansas. In 2000, 72 lbs/a iron sulfate ($FeSO_4$) monohydrate placed with the seed at planting increased average corn yield by 26 bu/a at two of the four small-plot sites in western Kansas. However, similar to 1999, the average yield response was not consistent among sites. All of them had been identified as sites on which crops exhibit Fe deficiency (chlorosis) symptoms.

Introduction

Many soils in southwest Kansas are known to be Fe deficient, and symptoms are displayed in grain sorghum, corn, and soybeans. Previous research in western Nebraska has indicated that Fe deficiency problems can be alleviated by the addition of $FeSO_4$ monohydrate in the seed row. This study was initiated in 1999 with the objectives of determining the correct application rate of $FeSO_4$ monohydrate for corn in southwest Kansas and evaluating the potential for targeted application using precision farming technologies.

Procedures

Small-Plot Experiment

Four irrigated cornfields in southwest Kansas were chosen for Fe deficiency symptoms. Small plots were placed in problematic areas that were known to display Fe chlorosis. In 2000, seven treatments included four rates of $FeSO_4$ monohydrate (0, 24, 48, and 72 lb product/a); one rate of $CaSO_4$ (76 lb product/a); one rate liquid $FeSO_4$ heptahydrate (40 gal/a); and one foliar application of Nortrace HEEDTA chelated Fe. All treatments were replicated four times in a randomized complete block design. The $FeSO_4$ monohydrate was applied directly in the seed slot with Gandy PDM fertilizer boxes, mounted on the planter toolbar. The liquid $FeSO_4$ heptahydrate treatment also was applied in the seed row with a fertilizer pump. The foliar Fe application was applied at approximately the V-4 growth stage. Each plot was four rows wide (30 in. rows) and 40 ft long. The two middle rows of each plot were harvested with a combine to determine yield at sites NW33, SE14, and Finney. At site SW29, each plot was subdivided into four subplots (four rows wide and 10 ft long). This was done in an attempt to identify the cause of the spatial variability in the small plots.

Field-Scale Component

The $FeSO_4$ monohydrate also was applied to strips in three separate fields at a rate of 72 lb product/a. Application strips were positioned to intersect a known Fe-deficient area in the field. These application strips were 120 ft. wide and ran continuously through the field. The $FeSO_4$ monohydrate was applied with Gandy PDM fertilizer boxes mounted on a 12- row planter. It was placed directly in the seed row by running a hose from the Gandy box directly in front of the packer wheels on the planter. Yield in these problematic areas was evaluated using yield monitor data. Yields were compared for rows receiving the Fe application and rows outside the application strip that did not receive Fe. Comparisons were focused on yield data points that were inside the problematic (Fe-deficient) area.

Results

Small-Plot Experiment

In 2000, Fe treatments gave a greater yield when the yield responses from all four sites were averaged (Table 10). The only significant treatment difference occurred at NW33. Yield from the 72 lb rate of $FeSO_4$

monohydrate averaged 30 bu/a greater than yield from the control treatment. Also, at this site, yield from the $FeSO_4$ heptahydrate (liquid) averaged 42 bu/a greater than the control yield. A significant treatment effect was not detected for any of the other sites when evaluated individually. However, at SW29, average yields for the $FeSO_4$ treatments were numerically greater than those of the control by 9-22 bu/a. At Finney Co. and SE 14 in Stevens Co. no significant treatment differences or notable trends were detected.

Detecting a significant treatment effect possibly was made more difficult by the addition of two extra treatments in 2000. Thus, contrasts were used to evaluate the effect of the addition of $FeSO_4$ monohydrate. Considering yield data from both 1999 and 2000, four out of the seven site years resulted in significantly linear increases in grain yield with the addition of $FeSO_4$ monohydrate (Table 11). Specifically, at the four responsive sites, grain yield increased by 35 bu/a with the addition of 72 lb product/a $FeSO_4$ monohydrate (Figure 1).

Even though small-plot soil characteristics were similar (Table 12), within- plot variability of Fe chlorosis probably masked significant treatment effects. Such variability is typical and contributes to the difficulty in developing an appropriate remedy for Fe-deficient soils. With the detailed yield data and soil samples collected from the SW29 small plot, we hope to identify the cause of this variability.

Field-Scale Component

Yield data collected from the Fe application strips indicated that the addition of 72 lb/a of $FeSO_4$ monohydrate resulted in significant increases in grain yield at sites NW33 and SE14 (Table 13). At NW33, grain yield increased by 21 bu/a in the problematic area, and the yield increase was 7 bu/a at SE14. A significant treatment effect was not detected at SW29. The average yields inside and outside the application strip were equal.

The variability associated with Fe deficiency makes it a difficult problem to manage. This research indicated that use of precision farming technologies to alleviate Fe deficiency may be possible. For this to occur, problematic areas of the field that respond to the addition of $FeSO_4$ monohydrate must be distinguished from the nonresponsive areas.

Table 10. Corn yield responses to iron sulfate from small-plot studies, SW Kansas, 1999 and 2000.

	1999				2000				
Treatment	Finney	Scott	SE 14	Avg	Finney	NW33	SE14	SW29	Avg
				- - - - - - - - - - - - - bu/a - - - - - - - - - - - - -					
24 lb/a $FeSO_4$	168	200	195	169	146	136	141	163	147
48 lb/a $FeSO_4$	149	200	194	159	142	136	149	169	149
72 lb/a $FeSO_4$	180	196	204	170	148	146	151	176	155
76 lb/a $CaSO_4$	--	--	--	--	146	135	137	158	144
Liquid $FeSO_4$	--	–	--	--	144	158	148	163	153
Foliar	160	183	197	165	149	115	157	147	142
Control	155	189	177	155	151	116	154	154	144
LSD (0.10)	20	NS*	NS*	10	NS*	32	NS*	NS*	NS*

*not significant for individual field

Table 11. Selected contrasts for small-plot grain yield responses to iron sulfate, SW Kansas.

	1999			2000			
				Pr>F			
Contrast	Finney	Scott	SE14	Finney	NW33	SE14	SW29
Dry Fe (linear)	0.09*	0.50	0.09*	0.58	0.08*	0.88	0.12*
Liquid Fe vs Dry Fe	–	--	--	0.76	0.16	0.83	0.27
Liquid Fe vs Control	--	--	--	0.31	0.01*	0.31	0.86
Foliar vs Control	0.62	0.55	0.17	0.75	0.94	0.62	0.61
Dry Fe vs Foliar Fe	0.50	0.07*	0.94	0.55	0.07*	0.05*	0.06*

*considered significant

Table 12. Selected soil characteristics for small-plot locations in southwestern Kansas.

Site	pH	Bray 1 P	Olsen P	K	Fe	$CaCO_3$%
Non-Responsive Sites		----------------------------	ppm	----------------------------		
Scott, 1999	7.9	7	24	735	3	5.1
SE14, 2000	8.0	2	9	429	3	11.1
Finney, 2000	8.2	8	8	487	2	--
Responsive Sites						
Finney, 1999	8.3	6	6	480	3	4.5
SE14, 1999	8.1	4	10	364	4	10.0
NW33, 2000	8.2	1	10	346	3	10.3
SW29, 2000	8.0	40	33	450	3	2.6

Table 13. Grain yield response to $FeSO_4$ in problematic areas at three sites in SW Kansas.

Site	Treatment	N	Mean	Prob>T
NW33			bu/a	
	Fe	11	166	0.0825
	No Fe	6	145	
SE14				
	Fe	44	148	0.0006
	No Fe	28	142	
SW29				
	Fe	11	164	0.9888
	No Fe	12	164	

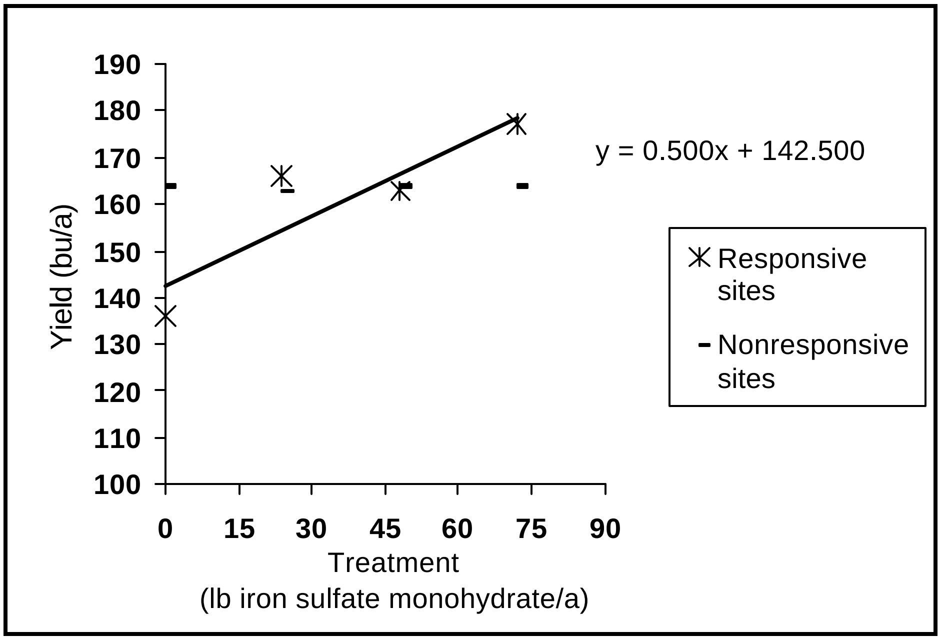


Figure 1. Overall grain yield response to $FeSO_4$ monohydrate at three sites in southwestern Kansas, 1999 and 2000.

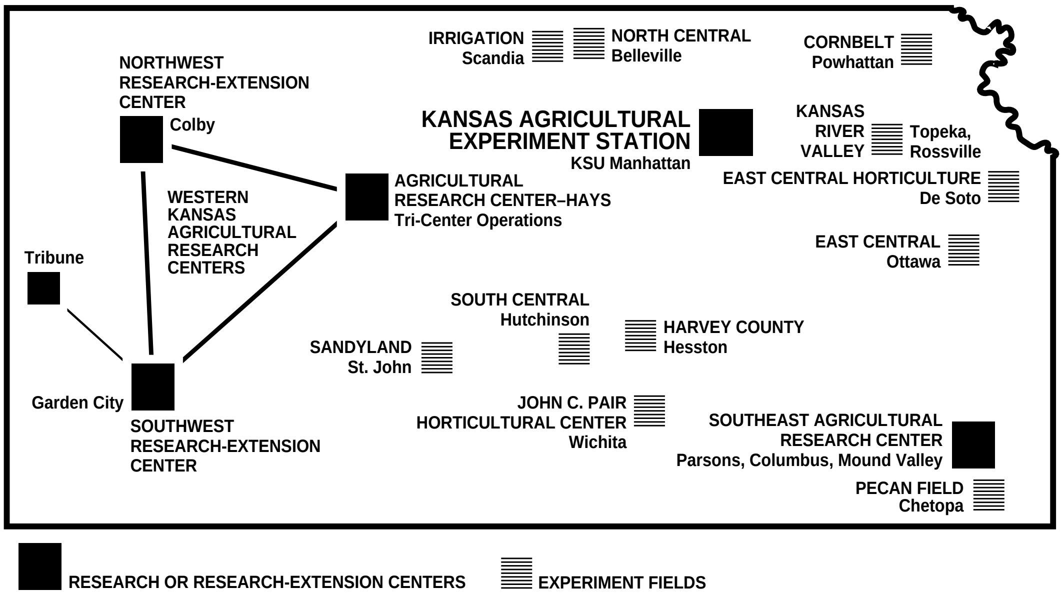
INDEX - 2000 KANSAS FERTILIZER REPORT

CROP

CONTRIBUTORS TO THE REPORT

H.D. Bond, Southwest Area Research Associate, Tribune
M.M. Claassen, Agronomist-in-Charge, Harvey County Experiment Field, Hesston
S. R. Duncan, South Central Area Crops and Soils Specialist, Hutchinson
D.L. Fjell, Extension Specialist, Crop Production, Dept. of Agronomy, KSU, Manhattan
R.J. Gehl, Graduate Student, Dept. of Agronomy, KSU, Manhattan
H.C. George, Miami County Agricultural Extension Agent, Paola
C.B. Godsey, Graduate Student, Dept. of Agronomy, KSU, Manhattan
W. B. Gordon, Agronomist-in-Charge, North Central Kansas Experiment Field, Scandia
K. A. Janssen, Agronomist-in-Charge, East Central Kansas Experiment Field, Ottawa
G. L. Kilgore, Southeast Area Crops and Soils Specialist, Chanute
R. E. Lamond, Extension Specialist, Soil Fertility & Management, Dept. of Agronomy, KSU, Manhattan
L. D. Maddux, Agronomist-in-Charge, Kansas River Valley Experiment Field, Topeka
C.W. Marr, Extension State Leader, Dept. of Horticulture, KSU, Manhattan
V. L. Martin, Agronomist-in-Charge, Sandyland Experiment Field, St. John
T. M. Maxwell, Saline County Agricultural Extension Agent, Salina
J. L. Moyer, Agronomist, Southeast Agricultural Research Center, Parsons
B.J. Niehues, Graduate Student, Dept. of Agronomy, KSU, Manhattan
C.J. Olsen, Graduate Student, Dept. of Agronomy, KSU, Manhattan
G. M. Pierzynski, Soil and Environmental Chemistry Agronomist, Dept. of Agronomy, KSU, Manhattan
K. Rector, Graduate Student, Dept. of Agronomy, Manhattan
A. J. Schlegel, Agronomist, Southwest Research-Extension Center, Tribune
J.P. Schmidt, Soil Fertility Agronomist, Dept. of Agronomy, KSU, Manhattan
G.J. Schwab, Graduate Student, Dept. of Agronomy, KSU, Manhattan
J.P. Shroyer, Extension Specialist, Crop Production, Dept. of Agronomy, KSU, Manhattan
S.A. Staggenborg, Northeast Area Crops and Soils Specialist, Manhattan
D. W. Sweeney, Agronomist, Southeast Agricultural Research Center, Parsons
R.K. Taylor, Extension Specialist, Machinery Systems, Dept. of Biological and Agricultural Engineering, KSU, Manhattan
C. A. Thompson, Agronomist, Agricultural Research Center, Hays
C.R. Thompson, Southwest Area Crops and Soils Specialist, Garden City
D. A. Whitney, Extension State Leader, Agronomy Program, Dept. of Agronomy, KSU, Manhattan

KANSAS STATE UNIVERSITY
STATEWIDE AGRICULTURAL RESEARCH SERVICES



Kansas State University Agricultural Experiment Station and Cooperative Extension Service, Manhattan 66506

SRP 868 January 2001