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TILLAGE, WATER, AND SOIL RESEARCH 1998

REPORT OF PROGRESS 813

Kansas State University
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Introduction

This is the first edition of the Tillage, Water, and Soil Research Report of Progress. This publication is a compilation of data collected by the Kansas State University researchers working in the areas of conservation tillage, soil, and water quality, and water use. Information is included from staff members of the Kansas Agricultural Experiment Station and the Kansas Cooperative Extension service.

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

Special recognition came and thanks are extended to Troy Lynn Eckart for her help in preparation of the manuscript.

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RETURNING CONSERVATION RESERVE PROGRAM LAND TO CROP PRODUCTION[1]

A.J. Schlegel and C.R. Thompson

Summary

The majority of the CRP acres in Kansas are in the western part of the state. The contracts under the initial CRP are expiring and, if not re-enrolled in the CRP program, most of the acreage will be returned to crop production. This study was initiated in 1995 to evaluate best management practices for returning CRP land to crop production. The CRP grasses (mixed species, warm-season grasses) were difficult to control with herbicides alone, and good grass control is essential for optimum crop production. Wheat yields were considerably higher with conventional tillage than with no-till. Removal of the old residue by burning or mowing had no positive effect on wheat yields, but burning tended to increase sorghum yields with conventional tillage. Soil water content was very low following destruction of the CRP grasses. Sufficient time should be allowed between destruction of the CRP grasses and planting of the first crop for accumulation of soil water. Tillage initiation in the fall or spring had little effect on wheat yields, but fall tillage may be preferred because of drier soil conditions. Wheat yields were similar when the first tillage was done with a disk or sweep plow, although the disk was much easier to pull through the sod. Residual soil inorganic N levels are extremely low in CRP land, and supplemental fertilization of 100 lb N/a or more was required for optimal wheat production.

Introduction

In Kansas, 2.9 million acres were enrolled in the Conservation Reserve Program (CRP) which was the third greatest participation by any state. The majority of the CRP acres in Kansas are in the western one-third of the state. Over 90% of the CRP land in Kansas is planted to grass. Based on past experience with an earlier land retirement program, the "Soil Bank", most acres planted to grass will return to crop production. The principal crop grown on land prior to enrollment in the CRP was winter wheat. With the expiration of CRP contracts, many of these acres will return to wheat production.

Procedures

This study was initiated in the spring of 1995 in west central Kansas near Tribune. The study area was enrolled in the CRP and had an established stand of warm-season grasses. Primary species were sideoats grama, little bluestem, blue grama, buffalograss, and switchgrass, which were typical for the area. Soil type was a Richfield silt loam with less than 1% slope. Soil chemical properties were pH of 8.0, organic matter of 1.4%, and inorganic N content of 2 ppm nitrate in the surface 1 ft and less than 1 ppm in the 2 through 6 ft depth. The objectives of the project were to determine best management practices for returning CRP land to crop production. The variables evaluated were residue pretreatment (burn, mow, or leave standing), grass control methods (tillage or chemical control); and N fertilization. The burn treatments were done in late April 1995. The mow treatments were done in early July and late September 1995.

The site was divided into two areas for planting of grain sorghum and winter wheat. For grain sorghum in 1996, the conventional-till plots were offset disked in early July and mid August 1995, followed by sweep plowing in mid September 1995 and early June 1996. The no-till plots received glyphosate (2 qt/a) plus ammonium sulfate and surfactant in mid July and again in late September 1995 followed by glyphosate and 2,4-D (Landmaster BW at 40 oz/a) in early June 1996. Reduced-till treatment combined one application of glyphosate (2 qt/a) plus ammonium sulfate and surfactant in July 1995 and then was offset disked in August and sweep plowed in September 1995 and again prior to sorghum planting on June 11, 1996. Atrazine (0.75 lb/a) was applied on June 19 to all treatments.

The no-till treatment for 1996-97 wheat received three applications of glyphosate (2 qt/a) plus ammonium sulfate and surfactant (mid July 1995, early July 1996, and late August 1996). The conventional- tillage treatment was offset disked twice (July and August 1995) and sweep plowed four times (September 1995, June, July, and September 1996). The reduced-tillage treatment received one application of glyphosate (2 qt/a) plus ammonium sulfate and surfactant in July 1995 and then was offset disked in August 1995 and sweep plowed once in September 1995 and three times in 1996 (June, July, and September). Winter wheat was planted on September 13, 1996 with starter fertilizer (100 lb/a of 11-52-0 applied with the seed). Stand establishment was adequate in all treatments. Fertilizer N (as urea) was applied in December at rates of 50, 100, and 150 lb/a along with a zero N control.

A second wheat study evaluated the time of tillage initiation and the type of tillage. Tillage was initiated either in the fall or spring with either a disk or sweep plow. For spring tillage initiation, the residue was either burned or left standing.

Results And Discussion

Grain sorghum yields in 1996 were greatest in the conventional-tillage treatments and least in the no-till treatments (Table 1). Yields in the tilled treatments tended to be slightly greater when the residue had been burned rather than left standing. In general, grain yields were disappointingly low, possibly because of inadequate N availability.

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

Wheat yields were much better where the grass was controlled with tillage than with herbicides (Table 2). With reduced tillage, grain yields were intermediate between those of conventional and no-till. Neither mowing nor burning the residue prior to tillage/chemical application had much effect on grain yield.

Initiating tillage in the fall after contract expiration or waiting until spring had little effect (Table 3). However, the ground was drier in fall than in spring, which made the tilling easier. Burning the residue before tillage and using a disk or sweep plow for the initial tillage had little effect on wheat yield. However, pulling the sweep plow through the field and maintaining an even depth were extremely difficult.

Nitrogen applications improved grain yield in both wheat studies. Grain yields averaged across all treatments with application of 150 N/a were almost three times greater than yield of the control. All tillage and residue treatment combinations responded to N application. A 5 bu/a yield increase occurred when N rates were increased from 100 to 150 lb/a. Although this would be marginally profitable, it indicates that the system was deficient in N and high supplemental N rates will be required for yields comparable to those from other cropped land.

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[1] We thank Ross Kuttler for providing the land for this study and the Natural Resource Conservation Service, Monsanto, and Farm Journal for also participating.

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Table 1. Grain sorghum yields on former CRP land near Tribune, KS as affected by residue management and tillage, 1996

	Residue Treatment		
Tillage	Mow	Burn	Leave standing
		bu/a	
Conventional till	26	31	24
Reduced till	14	12	-
No-till	8	6	5
$LSD_{0.05}$ 7 bu/a			

Table 2. Winter wheat yields on former CRP land near Tribune, KS as affected by residue management, tillage, and N fertilization, 1997.

		Nitrogen Rate (lb/a)				
Treatment		0	50	100	150	Mean
		bu/a				
Mow	Conv. till	17	29	37	40	31
Mow	Reduced till	10	18	31	30	22
Mow	No-till	8	17	27	32	21
Burn	Conv. till	16	27	34	37	29
Burn	Reduced till	12	23	28	33	24
Burn	No-till	4	15	21	28	17
LS	Conv. till	24	30	36	44	33
LS	No-till	7	16	28	34	21
Mean		13	23	30	35	25
$LSD_{0.05}$	treatment=8, N rate=2					

LS = residue left standing

Table 3. Winter wheat yields on former CRP land near Tribune, KS as affected by time and kind of tillage residue management , and N fertilization, 1997.

	Nitrogen Rate (lb/a)				
Treatment	0	50	100	150	Mean
	bu/a				
Fall - LS					
Disk	10	21	25	31	22
Sweep	8	17	26	31	21
Spring - LS					
Disk	8	18	27	33	22
Sweep	11	18	26	32	22
Spring - Burn					
Disk	9	17	26	34	21
Sweep	10	17	30	34	23
Control	1	6	8	11	6
$LSD_{0.05}$	treatment=10, N rate=2				

Note: The initial tillage treatments listed. All treatments also received a second tillage operation (either disk or sweep), and then all treatments received two sweep plow operations during the summer of 1996. LS = residue left standing.

EFFECTS OF NITROGEN SOURCE AND TILLAGE ON SOIL ORGANIC MATTER

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

Summary

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

Introduction

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

Procedures

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

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

Results and Discussion

The amounts of organic C and N were not affected significantly by 5 years of continuous tillage (Table 1). No-tillage tended to increase TOC and TON and microbial biomass C and N. Potential mineralizable C (C_o) and N (N_o) were not affected by tillage. Nitrogen fertilization significantly increased the amounts of soil organic C and N. Fertilizer did not increase the N-supplying capacity of the soil. Manure significantly increased SOM and the N mineralization potential of the soil. We have found that 30% of the N mineralization potential is made available to the plant. The proportion of total organic C as microbial biomass C was 1.7%, and total organic N as microbial biomass N was 3.3% (Fig. 1). The nonbiomass active pools represented 40 and 19% of total organic C and N, respectively. This is the fraction that provides the mineralized N to the plant.

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

Table 1 Levels of N and C in the soil organic matter: total, microbial biomass, and potential mineralizable C and N.

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

*,** significant at 0.1 and 0.05 probability level. ns = no significant
£[1]Total organic C, £[2]Total organic N
§[1] microbial biomass N, §[2] Microbial biomass C
‡[1] Potential mineralizable N, ‡[2] Potential mineralizable C

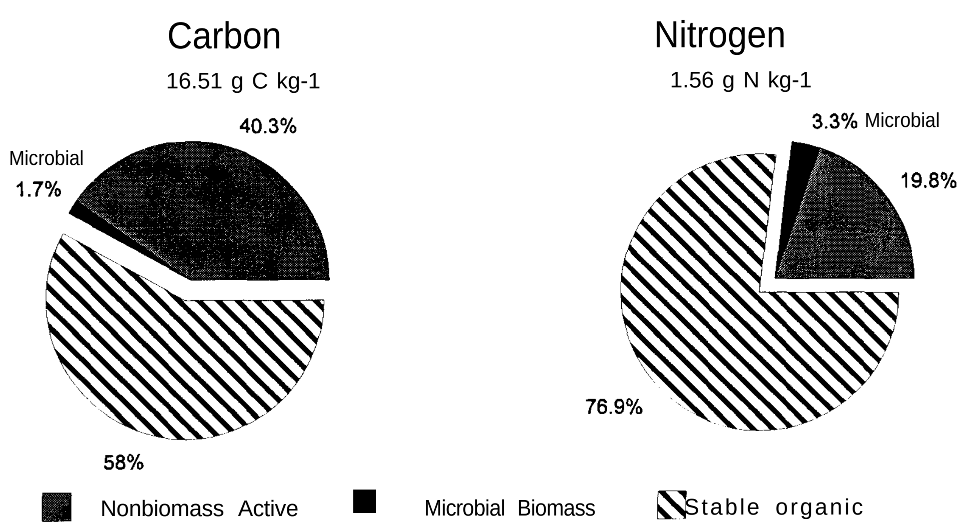

Figure 1. Distribution of C and N pools in Kennebec silt loam, Manhattan, KS.

NO-TILL, DRYLAND, CORN HYBRID PERFORMANCE TESTS

P.M. Evans, K.L. Roozeboom, and A.J. Schlegel

Summary

No-till, nonirrigated, corn hybrid performance tests have been planted for the past 4 years at Colby and Tribune. These tests were initiated to provide unbiased information on hybrid performance under the increasingly popular no-till, nonirrigated, cropping system. A total of 41 private hybrids, entered at the discretion of the marketing companies, has been evaluated in one or more of the seven tests conducted during this time period. Unfortunately, only a few hybrids were included in more than half the tests, making adequate characterization of all hybrids difficult. Of those entered in more than half the tests, several were identified as having stable, above-average yields under no-till, nonirrigated conditions. In general, hybrids in the middle maturity range (107-115 days to black layer) tended to avoid the lowest yields and provided the most opportunities for the highest yields in these tests.

Introduction

Nonirrigated, no-till, corn acreage has been increasing in the High Plains for the past few years. Corn production on nonirrigated acres fits well in rotations designed to increase production and residue levels over those achieved with traditional wheat/fallow rotations. The high residue level associated with this cropping system minimizes soil erosion and moisture loss which are important conservation considerations. Corn performance tests were established at Colby and Tribune to help identify hybrids that perform well under the nonirrigated, no-till, cropping system.

Procedures

Performance tests were initiated in 1994 and have continued through the present. A total of seven tests have been completed in the past 4 years. Table 1 summarizes the agronomic information for each test. The tests were planted on silt loam soils and fertilized with 60 - 180 lb N/a. Planting dates ranged from April 22 to June 15 but were typically near May 1. Silking normally took place in mid or late July. Harvest dates ranged from August 14 to October 18 but were usually in early or mid October.

Three or four hybrids were included as maturity checks and as standards for multiple-year comparisons. The remaining hybrids were entered by private companies on a fee basis. As a result, a different set of hybrids was evaluated in each test. Some entries were entered in several tests, but others may have been included in only one or two tests.

Hybrids were planted in four-row plots, 30 feet in length. Four replications of each hybrid were planted in a randomized complete block design. Plots were planted at 20% over the target stand (15,000 plants/a). Stand counts were taken at the 5-6 leaf stage to determine actual field emergence. The center two rows were harvested for yield. Nearest neighbors analysis was used to adjust for trends within replications when appropriate.

Results and Discussion

Tables 2 and 3 include yield results. Table 2 presents yields as bushels per acre. This is helpful when evaluating the absolute yielding ability of a hybrid or dryland corn in general or under specific conditions. For instance, the 1995 Tribune test produced very low yields after late planting and an early freeze. Table 3 presents yields as percent of the test average. This is useful for relative comparisons of hybrids within a test and across locations and years. Hybrids that consistently performed above average are readily apparent. Bo-Jac 438, Casterline CX1237, and Pioneer 3489 were all entered in four or more tests and yielded above average in each test. Mycogen 2689 was entered in five tests and yielded below average only once. The yields of these above-average hybrids ranged from 36 to 161 bu/a and averaged 91 bu/a over the seven tests. Several other hybrids that were entered in fewer tests appear promising.

Table 4 reveals that the short growing season and stressful growing conditions can result in lower test weights. Test weights averaged only 54 lb/bu even when the very low test weights from the late-planted 1995 Tribune test were excluded. The ability of a given hybrid to produce grain with adequate test weight may be an important consideration when deciding between several high-yielding hybrids.

Days to half silk (Table 5) indicate the relative maturity of a hybrid. The high-yielding hybrids identified above tended to silk at or before the average and were classified as 109- to110-day hybrids by their marketing company. One high-yielding hybrid, Casterline CX1237, was classified as 117 days to black layer but silked at about the same time as the hybrids mentioned above. Few of the fuller season hybrids consistently ranked near the top in yield.

Grain moisture at harvest (Table 6) provides additional information about hybrid maturity and reveals how quickly a hybrid dries down. Most of the above-average hybrids appeared to be drier than the average at harvest, except for Casterline CX1237. The ability to dry down quickly is important on the High Plains where the season often can be cut short by an early freeze.

Table 7 includes lodging notes expressed as % of stalks lodged. Lodging is an inconsistent trait because of the wide range of conditions that can cause it. However, it is generally the best indicator of stalk strength and the ability of a hybrid to withstand the various stresses that contribute to stalk breakage and dropped ears. Even in years when lodging is minimal in the performance tests, relatively higher levels of lodging may be indicators of potential problems under conditions of greater stress. Of course, high winds, snow, or other unusual conditions can overwhelm the ability of even the strongest stalks to remain standing.

Final plant stands are presented in Table 8 as % of the target stand of 15,000 plants/a. Average stands were usually within 10% of the target, except for the 1997 Tribune test when stands were much higher than anticipated. The top-yielding hybrids listed above did not have consistently higher stands but were usually near the target. The one below-average year for Mycogen 2689 may be explained by its poor stands in that test. Final stands may provide information about the ability of a hybrid to emerge under the somewhat demanding conditions associated with the no-till, nonirrigated, cropping system.

Conclusions

No-till, nonirrigated, corn hybrid performance tests provided information useful for identifying potentially superior hybrids for that cropping system. A major limitation of the current set of tests is that so few hybrids are entered in more than two or three tests. Having such a limited amount of information for these hybrids makes evaluation of their suitability for this cropping system difficult.

Table 1. Agronomic management, 1994-1997 no-till, nonirrigated, corn hybrid performance tests.

	1994		1995		1996	1997	
Variable	Colby	Tribune	Colby	Tribune	Colby	Colby	Tribune
Soil type	Keith silt loam	Richfield silt loam	Keith silt loam	Richfield silt loam	Keith silt loam	Keith silt loam	Richfield silt loam
N fert, lb/a	183	60	170	60	110	110	60
Plant date	April 25	April 22	May 13	June 15	April 24	April 29	May 5
Silk dates	July 9 - 18	July 10 - 18	August 2 - 9	August 19 - 25	July 15 - 22	July 21 - 31	July 21 - 29
Harvest date	Sept 29	August 14	Oct 18	Oct 16	Oct 11	Oct 11	Oct 10

Table 2. Yield as bu/a from no-till, nonirrigated, corn hybrid performance tests.

		1994		1995		1996	1997	
Brand	Name	Colby	Tribune	Colby	Tribune	Colby	Colby	Tribune
AGRIPRO	AP 9489	--		--	--	--	86	--
AGRIPRO	AP 9565	--	--	--	--	--	89	--
ASGROW	RX623	142	94	--	--	--	--	--
ASGROW	RX770	149	--	--	--	--	--	--
ASGROW	RX801	--	83	--	--	--	--	--
ASGROW	RX813	--	--	--	--	--	92	164
BO-JAC	135	136	67	--	--	--	--	--
BO-JAC	415	--	--	--	--	--	81	171
BO-JAC	438	148	94	60	40	--	--	--
BO-JAC	544	--	--	--	--	--	88	150
BO-JAC	577	138	102	50	26	--	--	--
BO-JAC	614	--	--	--	--	--	97	170
BO-JAC	629	--	--	39	24	--	--	--
CARGILL	6997	--	--	--	--	--	82	141
CARGILL	7770	--	--	--	--	--	114	169
CASTERLINE	250 EXP	--	--	36	26	--	--	--
CASTERLINE	9586 EXP	--	--	55	34	--	--	--
CASTERLINE	C-1191	126	83	--	--	--	--	--
CASTERLINE	CX1237	161	99	59	36	--	--	--
DEKALB	DK569	--	--	--	--	--	78	--
GREAT LAKES	GL 5715	--	--	--	--	--	90	111
GREAT LAKES	GL 5849	--	--	--	--	--	97	145
HYPERFORMER	HS 9773	--	85	--	--	--	--	--
MYCOGEN	2689	--	--	56	38	127	64	161
MYCOGEN	5480	--	--	--	--	115	--	--
NC+	1585	--	--	--	--	--	--	137
NC+	4616	--	--	--	--	113	72	164
NC+	4880	--	--	--	--	--	89	--
NC+	5037	142	--	50	--	--	--	--
NC+	5445	--	--	--	--	110	--	--
NC+	5514	159	--	53	--	--	--	--
NORTHRUP KING	N7070	--	--	59	--	--	--	--
OTTILIE	2438	140	--	--	--	--	--	--
OTTILIE	2453	--	--	--	--	120	89	142
OTTILIE	2466	--	--	--	--	108	--	--
OTTILIE	5460	--	--	--	--	--	102	160
PIONEER	3489	--	--	70	42	127	98	155
PIONEER	3568	--	--	--	--	111	70	120
STINE	9602	--	--	64	--	--	--	--
STINE	9703	--	--	65	--	--	--	--
STINE	9704	--	--	60	--	--	--	--
MATURITY CHECK	B73 x MO17	118	98	--	--	--	--	--
MATURITY CHECK	F-B73 X N204	--	--	40	20	129	98	146
MATURITY CHECK	FB73rhmXMO17	--	--	55	25	99	86	170
MATURITY CHECK	MID-H-2530	135	82	61	27	124	83	140
MATURITY CHECK	NEBRASKA 611	141	95	--	--	--	--	--
MATURITY CHECK	PIONEER 3162	--	--	--	--	--	90	153
MATURITY CHECK	SHORT-C4327	156	0	61	27	108	--	--
MATURITY CHECK	SHORT - C4111	--	--	--	--	--	71	128
AVERAGES		142	89	55	31	116	87	150
CV(%)		11	9	12	24	9	17	9
LSD(0.05)		23	10	8	9	13	18	16

Table 3. Yield as % of test average from no-till, nonirrigated, corn hybrid performance tests.

		1994		1995		1996	1997	
Brand	Name	Colby	Tribune	Colby	Tribune	Colby	Colby	Tribune
AGRIPRO	AP 9489	--	--	--	--	--	99	--
AGRIPRO	AP 9565	--	--	--	--	--	102	--
ASGROW	RX623	100	106	--	--	--	--	--
ASGROW	RX770	105	--	--	--	--	--	--
ASGROW	RX801	--	93	--	--	--	--	--
ASGROW	RX813	--	--	--	--	--	105	109
BO-JAC	135	96	75	--	--	--	--	--
BO-JAC	415	--	--	--	--	--	92	114
BO-JAC	438	105	106	108	131	--	--	--
BO-JAC	544	--	--	--	--	--	101	100
BO-JAC	577	98	114	90	85	--	--	--
BO-JAC	614	--	--	--	--	--	111	113
BO-JAC	629	--	--	71	77	--	--	--
CARGILL	6997	--	--	--	--	--	95	94
CARGILL	7770	--	--	--	--	--	131	113
CASTERLINE	250 EXP	--	--	65	87	--	--	--
CASTERLINE	9586 EXP	--	--	100	111	--	--	--
CASTERLINE	C-1191	89	94	--	--	--	--	--
CASTERLINE	CX1237	114	111	107	119	--	--	--
DEKALB	DK569	--	--	--	--	--	89	--
GREAT LAKES	GL 5715	--	--	--	--	--	104	74
GREAT LAKES	GL 5849	--	--	--	--	--	111	97
HYPERFORMER	HS 9773	--	95	--	--	--	--	--
MYCOGEN	2689	--	--	101	125	109	74	107
MYCOGEN	5480	--	--	--	--	99	--	--
NC+	1585	--	--	--	--	--	--	91
NC+	4616	--	--	--	--	98	82	110
NC+	4880	--	--	--	--	--	102	--
NC+	5037	100	--	91	--	--	--	--
NC+	5445	--	--	--	--	95	--	--
NC+	5514	112	--	97	--	--	--	--
NORTHRUP KING	N7070	--	--	107	--	--	--	--
OTTILIE	2438	99	--	--	--	--	--	--
OTTILIE	2453	--	--	--	--	104	102	95
OTTILIE	2466	--	--	--	--	93	--	--
OTTILIE	5460	--	--	--	--	--	117	107
PIONEER	3489	--	--	126	139	109	113	103
PIONEER	3568	--	--	--	--	96	80	80
STINE	9602	--	--	116	--	--	--	--
STINE	9703	--	--	119	--	--	--	--
STINE	9704	--	--	108	--	--	--	--
MATURITY CHECK	B73 x MO17	83	110	--	--	--	--	--
MATURITY CHECK	F-B73 X N204	--	--	73	66	111	112	97
MATURITY CHECK	FB73rhmXMO17	--	--	99	82	85	99	113
MATURITY CHECK	MID-H-2530	95	92	110	89	107	95	93
MATURITY CHECK	NEBRASKA 611	99	107	--	--	--	--	--
MATURITY CHECK	PIONEER 3162	--	--	--	--	--	103	102
MATURITY CHECK	SHORT-C4327	110	--	111	90	93	--	--
MATURITY CHECK	SHORT - C4111	--	--	--	--	--	81	86
AVERAGES		100	100	100	100	100	100	100
CV(%)		11	10	12	24	9	17	9
LSD(0.05)		16	11	15	29	11	20	11

Table 4. Test weight as lb/bu from no-till, nonirrigated, corn hybrid performance tests.

		1994		1995		1996	1997	
Brand	Name	Colby	Tribune	Colby	Tribune	Colby	Colby	Tribune
AGRIPRO	AP 9489	--	--	--	--	--	58	--
AGRIPRO	AP 9565	--	--	--	--	--	57	--
ASGROW	RX623	58	56	--	--	--	--	--
ASGROW	RX770	55	--	--	--	--	--	--
ASGROW	RX801	--	51	--	--	--	--	--
ASGROW	RX813	--	--	--	--	--	57	53
BO-JAC	135	57	54	--	--	--	--	--
BO-JAC	415	--	--	--	--	--	54	52
BO-JAC	438	55	53	56	45	--	--	--
BO-JAC	544	--	--	--	--	--	54	50
BO-JAC	577	53	51	54	40	--	--	--
BO-JAC	614	--	--	--	--	--	54	51
BO-JAC	629	--	--	53	40	--	--	--
CARGILL	6997	--	--	--	--	--	57	53
CARGILL	7770	--	--	--	--	--	57	54
CASTERLINE	250 EXP	--	--	52	43	--	--	--
CASTERLINE	9586 EXP	--	--	56	43	--	--	--
CASTERLINE	C-1191	57	54	--	--	--	--	--
CASTERLINE	CX1237	53	50	54	45	--	--	--
DEKALB	DK569	--	--	--	--	--	56	--
GREAT LAKES	GL 5715	--	--	--	--	--	59	58
GREAT LAKES	GL 5849	--	--	--	--	--	58	55
HYPERFORMER	HS 9773	--	51	--	--	--	--	--
MYCOGEN	2689	--	--	55	49	55	57	54
MYCOGEN	5480	--	--	--	--	57	--	--
NC+	1585	--	--	--	--	--	--	57
NC+	4616	--	--	--	--	53	57	54
NC+	4880	--	--	--	--	--	56	--
NC+	5037	53	--	55	--	--	--	--
NC+	5445	--	--	--	--	52	--	--
NC+	5514	54	--	52	--	--	--	--
NORTHRUP KING	N7070	--	--	55	--	--	--	--
OTTILIE	2438	56	--	--	--	--	--	--
OTTILIE	2453	--	--	--	--	55	58	56
OTTILIE	2466	--	--	--	--	53	--	--
OTTILIE	5460	--	--	--	--	--	56	53
PIONEER	3489	--	--	56	50	56	59	57
PIONEER	3568	--	--	--	--	56	58	57
STINE	9602	--	--	56	--	--	--	--
STINE	9703	--	--	55	--	--	--	--
STINE	9704	--	--	55	--	--	--	--
MATURITY CHECK	B73 x MO17	52	49	--	--	--	--	--
MATURITY CHECK	F-B73 X N204	--	--	55	47	53	56	51
MATURITY CHECK	FB73rhmXMO17	--	--	53	41	52	54	52
MATURITY CHECK	MID-H-2530	55	54	55	47	53	55	54
MATURITY CHECK	NEBRASKA 611	53	50	--	--	--	--	--
MATURITY CHECK	PIONEER 3162	--	--	--	--	--	57	54
MATURITY CHECK	SHORT-C4327	56	54	55	52	55	--	--
MATURITY CHECK	SHORT - C4111	--	--	--	--	--	58	58
AVERAGES		55	52	54	45	54	57	54
CV(%)		3	1	2	4	2	1	1
LSD(0.05)		2	1	1	2	1	1	1

Table 5. Days to half silk from no-till, nonirrigated, corn hybrid performance tests.

		1994		1995		1996	1997	
Brand	Name	Colby	Tribune	Colby	Tribune	Colby	Colby	Tribune
AGRIPRO	AP 9489	--	--	--	--	--	83	--
AGRIPRO	AP 9565	--	--	--	--	--	87	--
ASGROW	RX623	78	79	--	--	--	--	--
ASGROW	RX770	78	--	--	--	--	--	--
ASGROW	RX801	--	87	--	--	--	--	--
ASGROW	RX813	--	--	--	--	--	92	83
BO-JAC	135	75	81	--	--	--	--	--
BO-JAC	415	--	--	--	--	--	93	84
BO-JAC	438	79	83	82	66	--	--	--
BO-JAC	544	--	--	--	--	--	92	84
BO-JAC	577	84	85	87	70	--	--	--
BO-JAC	614	--	--	--	--	--	93	85
BO-JAC	629	--	--	87	71	--	--	--
CARGILL	6997	--	--	--	--	--	86	78
CARGILL	7770	--	--	--	--	--	90	82
CASTERLINE	250 EXP	--	--	88	70	--	--	--
CASTERLINE	9586 EXP	--	--	84	67	--	--	--
CASTERLINE	C-1191	80	82	--	--	--	--	--
CASTERLINE	CX1237	81	86	84	67	--	--	--
DEKALB	DK569	--	--	--	--	--	87	--
GREAT LAKES	GL 5715	--	--	--	--	--	86	77
GREAT LAKES	GL 5849	--	--	--	--	--	87	80
HYPERFORMER	HS 9773	--	87	--	--	--	--	--
MYCOGEN	2689	--	--	82	65	87	88	80
MYCOGEN	5480	--	--	--	--	83	--	--
NC+	1585	--	--	--	--	--	--	78
NC+	4616	--	--	--	--	87	89	81
NC+	4880	--	--	--	--	--	89	--
NC+	5037	83	--	86	--	--	--	--
NC+	5445	--	--	--	--	89	--	--
NC+	5514	82	--	84	--	--	--	--
NORTHRUP KING	N7070	--	--	83	--	--	--	--
OTTILIE	2438	80	--	--	--	--	--	--
OTTILIE	2453	--	--	--	--	83	84	77
OTTILIE	2466	--	--	--	--	84	--	--
OTTILIE	5460	--	--	--	--	--	90	79
PIONEER	3489	--	--	81	66	87	87	80
PIONEER	3568	--	--	--	--	82	85	77
STINE	9602	--	--	82	--	--	--	--
STINE	9703	--	--	81	--	--	--	--
STINE	9704	--	--	83	--	--	--	--
MATURITY CHECK	B73 x MO17	82	87	--	--	--	--	--
MATURITY CHECK	F-B73 X N204	--	--	85	71	89	91	83
MATURITY CHECK	FB73rhmXMO17	--	--	84	68	89	92	82
MATURITY CHECK	MID-H-2530	81	83	83	68	88	91	81
MATURITY CHECK	NEBRASKA 611	82	84	--	--	--	--	--
MATURITY CHECK	PIONEER 3162	--	--	--	--	--	90	81
MATURITY CHECK	SHORT-C4327	79	82	81	66	85	--	--
MATURITY CHECK	SHORT - C4111	--	--	--	--	--	86	78
AVERAGES		80	84	84	68	86	89	80
CV(%)		2	1	1	2	1	2	1
LSD(0.05)		2	1	1	2	1	2	1

Table 6. Grain moisture % at harvest from no-till, nonirrigated, corn hybrid performance tests.

		1994		1995		1996	1997	
Brand	Name	Colby	Tribune	Colby	Tribune	Colby	Colby	Tribune
AGRIPRO	AP 9489	--	--	--	--	--	14	--
AGRIPRO	AP 9565	--	--	--	--	--	16	--
ASGROW	RX623	13	15	--	--	--	--	--
ASGROW	RX770	17	--	--	--	--	--	--
ASGROW	RX801	--	28	--	--	--	--	--
ASGROW	RX813	--	--	--	--	--	17	24
BO-JAC	135	13	16	--	--	--	--	--
BO-JAC	415	--	--	--	--	--	17	23
BO-JAC	438	17	18	16	--	--	--	--
BO-JAC	544	--	--	--	--	--	16	26
BO-JAC	577	21	24	18	--	--	--	--
BO-JAC	614	--	--	--	--	--	18	28
BO-JAC	629	--	--	25	--	--	--	--
CARGILL	6997	--	--	--	--	--	16	21
CARGILL	7770	--	--	--	--	--	17	23
CASTERLINE	250 EXP	--	--	24	--	--	--	--
CASTERLINE	9586 EXP	--	--	16	--	--	--	--
CASTERLINE	C-1191	18	21	--	--	--	--	--
CASTERLINE	CX1237	19	31	20	--	--	--	--
DEKALB	DK569	--	--	--	--	--	14	--
GREAT LAKES	GL 5715	--	--	--	--	--	14	17
GREAT LAKES	GL 5849	--	--	--	--	--	15	20
HYPERFORMER	HS 9773	--	25	--	--	--	--	--
MYCOGEN	2689	--	--	16	--	18	16	22
MYCOGEN	5480	--	--	--	--	16	--	--
NC+	1585	--	--	--	--	--	--	15
NC+	4616	--	--	--	--	20	16	21
NC+	4880	--	--	--	--	--	17	--
NC+	5037	19	--	17	--	--	--	--
NC+	5445	--	--	--	--	22	--	--
NC+	5514	18	--	19	--	--	--	--
NORTHRUP KING	N7070	--	--	16	--	--	--	--
OTTILIE	2438	16	--	--	--	--	--	--
OTTILIE	2453	--	--	--	--	17	14	18
OTTILIE	2466	--	--	--	--	21	--	--
OTTILIE	5460	--	--	--	--	--	16	23
PIONEER	3489	--	--	14	--	17	14	18
PIONEER	3568	--	--	--	--	16	14	17
STINE	9602	--	--	14	--	--	--	--
STINE	9703	--	--	12	--	--	--	--
STINE	9704	--	--	14	--	--	--	--
MATURITY CHECK	B73 x MO17	20	29	--	--	--	--	--
MATURITY CHECK	F-B73 X N204	--	--	20	--	22	18	29
MATURITY CHECK	FB73rhmXMO17	--	--	22	--	24	18	27
MATURITY CHECK	MID-H-2530	13	16	14	--	18	14	20
MATURITY CHECK	NEBRASKA 611	18	24	--	--	--	--	--
MATURITY CHECK	PIONEER 3162	--	--	--	--	--	19	25
MATURITY CHECK	SHORT-C4327	16	17	13	--	18	--	--
MATURITY CHECK	SHORT - C4111	--	--	--	--	--	14	17
AVERAGES		17	22	17	--	19	16	22
CV(%)		13	8	8	--	9	5	5
LSD(0.05)		3	2	2	--	2	1	1

Table 7. Percent lodged stalks at harvest from no-till, nonirrigated, corn hybrid performance tests.

		1994		1995		1996	1997	
Brand	Name	Colby	Tribune	Colby	Tribune	Colby	Colby	Tribune
AGRIPRO	AP 9489	--	--	--	--	--	2	--
AGRIPRO	AP 9565	--	--	--	--	--	7	--
ASGROW	RX623	0	--	--	--	--	--	--
ASGROW	RX770	0	--	--	--	--	--	--
ASGROW	RX801	--	--	--	--	--	--	--
ASGROW	RX813	--	--	--	--	--	6	0
BO-JAC	135	0	--	--	--	--	--	--
BO-JAC	415	--	--	--	--	--	5	4
BO-JAC	438	0	--	6	30	--	--	--
BO-JAC	544	--	--	--	--	--	11	1
BO-JAC	577	3	--	2	26	--	--	--
BO-JAC	614	--	--	--	--	--	14	0
BO-JAC	629	--	--	2	23	--	--	--
CARGILL	6997	--	--	--	--	--	11	2
CARGILL	7770	--	--	--	--	--	1	3
CASTERLINE	250 EXP	--	--	3	9	--	--	--
CASTERLINE	9586 EXP	--	--	4	11	--	--	--
CASTERLINE	C-1191	0	--	--	--	--	--	--
CASTERLINE	CX1237	0	--	1	15	--	--	--
DEKALB	DK569	--	--	--	--	--	5	--
GREAT LAKES	GL 5715	--	--	--	--	--	2	0
GREAT LAKES	GL 5849	--	--	--	--	--	5	0
HYPERFORMER	HS 9773	--	--	--	--	--	--	--
MYCOGEN	2689	--	--	3	30	1	10	0
MYCOGEN	5480	--	--	--	--	1	--	--
NC+	1585	--	--	--	--	--	--	1
NC+	4616	--	--	--	--	1	5	0
NC+	4880	--	--	--	--	--	7	--
NC+	5037	1	--	1	--	--	--	--
NC+	5445	--	--	--	--	0	--	--
NC+	5514	0	--	5	--	--	--	--
NORTHRUP KING	N7070	--	--	1	--	--	--	--
OTTILIE	2438	1	--	--	--	--	--	--
OTTILIE	2453	--	--	--	--	0	5	0
OTTILIE	2466	--	--	--	--	0	--	--
OTTILIE	5460	--	--	--	--	--	11	13
PIONEER	3489	--	--	6	16	0	3	2
PIONEER	3568	--	--	--	--	0	2	0
STINE	9602	--	--	2	--	--	--	--
STINE	9703	--	--	5	--	--	--	--
STINE	9704	--	--	4	--	--	--	--
MATURITY CHECK	B73 x MO17	0	--	--	--	--	--	--
MATURITY CHECK	F-B73 X N204	--	--	10	41	2	10	2
MATURITY CHECK	FB73rhmXMO17	--	--	7	36	2	16	2
MATURITY CHECK	MID-H-2530	2	--	2	29	0	4	0
MATURITY CHECK	NEBRASKA 611	1	--	--	--	--	--	--
MATURITY CHECK	PIONEER 3162	--	--	--	--	--	4	1
MATURITY CHECK	SHORT-C4327	0	--	2	18	0	--	--
MATURITY CHECK	SHORT - C4111	--	--	--	--	--	7	3
AVERAGES		1	--	4	24	1	7	2
CV(%)		367	--	83	38	232	72	118
LSD(0.05)		3	--	4	11	NS	6	2

Table 8. Plant stands (% of target - 15,000/a) from no-till, nonirrigated, corn hybrid performance tests.

		1994		1995		1996	1997	
Brand	Name	Colby	Tribune	Colby	Tribune	Colby	Colby	Tribune
AGRIPRO	AP 9489	--	--	--	--	--	90	--
AGRIPRO	AP 9565	--	--	--	--	--	97	--
ASGROW	RX623	104	97	--	--	--	--	--
ASGROW	RX770	101	--	--	--	--	--	--
ASGROW	RX801	--	99	--	--	--	--	--
ASGROW	RX813	--	--	--	--	--	96	119
BO-JAC	135	106	98	--	--	--	--	--
BO-JAC	415	--	--	--	--	--	92	124
BO-JAC	438	97	99	97	96	--	--	--
BO-JAC	544	--	--	--	--	--	103	113
BO-JAC	577	101	100	98	107	--	--	--
BO-JAC	614	--	--	--	--	--	86	125
BO-JAC	629	--	--	95	108	--	--	--
CARGILL	6997	--	--	--	--	--	98	121
CARGILL	7770	--	--	--	--	--	91	124
CASTERLINE	250 EXP	--	--	100	97	--	--	--
CASTERLINE	9586 EXP	--	--	97	104	--	--	--
CASTERLINE	C-1191	88	78	--	--	--	--	--
CASTERLINE	CX1237	109	101	88	105	--	--	--
DEKALB	DK569	--	--	--	--	--	85	--
GREAT LAKES	GL 5715	--	--	--	--	--	97	110
GREAT LAKES	GL 5849	--	--	--	--	--	92	120
HYPERFORMER	HS 9773	--	97	--	--	--	--	--
MYCOGEN	2689	--	--	94	99	95	82	124
MYCOGEN	5480	--	--	--	--	85	--	--
NC+	1585	--	--	--	--	--	--	123
NC+	4616	--	--	--	--	89	86	129
NC+	4880	--	--	--	--	--	93	--
NC+	5037	107	--	99	--	--	--	--
NC+	5445	--	--	--	--	78	--	--
NC+	5514	103	--	100	--	--	--	--
NORTHRUP KING	N7070	--	--	100	--	--	--	--
OTTILIE	2438	100	--	--	--	--	--	--
OTTILIE	2453	--	--	--	--	95	99	119
OTTILIE	2466	--	--	--	--	86	--	--
OTTILIE	5460	--	--	--	--	--	92	121
PIONEER	3489	--	--	94	93	94	96	128
PIONEER	3568	--	--	--	--	87	89	109
STINE	9602	--	--	97	--	--	--	--
STINE	9703	--	--	96	--	--	--	--
STINE	9704	--	--	103	--	--	--	--
MATURITY CHECK	B73 x MO17	106	96	--	--	--	--	--
MATURITY CHECK	F-B73 X N204	--	--	96	105	85	94	116
MATURITY CHECK	FB73rhmXMO17	--	--	100	112	85	95	119
MATURITY CHECK	MID-H-2530	106	97	97	114	94	98	117
MATURITY CHECK	NEBRASKA 611	100	98	--	--	--	--	--
MATURITY CHECK	PIONEER 3162	--	--	--	--	--	88	128
MATURITY CHECK	SHORT-C4327	101	95	101	101	88	--	--
MATURITY CHECK	SHORT - C4111	--	--	--	--	--	93	118
AVERAGES		102	96	97	103	88	93	120
CV(%)		8	4	5	8	11	10	6
LSD(0.05)		10	5	NS	9	NS	NS	9

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

D.W. Sweeney and D.J. Jardine

Summary

In 1996, poor stands, poor growing conditions, and insect damage may have masked early-season corn response to tillage, nitrogen (N) placement, and N rate. Under these adverse conditions, early-season corn appeared to respond more to changes in N rate than tillage or N placement. However, in 1997 with more favorable growing conditions, tillage, N placement, and N rate all affected corn yield. Ridge tillage, broadcast N applications, and 120 lb N/a were management levels that resulted in the greatest yields.

Introduction

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

Procedures

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

Results and Discussion

Very dry conditions from fall 1995 to spring 1996 prevented previous grain sorghum stalks from decomposing, resulting in poor planting conditions and substandard corn plant stands. Average yield of short-season corn in 1996 was low (<50 bu/a) and may have been partially due to poor stands, poor growing conditions, and insect damage. Grain yield was not affected by tillage or N placement (data not shown). Yield increased with increasing N rate to 60 lb/a but was not increased with higher N rates to 120 lb/a. In 1997, planting conditions were more favorable. Ridge tillage resulted in more than 20 bu/a greater yield than no tillage (Table 1).

Broadcast N produced significantly greater yields than dribble applications, with yields from knife placement being intermediate. Each additional fertilizer N increment of 30 lb/a resulted in a 15-20 bu/a increase in corn yield.

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

Table 1. Effects of tillage, N placement, and N rate on yield of short-season corn in 1997, southeast Kansas.

Treatment	Yield
	bu/a
Tillage	
Ridge	96.2
No tillage	75.4
$LSD_{(0.10)}$	20.5
Placement	
Broadcast	89
Dribble	82.2
Knife	86.2
$LSD_{(0.05)}$	5.3
N Rate (lb/a)	
0	47.7
30	67.1
60	87.9
90	105.7
120	120.6
$LSD_{(0.05)}$	6.8

EFFECTS OF PLANTING DATE, IRRIGATION RATE, AND TILLAGE ON PRODUCTION OF VARIED-MATURITY CORN

V.L. Martin, G.A. Clark, R.L. Vanderlip, and D.L. Fjell

Summary

This multiyear study was designed to determine the effects of no-tillage vs. conventional tillage, hybrid maturity, planting date, level of irrigation inputs, and their interactions on yield, water usage, and economic return of corn produced on the sandy soils of south central Kansas. Results from 1996 and 1997 showed that mid-May planting significantly decreased yield, and increasing irrigation levels increased yields slightly in 1996. No-tillage decreased yields in 1996 but had no significant effect in 1997. The earlier-maturing hybrids were competitive with the later-maturing hybrid. Generally, yields decreased with increasing maturity and later planting date. The latter variable had the most significant impact on yield. The data so far indicate that no-tillage is a viable alternative, even for earlier planting.

Introduction

The nine county area of the Great Bend Prairie accounts for 13% of the state's corn crop, primarily under irrigation. The sandy soils and climate of the region in combination with irrigation result in average yields of 150 to 160 bu/a in most years.

Although irrigated corn production has been an economic boom for Kansas, it has not been without problems, especially in western Kansas where aquifer depletion is a concern. Vast improvements have been and are being made in irrigation technology, but many questions remain.

The aquifer in the region of the Great Bend Prairie has not experienced such a dramatic depletion. The structure of the aquifer and the soils have allowed for lesser decreases, and periods of high rainfall result in significant recharge of the aquifer in much of the region. Thus, groundwater can be viewed as a renewable resource, with careful management of irrigation and agronomic systems to maximize water use efficiency.

An additional factor compounds the view of sustainable irrigation, especially in the Rattlesnake Creek Watershed where the Quivira National Wildlife Refuge is located and from which it receives its water. Although groundwater can be viewed as renewable for irrigators, the lowering of water table levels associated with irrigation has diminished stream flow into Quivira and resulted in less water than needed to maintain the refuge during periods of below normal precipitation. Thus, strategies are needed not only for managing irrigation to sustain itself but also for helping ensure adequate surface waters to maintain the Quivira Refuge. Switching hardware on pivots and using irrigation scheduling should help decrease irrigation inputs; however, the selection of proper agronomic practices (planting date, tillage, hybrid maturity) is potentially as important in reducing water usage.

The primary objective of this study is to determine the effect of no-tillage vs. conventional tillage, hybrid maturity, planting date, level of irrigation inputs, and their interactions on the yield, water usage, and economic return for corn produced on the sandy soils of SC Kansas. This is a multiyear study involving the departments of Agronomy, Biological and Agricultural Engineering, and Agricultural Economics. Support for this project has been provided by the Kansas Corn Commission.

Procedures

The soil for this study is predominantly loamy fine sand with some fine sandy loam cropped to grain sorghum in 1994 and 1995 and wheat in the prior 2 years. Fertilization consisted of 100 lb/a 18-46-0 applied each year in March. Nitrogen was applied as granular urea (46-0-0). The application was split into two 125 lb N/a increments at preplant and V6. All planting dates received 1 qt/a Dual II + 1 pt/a Atrazine preemergence followed by 1 qt/a Marksman postemergence. The first two planting dates also received 2/3 oz/a Accent to control crabgrass and volunteer grain sorghum in 1996. All plots were planted at 34,000 seeds/a with a John Deere no-till row planter.

Treatments were as follows:

1. Main plots–Planting date: April 16, May 2, May 15 (1996); April 21, May 5, May 19 (1997).
2. Split plots–Irrigation level: 120% (0.92 in./application), 100% (0.78 in./application), 80% (0.62 in./application).

3. Sub-subplots - Tillage: no-tillage, chisel-disk

4. Final split plots - Hybrid: early (Pioneer 3563-103 day), medium (DeKalb DK 591-109 Day), Pioneer 3162-118 day)

Plots were arranged in a randomized complete block with four replications. Irrigation level differences were achieved by replacing the overhead system with drops, pressure regulators, and three different nozzles.

Measurements include final plant population, dates of 50% emergence and silking, grain yield, and grain moisture.

Results and Discussion

As will be noted when examining the data presented, part of the site where the medium irrigation rate was applied contained large variations in corn yield, most likely related to soil compaction. The differences were larger for 1996 than 1997. This resulted in wide yield variation and lower than expected yields.

Precipitation was much above normal during both growing seasons (Table 1) and resulted in the need for less irrigation than normal (Table 2). The maximum differences in water applied were 2 inches in 1996 and 2.1 inches in 1997.

Mid-May planting significantly decreased yield overall. Increasing irrigation levels slightly increased yield in 1996 but had no effect in 1997 (Fig. 1). No-tillage resulted in lower yields in 1996 but had no significant effect in 1997 (Fig. 1). The 108- and 103-day hybrids were competitive with the 118-day hybrid (Fig. 1).

Overall, the two early hybrid yields were unaffected by planting date, and yields decreased with increasing maturity and later planting date (Fig. 2). Yields of all three hybrid were lower overall with the no-tillage system in 1996 and unaffected by tillage in 1997 (Fig. 3).

Planting date has been the single most important variable in determining yield. As planting is moved later, yields decrease significantly. Overall, eliminating tillage has not resulted in significant yield reductions. Earlier maturing hybrids are competitive with a full-season hybrid and are relatively less sensitive to planting date. Finally, during these two mild, wet years, decreasing irrigation did not adversely affect yields.

The data are starting to indicate that no-tillage is a viable alternative to conventional tillage operations, even for earlier planting. If this trend holds during more typical conditions of rainfall and temperature during summer, potential exists to save significant amounts of irrigation water while maintaining crop residue.

Table 1.Precipitation for the Dryland Quarter at the Sandyland Experiment Field, St. John, KS.

Month	16-Year Average	1996	1997
	- - - - - - - inches - - - - - - -		
January	0.56	0.2	0
February	0.9	0.1	2.5
March	2	2.1	0.1
April	2.6	2.4	3
May	3.9	4.8	1.9
June	4.1	3.8	5.1
July	2.7	4.4	3.7
August	2.9	5.1	5.3
September	2.2	4.9	2.5
October	1.9	1.4	4
November	1.2	2.8	0.5
December	1.1	0	2.6
Annual Total	25.9	31.8	31

Table 2. Numbers and amounts of irrigations in corn study, 1996-1997, St. John, KS.

	Irrigation	Irrigation Rate and Total (inches)		
Planting Date	Number	80%	100%	120%
35170	9	3.7	4	4.3
35186	11	4.3	4.8	5.3
35199	12	4.6	5.2	5.7
35540	7	4.3	5.5	6.4
35554	7	4.3	5.5	6.4
35568	7	4.3	5.5	6.4

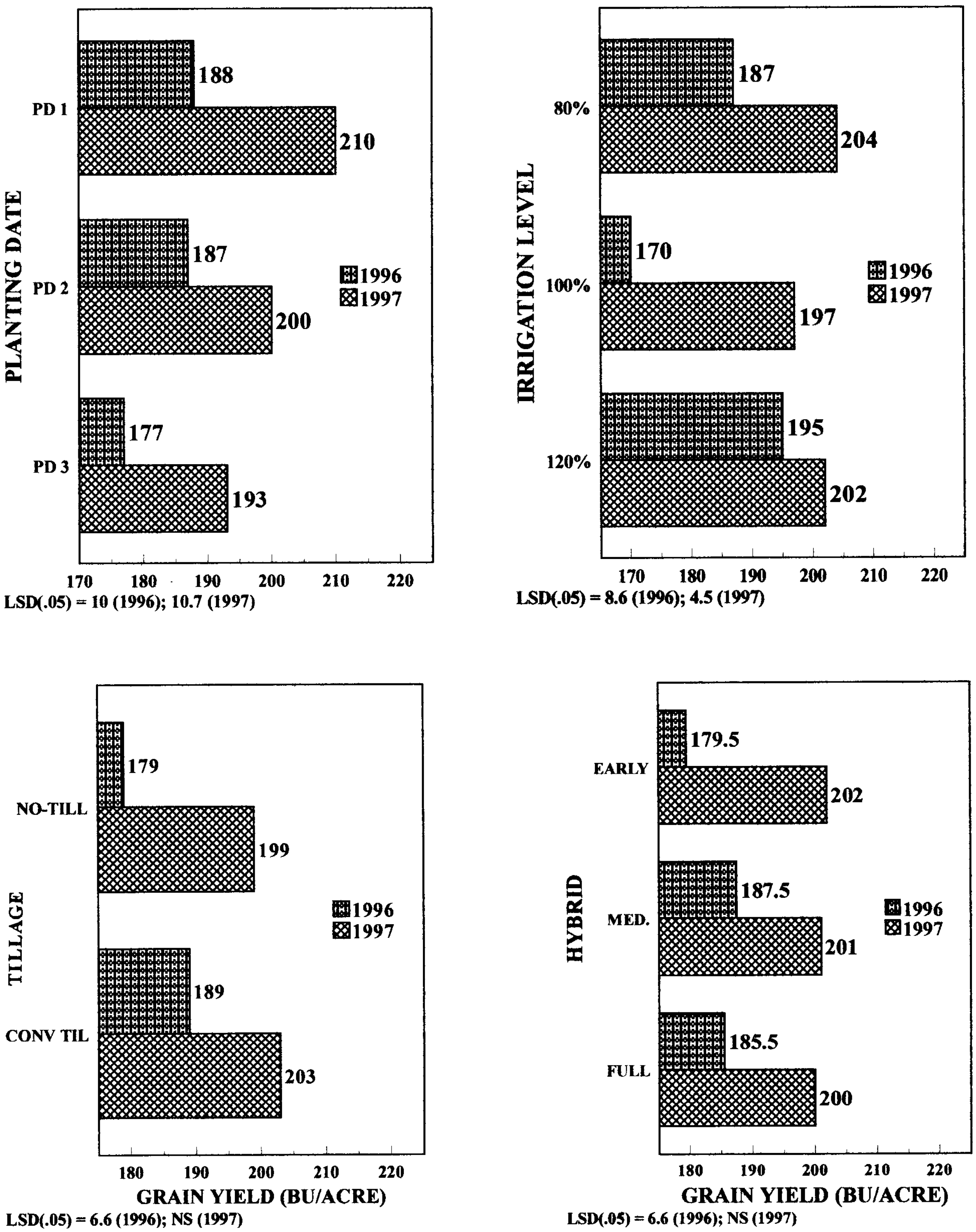


Figure 1. Effects of planting date, irrigation level, tillage, and hybrid maturity on corn grain yield, St. John, KS. 1996.

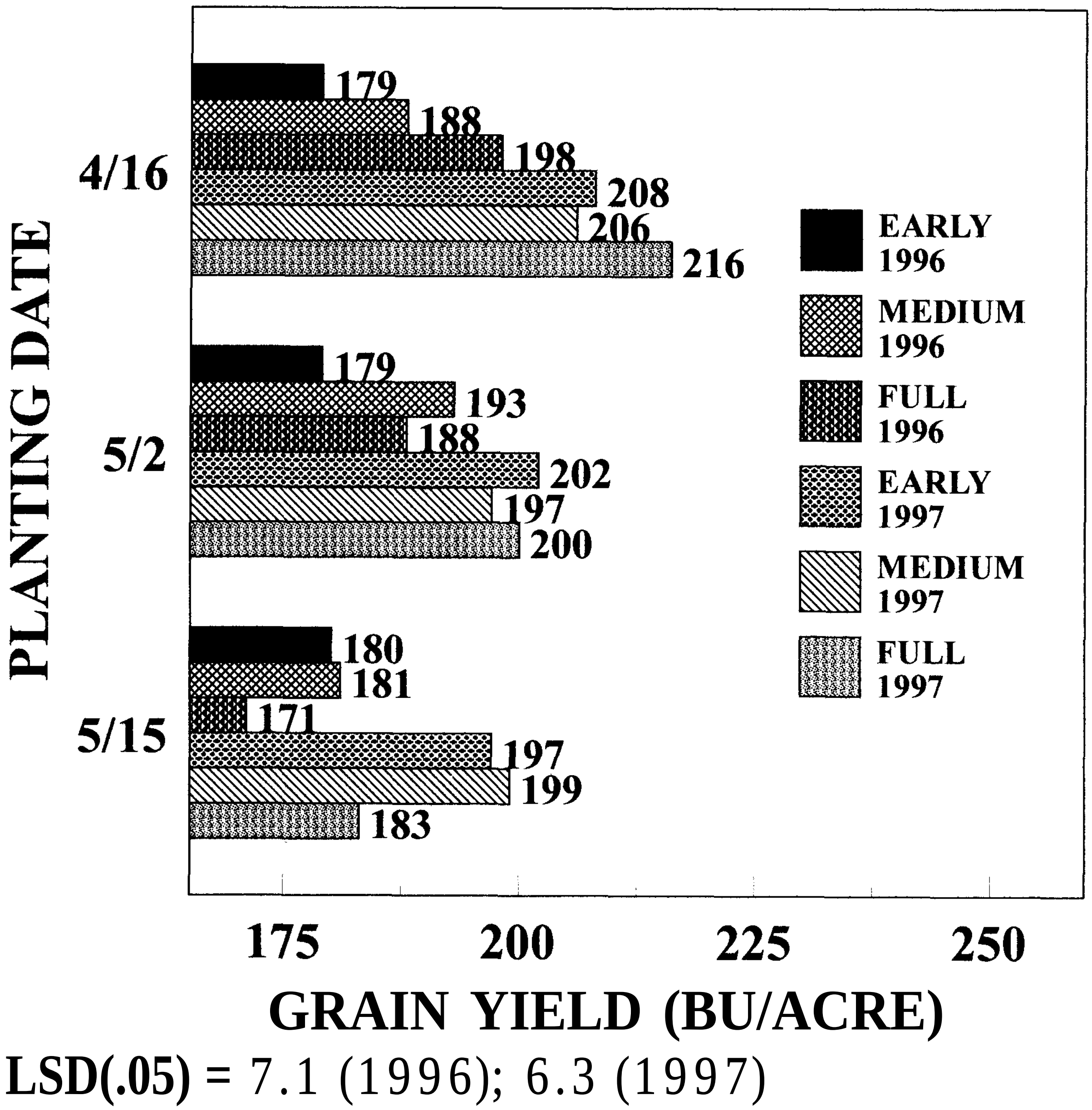
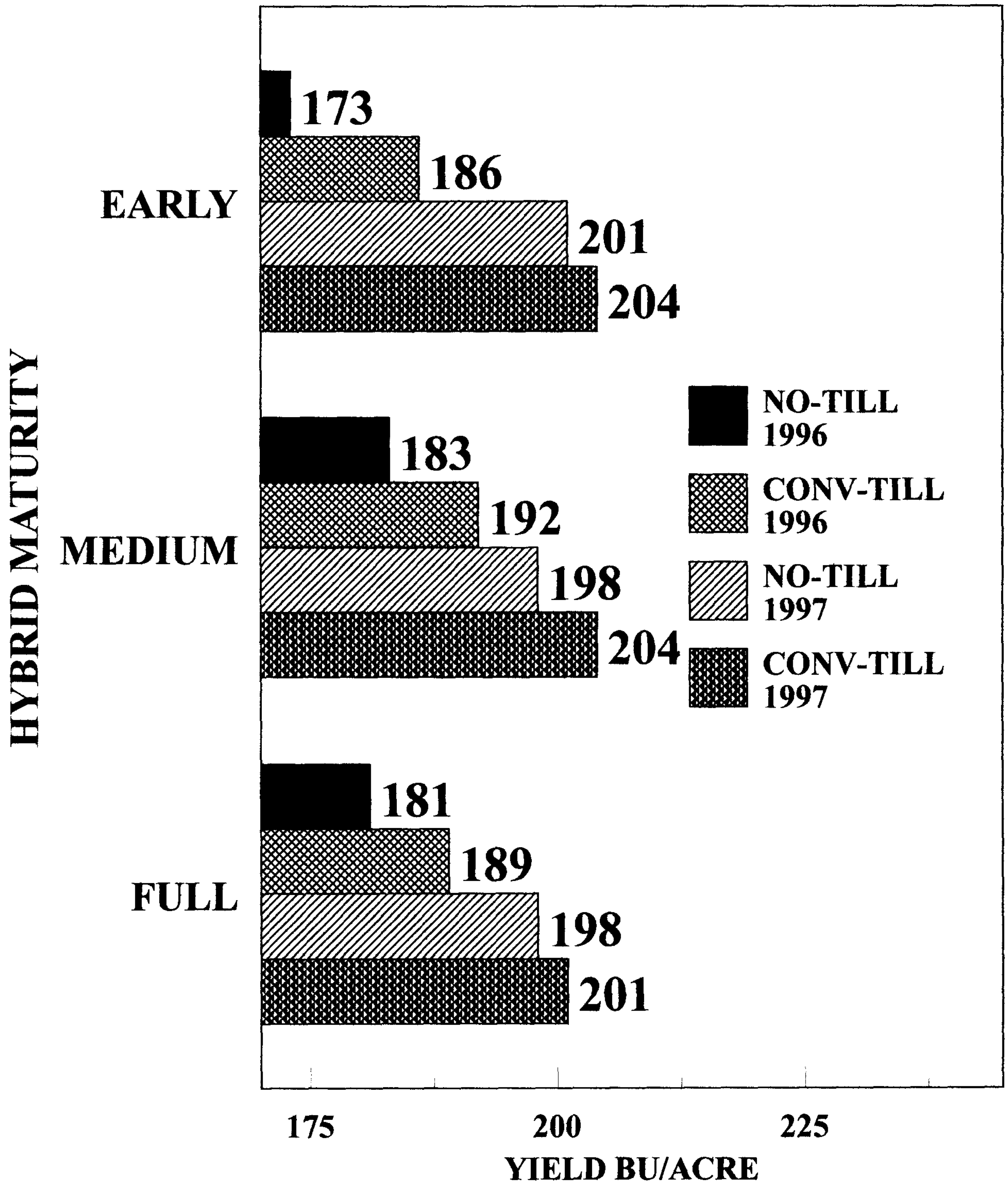


Figure 2. Effect of hybrid x planting date interaction on yield of irrigated corn, St. John, KS, 1996-97.



LSD(.05) = NS (1996 & 1997)

Figure 3. Effect of hybrid x tillage interaction on yield of irrigated corn, St. John, KS, 1996.

NITROGEN - TILLAGE SORGHUM STUDY

R.E. Lamond, D.A. Whitney, G.M. Pierzynski, D.D. Roberson, and M.A. Davied

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 30, 60, 120 lbs N/a. In 1995, the placement variable was dropped, and N sources (ammonium nitrate, urea, and AgrotaiN) were evaluated. All N was surface broadcast. The tillage systems used were no-till or conventional. Results in 1997 indicate that flag leaf N concentrations and grain yields were higher with conventional tillage. The lower yields in no-till were due primarily to the poor performance of urea. Where ammonium nitrate or AgrotaiN was used, no-till yields were similar to those with conventional tillage. Apparently, N efficiency was reduced by volatilization losses from urea under no-till conditions. Yields were good in 1997 and were increased by N application up to 120 lb/a.

Introduction

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

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

Procedures

Three N sources at three rates each (30, 60, 120 lb N/a) were used. These were ammonium nitrate, urea, and AgrotaiN. All materials were surface broadcast. The two tillage methods used were conventional tillage, consisting of fall chisel and field cultivation before planting, and no tillage. The N was incorporated in the conventional-tillage system. A check plot without N was included in each tillage method. The treatments were replicated three times and arranged in a split-plot design with tillage as the main plot treatment and N source by N rate as the subplot treatments. Planting (Pioneer 8505), flag leaf sampling, and harvesting were done on May 19, July 24, and October 1, respectively.

Results and Discussion

Results are summarized in Table 1. Grain yield, flag leaf N, and grain protein were increased significantly by N application up to 120 lbs. Ammonium nitrate and AgrotaiN produced higher leaf N concentrations and grain yields than urea, particularly in no-till. Apparently, N loss via volatilization was significant from urea. As in years past, flag leaf N concentrations were significantly higher for conventional tillage compared to no-till. In 1997, grain yields with conventional tillage were higher than those with no-till because of the poor performance of urea in no-till. When AgrotaiN or ammonium nitrate was used as a N source in no-till, yields were very similar to those with conventional tillage. Maturity was delayed in no-till plots compared to conventional-tillage in 1997.

Table 1. Nitrogen management and tillage effects on continuous grain sorghum, North Agronomy Farm, Manhattan, KS, 1997.

N Rate	N Source	Tillage	Leaf N	Grain Yield	Grain Protein
lb/a			%	bu/a	%
0	--	No-till	1.27	31	6.1
30	Am. nit.	No-till	1.62	61	5.4
60	Am. nit.	No-till	1.91	74	6.5
120	Am. nit.	No-till	2.49	97	8.3
30	Urea	No-till	1.54	44	6.3
60	Urea	No-till	1.96	63	6.2
120	Urea	No-till	2.2	86	7.6
30	AgrotaiN	No-till	1.85	52	6.4
60	AgrotaiN	No-till	1.87	73	6.4
120	AgrotaiN	No-till	2.46	98	8.1
0	--	Conventional	1.61	35	5.9
30	Am. nit.	Conventional	1.75	59	6
60	Am. nit.	Conventional	2.31	88	7.5
120	Am. nit.	Conventional	2.55	94	9.6
30	Urea	Conventional	2.04	67	5.9
60	Urea	Conventional	2.03	85	6.7
120	Urea	Conventional	2.53	91	10.2
30	AgrotaiN	Conventional	1.83	60	6.5
60	AgrotaiN	Conventional	2.18	85	7.2
120	AgrotaiN	Conventional	2.4	91	9.9
LSD (0.10)			0.31	10	0.9
Mean Values:					
N	30		1.77	57	6.1
Rate	60		2.04	78	6.8
	120		2.44	93	9
LSD (0.10)			0.13	4	0.4
N	Am. nit.		2.11	78	7.2
Source	Urea		2.05	73	7.1
	AgrotaiN		2.1	77	7.4
LSD (0.10)			NS	4	NS
Tillage	No-till		2	72	6.8
	Conventional		2.18	80	7.7
LSD (0.10)			0.11	3	0.3

EFFECTS OF TERMINATION DATE OF HAIRY VETCH, WINTER, COVER CROP AND NITROGEN RATES ON GRAIN SORGHUM[1]

M.M. Claassen

Summary

Mid-September planting of hairy vetch following winter wheat provided an average ground cover of 63% by late fall. Dry matter yields of 2.66 tons/a and 2.99 tons/a were produced by vetch at termination on April 25 (DOT 1) and May 14 (DOT 2), respectively. The corresponding potential N contributions were 147 lb/a and 188 lb/a for the succeeding sorghum crop. In a season with ample rainfall, delayed vetch termination tended to result in higher sorghum leaf N levels and grain yields, but treatment differences were not always significant. The positive effects of DOT 1 and DOT 2 vetch on the yield of sorghum without fertilizer N were equivalent to about 70 lb/a and 89 lb/a of N, respectively. Sorghum yields after vetch averaged over N rates were 6 to 10 bu/a more than yields without a preceding cover crop.

Introduction

Interest in the use of legume, winter, cover crops has been rekindled by concerns for soil and water conservation, dependency on commercial fertilizer, and maintenance of soil quality. Hairy vetch is a good candidate for the cover crop role because it can be established in the fall when water use is reduced, it has winter hardiness, and it can fix substantial nitrogen (N). This experiment was conducted to investigate the effect of hairy vetch and N fertilizer rates on the supply of N to the succeeding grain sorghum crop and to assess sorghum yield response when the vetch is terminated at different time intervals ahead of sorghum planting.

Procedures

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

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

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

Results and Discussion

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

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

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[1]This project was funded partially by a USDA (SARE) grant through the Kansas Rural Center.

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

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

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

Table 2. Effects of hairy vetch termination date and N rate on nutrient uptake, maturity, and yield of grain sorghum, Harvey County Experiment Field, Hesston, KS, 1997.

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

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

EFFECTS OF TERMINATION METHOD FOR HAIRY VETCH, WINTER, COVER CROP; TILLAGE; AND NITROGEN RATE ON GRAIN SORGHUM

M.M. Claassen

Summary

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

Introduction

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

Procedures

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

Results and Discussion

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

Table 1. Effects of hairy vetch cover crop, tillage, and N rate on grain sorghum - Hesston, KS, 1997.

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

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

IMPACT OF CONSERVATION COMPLIANCE ON NITROGEN RECOMMENDATIONS FOR DRYLAND WINTER WHEAT[1]

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

Summary

Many producers in western Kansas are required to have at least 30% crop residue cover to be in compliance with their conservation farm plan. Research was initiated in 1993 to determine whether increased crop residue affects the N fertilizer requirement for dryland winter wheat. Six sites in west central KS were selected each year for 4 years in cooperation with area farmers. The typical cropping system was wheat-fallow using reduced-tillage practices. All sites were on silt loam soil that ranged in residual soil nitrate content from less than 1 ppm (0- to 24-inch sample) to about 10 ppm. Surface residue cover at wheat planting averaged 30%. Fluid N (28% N as urea-ammonium nitrate solution) was spoke injected in September and March and surface broadcast in January and March at five rates (20, 40, 60, 80, and 100 lb N/a), and a zero N control was included. The typical production practice was planting TAM 107 winter wheat in mid-September with a hoe drill on 12-inch row spacing. Grain protein increased linearly with increased N rates. Grain protein was over 13% when 100 lb N/a was injected. Nitrogen use efficiency decreased with increased N rates but was consistently higher with injected rather than broadcast N. The residue/yield ratio was 125 lb residue/bu of yield or higher, which is greater than the commonly used value of 100 lb. The soil N test was a good indicator of yield response to N fertilization. Grain yields were greater when N was injected rather than broadcast. The time of N application had little effect on grain yield. Increased surface residue cover increased grain yields. The economic optimal N rate was greater when N was injected than broadcast at all soil N levels because of higher yield levels. Compared to the current KSU N recommendation model, these data suggest that N rates should be increased by 15 to 30 lb/a to optimize dryland wheat profitability in reduced- tillage systems. This indicates that conservation compliance increases N fertilizer requirements for dryland winter wheat but also increases yield potential, which provides a positive impact on profitability.

Introduction

The N fertilizer recommendations for winter wheat in western Kansas were developed under clean tillage systems. In these systems, most of the residue is incorporated into the soil, leaving a seedbed with minimal residue cover. Approximately 70% of the land planted to wheat in Kansas is classified as highly erodible (USDA-NRCS). To control erosion on these lands, over 50% of the NRCS conservation farm plans include a requirement for at least 30% surface residue cover. Reduced tillage practices conserve surface residue, which reduces erosion potential and enhances soil water storage. However, crop residue on the soil surface can reduce the efficiency of N fertilizer utilization by plants especially with broadcast applications. This research was initiated to determine whether adoption of reduced-tillage systems to satisfy conservation compliance requirements has changed the N fertilizer requirements for dryland winter wheat in western Kansas.

Procedures

Six sites in west central Kansas were selected each year for 4 years (1994-1997) in cooperation with area farmers. The typical cropping system was wheat-fallow using reduced- tillage practices. Residual soil N samples were taken in August prior to wheat planting. All sites were on silt loam soil that varied in residual soil nitrate content from less than 1 ppm (0- to 24-inch sample) to slightly over 10 ppm. Residual soil N in lb/a was calculated as soil N in ppm times 7.5. Soil P levels were adequate at all sites. Surface residue cover at wheat planting averaged 30% (as measured by the line transect method) and ranged from less than 10% to greater than 50%.

Fluid N (28% N as urea-ammonium nitrate solution) was spoke injected in the fall (September) and spring (March) and broadcast in the winter (January) and spring at five rates (20, 40, 60, 80, and 100 lb N/a) and a zero N control was included. The spoke applicator had 8 spokewheels (manufactured by Spoke Injector Systems, Inc., Lemberg, Saskatchewan) on 15-inch spacing (total width of 10 ft). The fluid N was delivered using a compressed air system mounted on the applicator. The spokewheels placed the fluid N about 2 to 3 inches into the soil with minimal disturbance. The broadcast applications were made using a 10-ft spray boom with 15-inch nozzle spacing and compressed-air delivery of fluid N. Plot size was 10 by 40 ft. The experimental design was a randomized complete block replicated four times.

The farmer cooperators were responsible for tillage and planting operations, so some variation occurred. Typical production practices consisted of planting in mid September with a hoe drill on 12-inch row spacing. The most common variety planted was TAM 107.

The center of each plot was combine harvested, and grain yields were adjusted to 12.5% moisture. The wheat at several sites were damaged by climatic conditions (hail and a spring freeze), so only 13 site-years (out of 24 established) were included in the analysis. Aboveground biomass was collected from each plot at harvest, dried, and weighed. Residue was calculated as aboveground biomass minus grain yield. The residue/yield ratio was calculated as residue (lb/a) divided by grain yield (bu/a). Grain samples collected at harvest were analyzed for grain N content. Grain protein was calculated as grain N times 5.7. Apparent N use efficiency was calculated as the increase in grain N in treatments receiving fertilizer N over that of the control treatment divided by the fertilizer N rate. The results for residue, grain protein, and apparent N use efficiency information are presented as averages across all site-years.

A regression equation was fitted to the yield information from all of the site-years with the independent variables were total N (residual soil nitrate + fertilizer N), surface residue cover, and method of application. The production function is:

$$\text{grain yield} = 12.2 + 0.2949N - 0.0012N^2 + 0.0654\ I\_N + 0.0234\ B\_N + 0.6299\ R - 0.0076\ R^2 + \text{year variables}$$

where N= residual soil nitrate + fertilizer N, lb/a
I_N = injected N, lb/a
` B_N = broadcast N, lb/a
R = surface residue cover at planting, %
with an R^2 of 0.3837.

The time of N application had little effect on grain yield and was not included in the regression equation.

When the yield function was estimated, the economic optimal N rates were calculated by equating the first derivative of the yield function to the fertilizer N/wheat price ratio and solving for N using the following two equations.

For broadcast N:

$$\text{economic optimal N rate (lb/a)} = [(P_n/P_w) - 0.3183 + (0.0024 \times \text{soil N})] / -0.0024$$

For injected N:

$$\text{economic optimal N rate (lb/a)} = [(P_n/P_w) - 0.3603 + (0.0024 \times \text{soil N})] / -0.0024$$

where P_n = price of N, \$/lb
P_w = price of wheat, \$/bu
soil N = residual soil nitrate, lb/a.

The economic optimal N rate depends on the price of N, the price of wheat, and residual soil nitrate content.

Results and Discussion

Grain protein levels increased linearly with increased N rates (Fig. 1). Grain protein was greater with N fertilizer injected than broadcast and was over 13% when N fertilizer was injected at the higher rates. Apparent N use efficiency also was greater when fertilizer N was injected rather than broadcast (Fig. 2). Apparent N use efficiency also was over 30% with N injected in the spring at the lowest N rates and tended to decrease as N rates increased.

The general assumption used for estimating residue production by wheat has been 100 lb residue/bu of yield. In this study, the ratio was 180 lb of residue/bu of grain yield without N and decreased to about 125 lb residue/bu of yield at the higher N rates (Fig. 3). This shows that residue production, even with a semi-dwarf wheat like TAM 107, is greater than has been assumed. Fertilizer placement and time of application had little effect on the residue/yield ratio.

Grain yield was increased in most site-years by N fertilization. The amount of yield increase varied across site-years but increased with decreases in residual soil nitrate levels, indicating the value of a soil residual N test. At low levels of residual soil nitrate, the relative yield of the control treatment was generally less than 50% of the yield of the highest yielding treatment. The time of N application had little effect on grain yield. Grain yields were similar from broadcast applications made in the winter and spring, indicating that topdress N applications can be made over a several month period without affecting grain yield.

Grain yields were also similar for injected N treatments made in the fall and spring, indicating that little N loss occurred from fall applications. Grain yields tended to increase with increased amounts of surface residue cover, possibly reflecting better water storage with higher residue amounts.

The yield production function was used to estimate yield responses to fertilizer N at various levels of residual soil N (Figs, 4 and 5). Grain yields were greater with injected rather than broadcast N at all residual soil N levels. The yield increase from injected N over broadcast N was not compensated for by increased rates of broadcast N. Grain yields increased up to the highest N rate when residual soil nitrate was below 50 lb/a indicating that the study should have included N rates greater than 100 lb N/a. However, that is much greater than the rate of about 40 lb N/a commonly applied by producers in this region.

The economic optimal fertilizer N rate was calculated for broadcast and injected N over a range of residual soil N levels (Fig. 6). In our example, we assumed a wheat price of $3.25/bu and N cost of $0.25/lb. Fertilizer N recommendations are greater with injected than broadcast applied N. Initially, this seems to contradict the higher N use efficiency with injected compared to broadcast N; however, the higher yield potential with injected N results in a higher fertilizer N recommendation. These N recommendation models were compared to the current KSU model which in its simplest form is:

$$\text{N rec (lb/acre)} = (\text{YG} \times 1.75) - \text{soil N}$$

where

N rec = fertilizer N recommended, lb/a
YG = yield goal, bu/a
soil N = residual soil nitrate, lb/a.

A yield goal of 50 bu/a was assumed for our comparison. With these assumptions, the KSU model recommends 88 lb fertilizer N/a when residual soil N is zero compared to recommendations of 102 lb/a for broadcast N and 119 lb/a for injected N using the models developed from this study. This suggests that fertilizer N should be applied at higher than currently recommended rates in reduced-tillage systems to optimize economic returns. The increases in N fertilizer recommendations would be about 15 lb/a for broadcast and 30 lb/a for injected applications. Thus, the impact of conservation compliance is an increase in N fertilizer requirements along with an increase in yield potential.

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

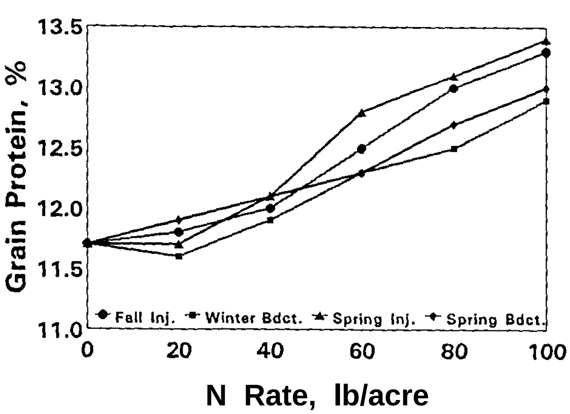

Figure 1. Wheat grain protein response to N fertilization (average of 13 site-years), west central Kansas.

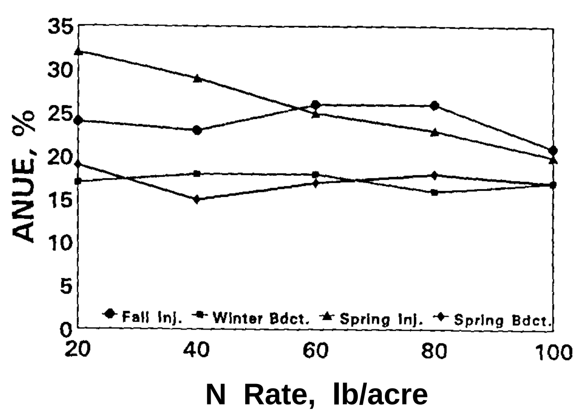

Figure 2. Apparent N use efficiency of wheat as affected by N fertilization (average of 13 site-years), west central Kansas.

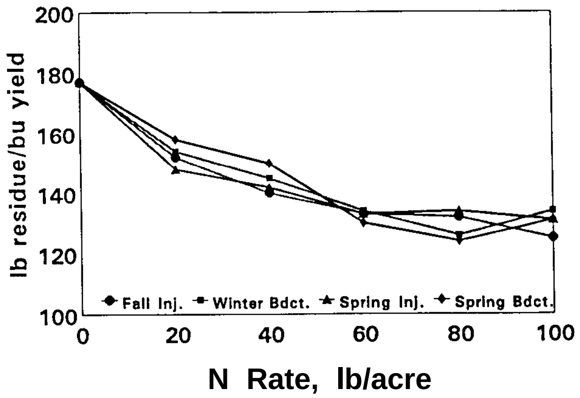

Figure 3. The relationship of residue production and wheat grain yield as affected by N fertilization (average of 13 site-years), west central Kansas.

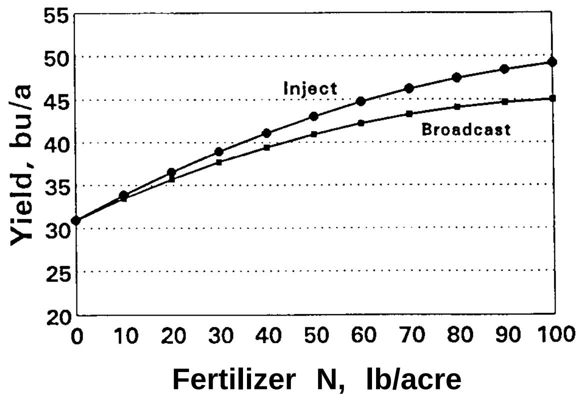

Figure 4. Estimated wheat yields for injected and broadcast N fertilizer applications with residual soil nitrate content of 25 lb/a, west central Kansas.

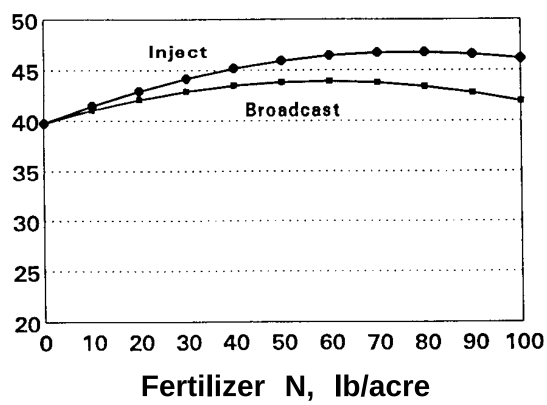

Figure 5. Estimated wheat yields for injected and broadcast N fertilizer applications with residual soil nitrate content of 75 lb/a, west central Kansas.

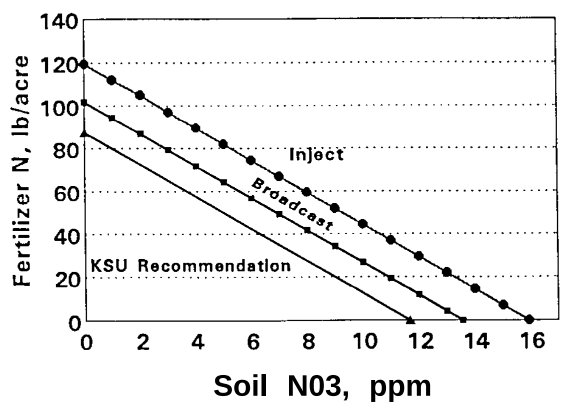

Figure 6. The economic optimal N rates for broadcast and injected fertilizer (assuming wheat at $3.25/bu and N at $0.25/lb) in west central Kansas compared to the current KSU N recommendation model (yield goal of 50 bu/a).

EFFECTS OF PLANT POPULATION AND WEED CONTROL METHOD ON NO-TILL SUNFLOWER

C.R. Thompson and A.J. Schlegel

Summary

Herbicide options in sunflower are limited, especially in reduced- or no-till cropping systems. Increasing populations from 12,000 to 30,000 plants/a increased weed control from 0 to 50% in sunflowers not treated with herbicides. Increasing plant population and cultivation gave 60 to 85% control of kochia and pigweed species, respectively. Prowl in combination with high sunflower population gave excellent weed control. Weeds were present in low densities, 1 to 2 plants/sq yd.

Introduction

Research has shown that a winter wheat - summer row crop - fallow rotation is more profitable and less risky than wheat - fallow, especially when the summer crop is planted no-till into winter wheat stubble. Good weed control is essential to optimize production and profits. No-till enhances efficiency of moisture storage by increasing snow movement and reducing run-off and evaporation from the soil. No-till planting of sunflower provides additional challenges, because most registered herbicides require incorporation. Currently, no postemergence broadcast herbicides are available for broadleaf weed control in sunflower.

Row crop cultivation can reduce weed competition and increase yield potential, but moisture loss following cultivation can be a concern. If cultivation has no effect on yields, then the moisture loss in a cultivated system is likely less than the moisture utilized by weeds in a noncultivated system.

This experiment evaluated weed control efficacy and sunflower yields as influenced by planting rate and various combinations of row crop cultivation and herbicide treatments.

Procedures

Experiments were established in 1995 and 1997 in west central Kansas near Tribune in no-till wheat stubble. Treatments were arranged as a split plot with main plots being plant population by herbicide and subplots being cultivation. All treatments were replicated four times. Roundup at 0.75 lb ai/a was broadcast applied to the entire area at planting. Sunflowers were planted at 12,000; 18,000; 24,000; and 30,000 seeds/a in 30-inch rows with a 4-row Model 7300 John Deere planter on June 21, 1995 and May 31, 1997. Sunflower hybrids were Mycogen 685 in 1995 and Pioneer 6300 in 1997. Prowl at 1.25 lb ai/a was applied preemergence on the appropriate treatments. Poast + methylated seed oil at 0.2 lb ai + 2 pints/a were applied postemergence on July 27, 1995 and July 4, 1997 on the appropriate treatments. Cultivation treatments were implemented on July 17, 1995 and June 30, 1997. Weed control was evaluated visually prior to sunflower harvest. Plants in the two center rows of four-row plots were counted and harvested for yield on October 19, 1995 and September 19, 1997.

Results and Discussion

Sunflower population was affected by planting rate in both years (Table 1). The difference between the intended and actual populations increased as the intended population increased. Only at the 12,000 seed rate was the intended population met. Cultivation did not affect sunflower plant population. Herbicide treatment affected final population in 1997. Sunflower population was slightly lower with the Prowl treatment than with the no-herbicide treatment; however, the difference would be insignificant to sunflower yield or weed control.

In 1997, the best yields were attained with sunflowers planted at 12,000 seeds/a (Table 2). In both years, yields tended to decrease as sunflower population increased; however, differences were quite small. Sunflower populations should be sufficiently high to prevent the development of large sunflower heads (greater than 8 inches in diameter), which generally have more potential for lodging and increased harvest losses.

Weed densities were low and did not affect sunflower yield (Table 2). Therefore, neither cultivation nor herbicide treatment affected sunflower yield in either year of the experiment. Moisture loss from cultivation was not sufficient to reduce sunflower yields. If weed densities had been greater, cultivation likely would have provided an increase in sunflower yield. In 1995, yields were very low because of dry weather conditions and bird damage.

Kochia can be a serious and difficult weed to control in sunflower. In these experiments, kochia densities were 1 to 2 plants/sq yd. Cultivation alone provided approximately 50% kochia control (Table 3). In 1995, kochia control was best at the 30,000 sunflower seed rate when evaluations were averaged over herbicide and cultivation treatments. The higher planting rates and cultivation provided better kochia control within the no-herbicide plots, and Prowl provided excellent kochia control regardless of the sunflower planting rate or cultivation treatment. Poast is a grass herbicide and had no effect on kochia or the pigweed species.

Responses of redroot and tumble pigweeds were similar to those observed with kochia (Table 4). Cultivation alone controlled pigweed about 50%. The addition of Prowl into the system increased pigweed control to greater than 80% in 1995 and greater than 90% in 1997. Timely rainfall after application resulted in excellent pigweed control in 1997, regardless of population or cultivation. In 1995, cultivation was required to attain 90% pigweed control.

Table 1. Sunflower population response to planting rate and method of weed control, west central Kansas.

	No Herbicide			Prowl			Prowl/Poast			
Planting	Cultivated			Cultivated			Cultivated			Overall
Rate	No	Yes	Avg	No	Yes	Avg	No	Yes	Avg	Avg
seeds/a	plants/a ÷ 1000									
1995										
12000	12.0	11.6	11.8	11.0	13.3	12.2	11.4	12.8	12.1	12.0
18000	17.6	17.0	17.3	14.6	15.4	15.0	16.2	18.0	17.1	16.5
24000	18.7	19.7	19.2	21.4	20.1	20.8	19.2	19.5	19.3	19.8
30000	23.2	24.2	23.7	23.3	24.7	24.0	23.3	24.8	24.0	23.9
Average	17.9	18.1	18.0	17.6	18.4	18.0	17.5	18.8	18.2	
	No-cult avg = 17.7			Cult avg = 18.4						
LSD (0.05)	Planting rate = 2.1		All other interactions were not significant.							
1997										
12000	14.4	13.9	14.1	14.7	11.6	13.1	12.6	12.8	12.7	13.3
18000	16.4	16.9	16.7	15.1	15.7	15.4	16.2	15.6	15.9	16.0
24000	19.0	19.7	19.4	17.1	16.9	17.0	21.0	18.9	20	18.8
30000	21.1	21.4	21.3	19.8	18.9	19.3	19.8	21.6	20.7	20.4
Average	17.8	18.0	17.9	16.7	15.8	16.3	17.4	17.2	17.3	
	No-cult avg = 17.3			Cult avg = 17.0						
LSD (0.05)	Planting rate = 1.1		Herbicide = 1.0		All other interactions were not significant.					

Table 2. Sunflower seed yield response to planting rate and method of weed control, west central Kansas.

	No Herbicide			Prowl			Prowl/Poast			
Planting	Cultivated			Cultivated			Cultivated			Overall
Rate	No	Yes	Avg	No	Yes	Avg	No	Yes	Avg	Avg
seeds/a	lbs/a, at 10% moisture									
1995										
12000	410	250	330	290	240	270	440	290	360	320
18,000	220	400	310	290	280	290	350	250	300	300
24,000	200	180	180	440	330	380	230	280	250	280
30,000	270	410	340	290	240	260	260	180	220	280
Avg	270	310	290	330	270	300	320	250	280	
	No-cult avg = 310			Cult avg = 280						
LSD (0.05)	No interactions were significant.									
1997										
12000	2070	2100	2090	2510	2290	2400	2320	2290	2300	2260
18,000	2050	2140	2090	2190	2060	2130	2490	2230	2360	2190
24000	1700	2080	1890	2240	2140	2190	2060	2010	2030	2040
30000	2050	2000	2020	1800	1650	1720	2010	2230	2120	1960
Avg	1970	2080	2020	2180	2030	2110	2220	2190	2200	
	No-cult avg = 2120			Cult avg = 2100						
LSD (0.05)	Planting rate = 200			All other interactions were not significant.						

Table 3. Kochia response to sunflower planting rate and method of weed control, west central Kansas.

	No Herbicide			Prowl			Prowl/Poast			
Planting	Cultivated			Cultivated			Cultivated			Overall
Rate	No	Yes	Avg	No	Yes	Avg	No	Yes	Avg	Avg
seeds/a	% control									
1995										
12,000	0	40	20	61	97	79	87	91	89	63
18000	29	70	49	53	95	74	70	96	83	69
24,000	13	62	37	62	94	78	67	99	81	65
30,000	28	83	55	89	97	93	76	99	88	79
Average	17	64	40	66	96	81	74	96	85	
	No-cult avg = 52			Cult avg = 85						
LSD (0.05)	Planting rate = 13 Cultivation = 8 All other interactions were not significant.									
1997										
12,000	4	74	39	91	95	93	88	93	90	74
18,000	52	79	65	85	97	91	95	94	95	84
24,000	36	90	63	92	95	93	94	95	95	84
30,000	43	81	62	96	96	96	96	97	97	85
Average	34	81	57	91	96	93	93	95	94	
	No-cult avg = 73			Cult avg = 90						
LSD (0.05)	Planting rate = 6 Herbicide = 6 PR x Herb = 11 Cultivation = 4 Herb x Cult = 8									
	All other interactions were not significant.									

Table 4. Redroot and tumble pigweed responses to sunflower planting rate and method of weed control, west central Kansas.

	No Herbicide			Prowl			Prowl/Poast			
Planting	Cultivated			Cultivated			Cultivated			Overall
Rate	No	Yes	Avg	No	Yes	Avg	No	Yes	Avg	Avg
seeds/a	% control									
1995										
12000	0	44	22	70	100	85	83	83	83	63
18000	36	73	54	64	99	81	78	98	88	74
24000	13	76	44	79	94	86	89	100	94	75
30000	30	91	60	96	99	97	93	100	97	85
Average	20	70	45	77	98	87	86	95	90	
	No-cult avg = 61 Cult avg = 88									
LSD (0.05)	Herbicide = 11 Planting rate = 12 Cultivation = 8 Herb x Cult = 14									
	All other interactions were not significant.									
1997										
12000	3	80	41	94	95	95	91	91	91	76
18000	52	85	69	92	97	94	97	97	96	86
24000	39	90	64	94	96	95	94	95	94	84
30000	44	84	64	96	96	96	95	97	96	85
Average	34	85	59	94	96	95	94	95	94	
	No-cult avg = 74 Cult avg = 92									
LSD (0.05)	Planting rate = 7 Cultivation = 4 PR x Herb = 12 Herbicide = 6									
	Herb x Cult = 7 PR x Herb x Cult = 15 All other interactions were not significant.									

NITROGEN MANAGEMENT FOR NO-TILL PRODUCTION OF CORN AND GRAIN SORGHUM

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V.L. Martin, B.H. Marsh, D. Key, M.A. Davied, and D.D. Roberson

Summary

Surface-applied, urea-containing fertilizers have potential for volatilization and immobilization losses of nitrogen (N), particularly when residue levels are high. Results in 1997 indicate that ammonium nitrate and AgrotaiN (urea with a urease inhibitor) outperformed urea at three of four corn sites and both grain sorghum sites. The poor performance of urea likely was due to volatilization losses of N following fertilizer application. Time of N application had minimal impact on corn or sorghum yields.

Introduction

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

Procedures

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

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

Results and Discussion

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

Corn and grain sorghum yields (both dryland and irrigated) were average to excellent. AgrotaiN and ammonium nitrate produced higher yields and higher grain protein than urea at three of four corn sites and both grain sorghum sites. The urease inhibitor in AgrotaiN has potential to reduce both volatilization and immobilization by slowing urea breakdown and allowing it to get into the soil. Both volatilization and immobilization can be problems with surface- applied N in high-residue production systems, and these results indicate N losses from urea this year.

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

Results over the past 3 years indicate that ammonium nitrate and AgrotaiN often outperformed urea where N fertilizers were broadcast in high residue, no-till production systems.

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

Table 1. Nitrogen management of continuous no-till corn, North Agronomy Farm, Manhattan, KS, 1997.

N	N	6-Leaf	Tassel	Grain	
Rate	Source	N	N	Yield	Protein
lb/a		%		bu/a	%
0	--	2.9	1.41	18	7.8
50	Urea	3.92	1.8	53	6.6
100	Urea	4.13	2.17	53	7.3
150	Urea	3.98	2.19	64	7.9
50	AgrotaiN*	3.94	1.77	56	6.9
100	AgrotaiN	4	2.22	64	8
150	AgrotaiN	4.04	2.48	77	9.3
50	Am. nit.	3.97	2.21	61	6.8
100	Am. nit.	4.13	2.46	57	9.4
150	Am. nit.	4.2	2.63	72	9.9
LSD (0.10)		0.19	0.27	9	0.8
Mean Values:					
N	50	3.94	1.93	57	6.8
Rate	100	4.09	2.28	58	8.2
	150	4.07	2.44	71	9
LSD (0.10)		0.1	0.16	5	0.4
N	Urea	4.01	2.05	56	7.3
Source	AgrotaiN	4	2.16	66	8.1
	Am. nit.	4.1	2.43	63	8.7
LSD (0.10)		NS	0.16	5	0.4

* AgrotaiN is urea + NBPT

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

N	N	Time of	6-Leaf	Tassel	Grain	
Rate	Source	Application	N	N	Yield	Protein
lb/a			%		bu/a	%
0	--	--	4.29	1.82	73	6.7
75	Urea	Early	4.18	2.33	151	6.9
150	Urea	Early	4.35	2.86	183	7.8
75	AgrotaiN	Early	4.35	2.44	148	7
150	AgrotaiN	Early	4.18	2.87	194	8.1
75	Am. nit.	Early	4.27	2.47	166	7
150	Am. nit.	Early	4.33	2.88	195	8
75	Urea	Planting	4.05	2.17	127	6.8
150	Urea	Planting	4.34	2.44	159	7.1
75	AgrotaiN	Planting	4.35	2.42	148	6.9
150	AgrotaiN	Planting	4.31	2.71	183	7.7
75	Am. nit.	Planting	4.37	2.35	155	7
150	Am. nit.	Planting	4.31	2.95	177	8.2
LSD (0.10)			NS	0.19	20	0.3
Mean Values:						
N	75		4.26	2.36	145	6.9
Rate	150		4.3	2.79	182	7.8
LSD (0.10)			NS	0.08	8	0.1
N	Urea		4.23	2.45	155	7.1
Source	AgrotaiN		4.3	2.6	168	7.4
	Am. nit.		4.32	2.66	173	7.6
LSD (0.10)			NS	0.1	10	0.2
Time of	Early		4.27	2.64	172	7.5
Application	Planting		4.29	2.51	154	7.3
LSD (0.10)			NS	NS	8	0.1

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

N	N	Time of	6-Leaf	Tassel	Grain	
Rate	Source	Application	N	N	Yield	Protein
lb/a			%		bu/a	%
0	--	--	3.17	2.03	181	6.5
75	Urea	Early	3.74	2.41	215	7.3
150	Urea	Early	3.45	2.65	226	7.9
75	AgrotaiN	Early	3.58	2.6	213	7.7
150	AgrotaiN	Early	3.7	2.71	221	8.6
75	Am. nit.	Early	3.66	2.62	217	7.7
150	Am. nit.	Early	3.78	2.68	213	8.1
75	Super urea	Early	3.79	2.62	225	7.7
150	Super urea	Early	3.91	2.7	232	8.4
75	Urea	Planting	3.62	2.38	202	7.4
150	Urea	Planting	3.78	2.58	218	7.9
75	AgrotaiN	Planting	3.64	2.43	215	6.9
150	AgrotaiN	Planting	3.8	2.65	209	7.6
75	Am. nit.	Planting	3.79	2.49	209	7.5
150	Am. nit.	Planting	3.95	2.85	236	8.2
75	Super urea	Planting	3.66	2.41	211	7.1
150	Super urea	Planting	4.06	2.75	226	8.3
LSD (0.10)			0.26	0.14	18	0.4
Mean Values:						
N	75		3.69	2.49	213	7.4
Rate	150		3.8	2.69	223	8.1
LSD (0.10)			0.1	0.05	7	0.1
N	Urea		3.65	2.5	215	7.6
Source	AgrotaiN		3.68	2.6	214	7.7
	Am. nit.		3.79	2.66	219	7.9
	Super urea		3.86	2.62	223	7.9
LSD (0.10)			0.13	0.07	NS	0.2
Time of	Early		3.7	2.62	220	7.9
Application	Planting		3.79	2.57	216	7.6
LSD (0.10)			NS	NS	NS	0.1

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

N Rate	N Source	Time of Application	6-Leaf N	Tassel N	Grain Yield
lb/a			%		bu/a
0	--	--	2.96	2.46	56
60	Urea	Early	3.13	2.61	76
120	Urea	Early	3.25	2.75	92
60	AgrotaiN	Early	3.37	2.69	89
120	AgrotaiN	Early	3.39	2.93	100
60	Am. nit.	Early	3.26	2.85	95
120	Am. nit.	Early	3.33	3.05	95
60	Urea	Planting	3.22	2.75	82
120	Urea	Planting	3.63	2.93	100
60	AgrotaiN	Planting	3.31	2.92	85
120	AgrotaiN	Planting	3.57	3.12	103
60	Am. nit.	Planting	3.29	2.9	92
120	Am. nit.	Planting	3.69	3.22	99
LSD (0.10)			0.3	0.22	9
Mean Values:					
N	60		3.26	2.78	87
Rate	120		3.47	3	98
LSD (0.10)			0.13	0.09	3
N	Urea		3.31	2.76	88
Source	AgrotaiN		3.41	2.91	94
	Am. nit.		3.39	3.01	95
LSD (0.10)			NS	0.12	4
Time of	Early		3.29	2.81	91
Application	Planting		3.45	2.97	93
LSD (0.10)			0.13	0.09	NS

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

N	N	Time of	6-Leaf	Grain
Rate	Source	Application	N	Yield
lb/a			%	bu/a
0	--	--	1.57	59
60	Urea	Early	2.17	108
120	Urea	Early	2.25	125
60	AgrotaiN	Early	2.1	107
120	AgrotaiN	Early	2.37	137
60	Am. nit.	Early	2.15	109
120	Am. nit.	Early	2.25	127
60	Urea	Planting	2.22	101
120	Urea	Planting	2.19	121
60	AgrotaiN	Planting	2.25	110
120	AgrotaiN	Planting	2.37	129
60	Am. nit.	Planting	2.17	115
120	Am. nit.	Planting	2.39	126
LSD (0.10)			0.12	10
Mean Values:				
N	60		2.18	108
Rate	120		2.3	128
LSD (0.10)			0.05	4
N	Urea		2.21	114
Source	AgrotaiN		2.27	121
	Am. nit.		2.24	119
LSD (0.10)			NS	5
Time of	Early		2.22	117
Application	Planting		2.26	119
LSD (0.10)			NS	NS

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

N Rate	N Source	Time of Application	Boot N	Grain Yield
lb/a			%	bu/a
0	--	--	1.87	113
75	Urea	Early	2.25	155
150	Urea	Early	2.44	162
75	AgrotaiN	Early	2.25	159
150	AgrotaiN	Early	2.54	175
75	Am. nit.	Early	2.9	166
150	Am. nit.	Early	2.94	184
75	Super urea	Early	2.44	158
150	Super urea	Early	2.73	170
75	Urea	Planting	2.58	158
150	Urea	Planting	2.53	158
75	AgrotaiN	Planting	2.52	165
150	AgrotaiN	Planting	2.72	174
75	Am. nit.	Planting	2.55	165
150	Am. nit.	Planting	2.88	180
75	Super urea	Planting	2.67	169
150	Super urea	Planting	2.99	180
LSD (0.10)			0.25	13
Mean Values:				
N	75		2.49	162
Rate	150		2.72	173
LSD (0.10)			0.08	5
N	Urea		2.45	158
Source	AgrotaiN		2.51	168
	Am. nit.		2.82	174
	Super urea		2.71	169
LSD (0.10)			0.12	7
Time of	Early		2.56	166
Application	Planting		2.67	168
LSD (0.10)			0.08	NS

EFFECTS OF PLANTING DATE, TILLAGE, AND HERBICIDE LEVEL ON THE YIELD OF GRAIN SORGHUM FOLLOWING WHEAT ON DRYLAND SANDY SOILS

V.L. Martin and R.L. Vanderlip

Summary

The objective of this study is to determine the agronomic and economic feasibilities of introducing grain sorghum into a continuous wheat production system on dryland sandy soils. It considers the effects of tillage, weed control, planting date, and their interactions on yield of grain sorghum after wheat. Results from 1996 and 1997 showed that a mid-May planting date increased yield regardless of tillage or weed control levels. No-tillage yields were slightly lower than those of conventional tillage in 1996 but slightly higher in 1997. Overall, herbicide was necessary, regardless of planting date or tillage. Results so far suggest that tillage could be eliminated and planting of grain sorghum could be earlier.

Introduction

Although grain sorghum is the second major dryland crop in Kansas after wheat, sorghum acreage is much lower. Although the practice of continuous wheat production is slowly changing, it is still common. The new Freedom to Farm legislation and several other factors will assist the conversion from continuous wheat.

Producers on sandy soils in the Lower Arkansas Basin have two primary rotation choices, corn and sorghum. Corn possesses certain advantages over grain sorghum, however, greater risk of crop failure, increased input costs, and required machinery make dryland production less attractive for typical continuous wheat farmers.

Grain sorghum, the other primary rotation option, is better able to withstand drought, produces more consistent yields, and produces less residue to manage. Disadvantages include the inability to safely use Atrazine pre-emergence on sandy soils, using available soil water for a longer period of time, and difficulties harvesting sorghum and returning to wheat in the same season. This means that farmers rotating out of wheat to sorghum need a fallow year before returning to wheat. The need to idle land makes many producers unwilling to rotate to sorghum. If producers could successfully plant shorter-maturity grain sorghum earlier than the typical mid- to late- June planting date and minimize the amount of tillage involved, they might be able to introduce sorghum for 1 to 3 years, correct their continuous wheat production problems, and return to wheat without losing a crop.

The development of newer, higher yielding, early- to medium-maturity grain sorghum hybrids; seed safeners; effective no-till planters; and other advances/changes in cultural practice options requires producers to re-examine their best management practices for grain sorghum production.

No-tillage results in three primary benefits. It eliminates soil moisture loss by tillage and decreases evaporation early in the growing season. The potential for wind and water erosion decreases significantly with surface residue. Over time, potentially less herbicide may be necessary.

The primary objective of this study is to determine the agronomic/ economic feasibility of producers introducing grain sorghum into their current continuous wheat production system. The study will determine the effect of tillage, weed control intensity, planting date and their interactions on the yield of grain sorghum.

Procedures

The soil at the study site is a fine sandy loam cropped to wheat for 2 years prior to planting in both 1996 and 1997. Fertilization consisted of 100 lb/a 18-46-0 preplant with 120 lb N/a applied as urea (46-0-0) using a split application with 50 lb/a preplant and 75 lb/a sidedressed in both years. Plots were planted with a six-row John Deere no-till planter at 51,000 seeds/a. Plots were harvested mechanically in mid-October, grain moisture and test weight determined, and yields adjusted to 12.5% moisture.

Treatments were as follows:

1. Main plots: Planting date - May 21, June 10 (1996); May 21, June 3 (1997).
2. Split plots: Tillage - no-tillage and conventional (chisel-disk).
3. Split-split plots: Weed control - standard (Dual followed by Marksman. No-till preplant weed control with Roundup or Landmaster. Conventional preplant control by tillage);

reduced (preplant with no-till using Roundup and a rescue treatment of 2,4-D or Banvel if necessary. Conventional tillage will have only tillage for weed control and a 2,4-D or Banvel rescue treatment if necessary.)
4. Final split: Hybrid maturity - early (NC+ 5C35) and medium (NC+ 6B50).
Plots were planted in a randomized complete block design with four replications.

Results and Discussion

Precipitation was much above average during the 1996 and 1997 growing seasons (Table 1), and temperatures were relatively mild. The wet conditions from May through June prevented the application of Marksman in 1996, so the standard weed control treatment consisted of Dual only.

Planting on May 21 versus in early June increased yield regardless of tillage and weed control levels (Fig.1). Overall, no-tillage yields were lower than those of conventional tillage in 1996 but not significantly so (Fig. 1). In 1997, no-tillage yields were slightly higher than conventional tillage yields. The conventional weed control treatment (Dual only in 1996) significantly increased yields over no herbicide inputs, and the medium-maturity hybrid (NC+ 6B50) significantly out yielded the early-maturity hybrid (NC+ 5C35). The long-term average, sorghum yield for the area is approximately 50 to 60 bu/a. Yields in 1996 and 1997 were exceptionally high throughout the region.

Overall, herbicide was necessary regardless of planting date or tillage (Fig 2). This figure also shows a large yield increase from planting just 2 weeks earlier, even under less than ideal conditions.

Examining the interaction of all factors demonstrates the benefits of planting earlier regardless of hybrid maturity (Fig. 3) and the need for chemical weed control inputs regardless of tillage when planting early. Finally, these data show no-tillage to be competitive with conventional tillage, even when planting early during a cool, wet spring.

Although no conclusions can be drawn yet, the initial data indicate the potential for success in eliminating tillage while moving planting earlier into the growing season.

Table 1. Precipitation in the Dryland Quarter at the Sandyland Experiment Field, St. John, KS.

Month	16-Year Average	1996	1997
		inches	
January	0.56	0.2	0
February	0.9	0.1	2.5
March	2	2.1	0.1
April	2.6	2.4	3
May	3.9	4.8	1.9
June	4.1	3.8	5.1
July	2.7	4.4	3.7
August	2.9	5.1	5.3
September	2.2	4.9	2.5
October	1.9	1.4	4
November	1.2	2.8	0.5
December	1.1	0	2.6
Annual Total	25.9	31.8	31

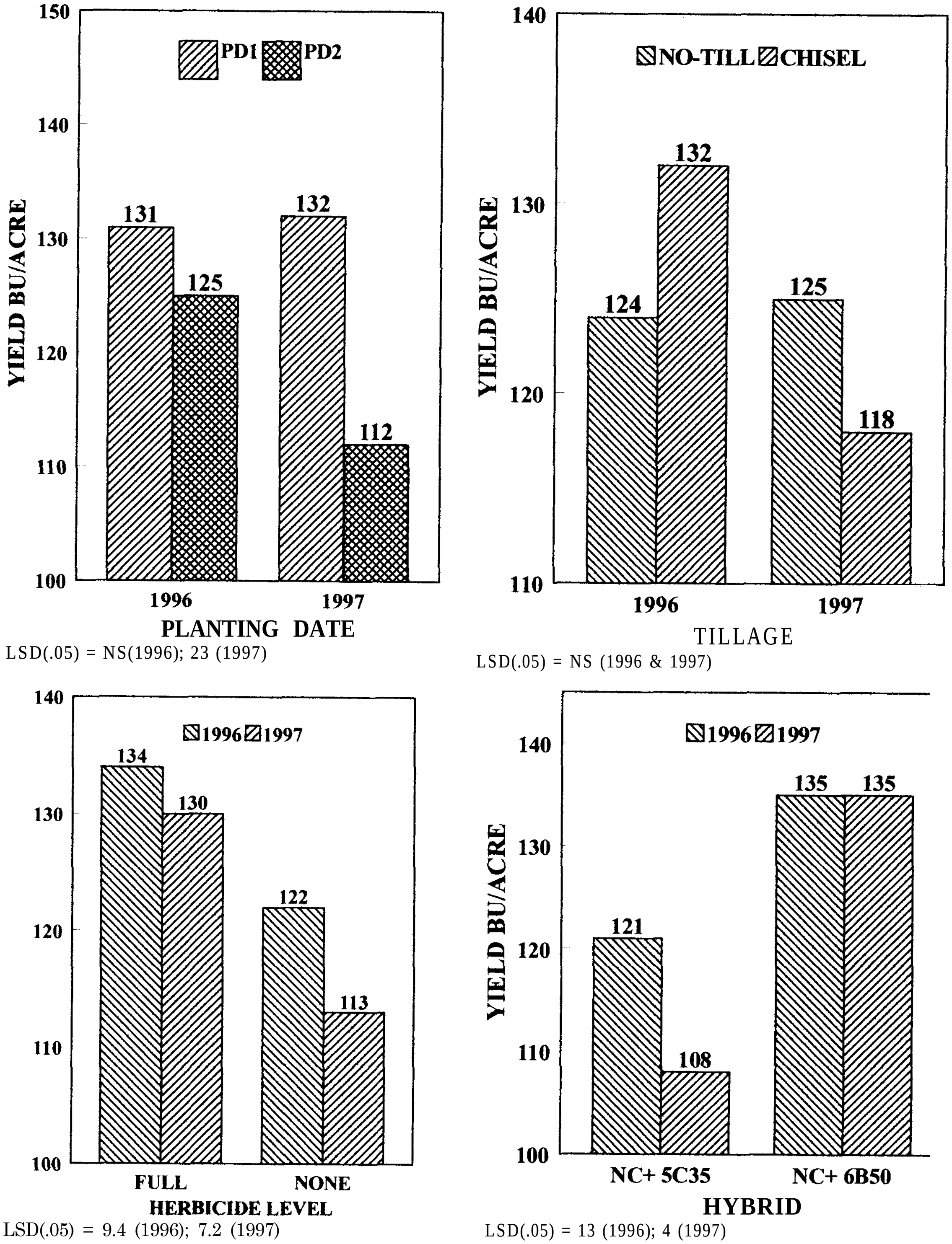
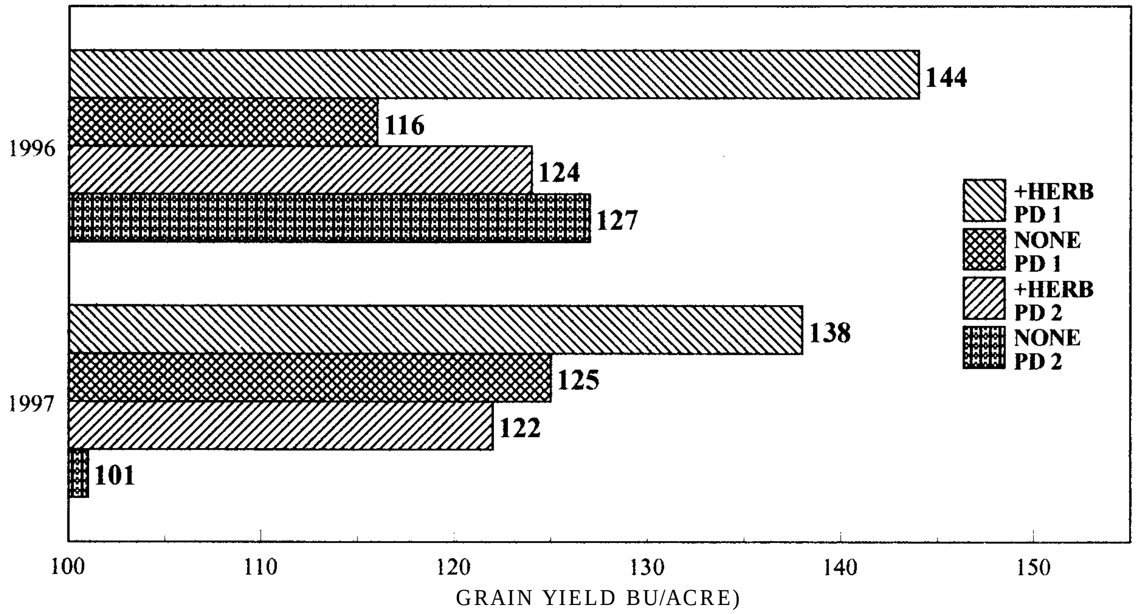
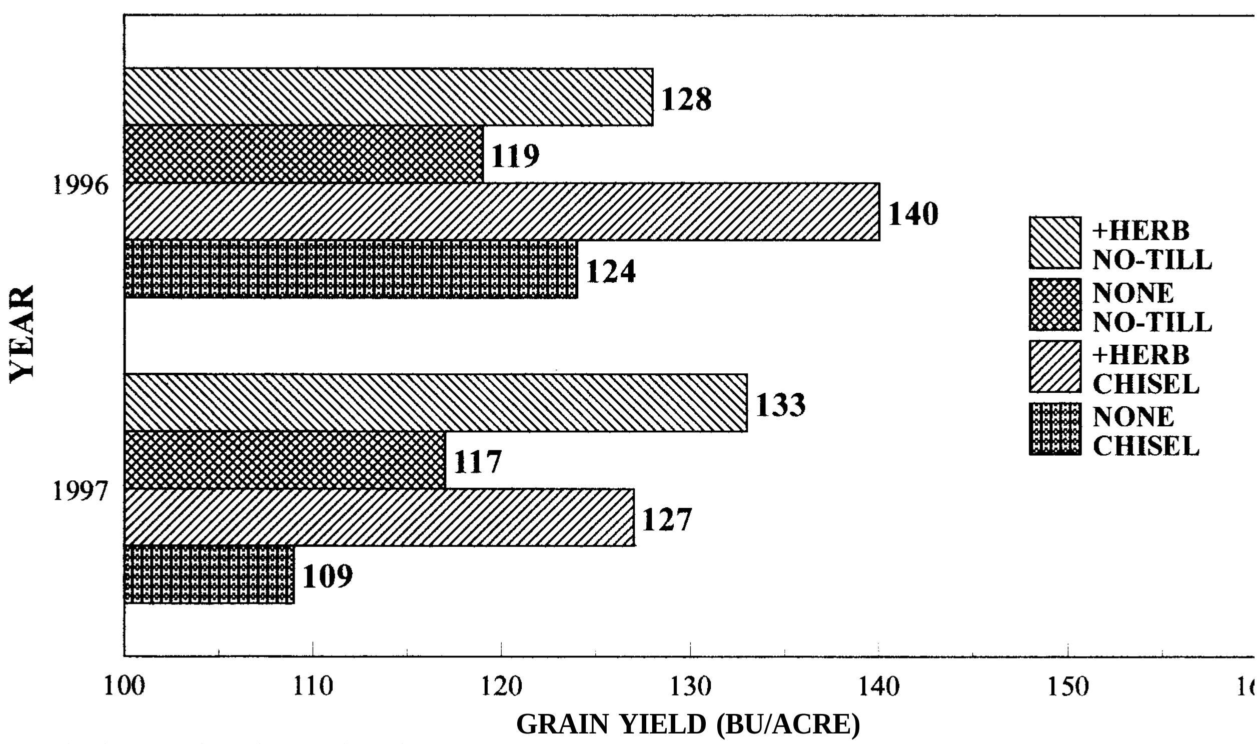


Figure 1. Effects of planting date, tillage, herbicide level, and hybrid on grain sorghum yield, St. John, KS, 1996-97.



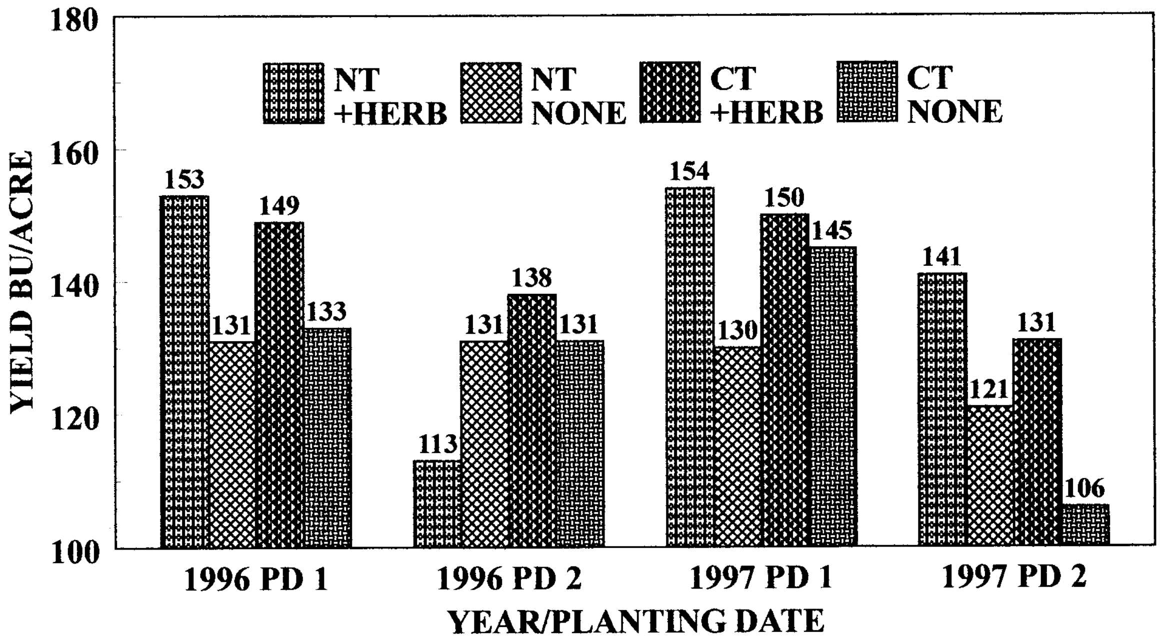
LSD(.05) = 13.3 (1996); 7.2 (1997)



LSD(.05) = 9.4 (1996); 16.7(1997)

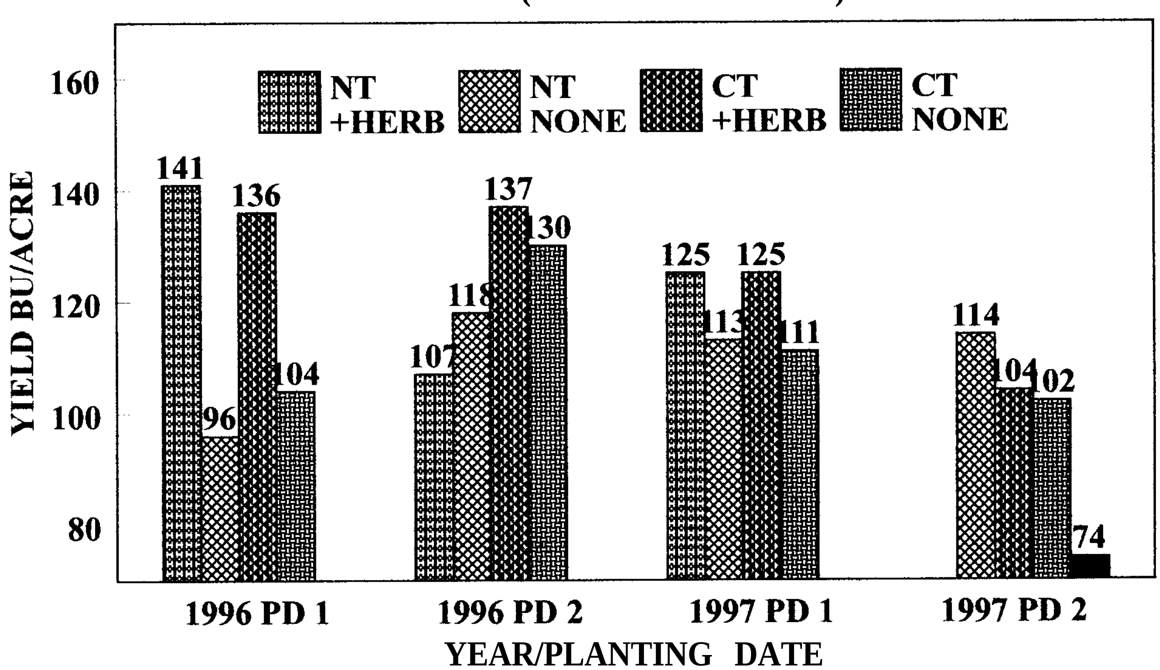
Figure 2. Effects of herbicide level x planting date and herbicide level x tillage interactions on grain sorghum yield, St. John, KS, 1996-97.

NC+ 6B50 (MEDIUM MATURITY)



LSD(.05)=NOT SIGNIFICANT

NC+ 5C35 (EARLY MATURITY)



LSD(.05)=NOT SIGNIFICANT

Figure 3. Effects of planting date x hybrid x tillage x herbicide level interactions on grain sorghum yield, St. John, KS, 1996-97.

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

D.W. Sweeney

Summary

In 1997, the fifteenth cropping year of a grain sorghum-soybean rotation, tillage and N management systems affected grain sorghum yields. The greatest yields resulted from conventional tillage and anhydrous ammonia.

Introduction

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

Procedures

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

Results and Discussion

In 1997, grain sorghum yields were affected by tillage in the order of conventional>reduced>no tillage (Table 1). Without N, yields averaged only about 5 bu/a, but all N sources resulted in grain sorghum yields exceeding 60 bu/a. Anhydrous ammonia resulted in greater yield than did urea application. UAN application resulted in yield that was intermediate between those with the other two N sources.

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

Treatment	Yield 1997	Yield Avg. 1983-1997
	bu/a	
Tillage		
Conventional	75.3	70.1
Reduced	57.7	67.6
No tillage	38.7	52.7
$LSD_{(0.05)}$	9.1	
N Fertilization		
Check	4.8	38.4
Anhydrous NH_3	88.3	76
UAN broadcast	64	67.4
Urea broadcast	72	71.8
$LSD_{(0.05)}$	17.2	
T x N Interaction	NS	

IMPACT OF TILLAGE IN A WHEAT-SORGHUM-FALLOW ROTATION

A.J. Schlegel

Summary

Grain yields of wheat and grain sorghum increased with decreased tillage intensity. Averaged across 8 years, wheat yields were 4 bu/a and sorghum yields 19 bu/a greater with no-till than with conventional tillage. The benefit of no-till compared to conventional tillage tended to increase over time. Residue cover at planting was affected by tillage intensity and was considerably greater at sorghum than at wheat planting. At sorghum planting, surface residue covers averaged 82% for no-till, 73% for reduced tillage, and 49% for conventional tillage. At wheat planting, surface residue covers were 40% for no-till, 26% for reduced tillage, and 15% for conventional tillage. Tillage intensity had little impact on soil organic matter when measured after 5 years; however, levels of soil organic matter were lower in the cropped systems than in native sod. Levels of organic matter, P, and K decreased and pH increased with soil depth. Tillage intensity had little effect on the distribution of nutrients within the soil profile.

Introduction

Reduced-tillage practices have been shown to increase grain yields in semi-arid regions. Adoption of no-till systems may further enhance crop productivity in western Kansas and maintain or improve soil quality. This study was initiated to determine the impact of tillage intensity in a wheat-sorghum-fallow system on grain yield and organic matter content of soil.

Procedures

The experimental design was a randomized complete block with three intensities of tillage (conventional, reduced, and no-till) in a wheat-sorghum-fallow system with all crops present each year. Plot size was 50 by 100 ft, and four replications were done. The study area had been broken out of native sod immediately prior to study establishment in 1989. The primary tillage implement was a sweep plow. The conventional tillage treatment was tilled as needed to control weed growth during the noncrop period, generally three to four operations. In no-till, weed growth was controlled with herbicides during the noncrop period. Between wheat harvest and sorghum planting, atrazine, glyphosate, and 2,4-D were used for weed control. Glyphosate and 2,4-D were used for weed control from sorghum harvest to wheat planting. The reduced-tillage system used a combination of tillage and herbicides for weed control during the noncrop period. Herbicides were used for in-crop weed control in all tillage systems. The center of each plot was machine harvested, and grain yields were adjusted to 12.5% moisture. Aboveground biomass was collected at harvest, dried, and weighed. Residue was calculated by subtracting grain yield from aboveground biomass. Surface residue cover at planting was measured by the line transect method. Soil samples (0- to 2-, 2- to 6-, and 6- to 12-inch depths) were collected in the summer of 1994 and analyzed for pH, and contents of P, K, and organic matter.

Results and Discussion

Wheat yields were increased as tillage decreased when averaged across all years (Table 1). However, a significant year by tillage interaction occurred, and a benefit from reducing tillage intensity was not seen in all years. In the first 2 years, wheat yields were similar for all tillage systems. In the last 2 years, however, wheat yields were 10 to 18 bu/a greater with no-till than conventional tillage. Wheat yields with reduced tillage were in between those of conventional tillage and no-till.

Grain sorghum yields have varied considerably across years from less than 10 to over 100 bu/a (Table 2). When averaged across all years, grain sorghum yields were 19 bu/a greater with no-till than conventional tillage. Similar to wheat, a significant year by tillage interaction occurred. In the first 3 years, yields were similar for all tillage systems. Since then, however, grain sorghum yields have been significantly higher each year with reduced- or no-till than with conventional tillage. For example, in the past 2 years, sorghum yields have been 33 bu/a greater with no-till. This indicates that when reduced tillage practices are adopted, yield increases may not become apparent for several years.

Residue cover at planting was affected by tillage intensity and was considerably greater at sorghum than at wheat planting. At sorghum planting, surface residue covers were 82% for no-till, 73% for reduced tillage, and 49% for conventional tillage (average of 1994 to 1997). At wheat planting, surface residue covers were 40% for no-till, 26% for reduced tillage, and 15% for conventional tillage.

The intensity of tillage can affect soil chemical properties, particularly organic matter content. In this study, however, tillage systems had little impact on soil organic matter when measured after 5 years (Table 3). Organic matter levels were lower in the cropped systems than in native sod. Levels of organic matter, P, and K decreased and pH increased with soil depth. Tillage intensity had little effect on the distribution of nutrients within the soil profile.

Table 1. Wheat response to tillage in a wheat-sorghum-fallow rotation, Tribune, KS 1990-1997.

Tillage	1990	1991	1992	1993	1994	1995	1996	1997	Mean
	bu/a								
Conventional	28	16	26	43	48	49	16	34	33
Reduced	26	14	14	55	48	51	25	42	34
No-till	27	15	21	58	46	56	26	52	38
$LSD_{0.05}$	3	6	10	4	7	7	9	17	3
<u>ANOVA</u>									
Tillage	0.459	0.672	0.067	0.001	0.602	0.066	0.073	0.121	0.001
Year									0.001
Tillage x year									0.001

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Table 2. Grain sorghum response to tillage in a wheat-sorghum-fallow rotation, Tribune, KS 1990-1997

Tillage	1990	1991	1992	1993	1994	1995	1996	1997	Mean
	bu/a								
Conventional	6	23	38	47	20	37	97	71	42
Reduced	8	39	41	83	38	54	117	94	59
No-till	6	39	27	68	57	59	119	115	61
$LSD_{0.05}$	5	18	15	11	9	5	12	33	5
<u>ANOVA</u>									
Tillage	0.444	0.110	0.118	0.001	0.001	0.001	0.007	0.044	0.001
Year									0.001
Tillage x year									0.001

Table 3. Effect of tillage intensity on crop residue at planting in a wheat-sorghum-fallow rotation, Tribune, KS 1994-1997.

Tillage	1994	1995	1996	1997	Mean
	% residue cover at planting				
Wheat					
Conventional	11	17	25	6	15
Reduced	26	31	31	15	26
No-till	41	52	54	15	40
$LSD_{0.05}$	5	22	13	5	6
ANOVA					
Tillage	0.001	0.022	0.005	0.009	0.001
Year					0.001
Tillage x year					0.034
Grain Sorghum					
Conventional	54	57	58	26	49
Reduced	84	61	84	63	73
No-till	87	82	86	74	82
$LSD_{0.05}$	10	22	13	23	7
ANOVA					
Tillage	0.001	0.066	0.003	0.005	0.001
Year					0.011
Tillage x year					0.05

Table 4. Impact of 5 years of three tillage intensities in a wheat-sorghum-fallow rotation on soil properties compared to native sod, Tribune, KS.

Tillage	Depth	pH	Bray-1 P	K	Organic Matter
	inch		ppm	ppm	%
Conventional	0-2	6.7	58	843	3.2
	2-6	7.3	37	508	2.6
	6-12	7.6	22	453	1.8
Reduced	0-2	6.6	59	880	3.2
	2-6	7.2	38	504	2.6
	6-12	7.5	23	445	2.0
No-till	0-2	6.6	61	886	3.2
	2-6	7.2	38	523	2.7
	6-12	7.5	21	450	2.1
Native sod	0-2	6.8	44	579	3.7
	2-6	7.3	36	496	2.8
	6-12	7.6	28	460	2.2
ANOVA					
Tillage		0.068	0.817	0.49	0.088
Depth		0.001	0.001	0.001	0.001
Tillage x depth		0.863	0.837	0.682	0.534
Main effect means					
Tillage					
Conventional		7.2	39	601	2.5
Reduced		7.1	40	610	2.6
No-till		7.1	40	620	2.6
$LSD_{0.05}$		0.1	3	31	0.1
Depth					
0-2 inches		6.6	59	870	3.2
2-6		7.2	38	512	2.6
6-12		7.5	22	449	2
$LSD_{0.05}$		0.1	3	31	0.1

Native sod is not included in statistical analysis for ANOVA and main effect means.

REDUCED TILLAGE AND CROP ROTATION SYSTEMS WITH WHEAT, GRAIN SORGHUM, CORN, AND SOYBEANS

M.M. Claassen

Summary

Crop residue cover in no-till wheat after row crops ranged from 33% to 80%, and chisel and no-till systems in continuous wheat had 17% and 80% residue cover after planting, respectively. Average wheat yields were highest after corn (86.4 bu/a), followed by wheat after soybeans, continuous wheat, and wheat after sorghum. The lowest continuous wheat yield occurred with no-till. V-blade and no-till systems in row crops following wheat averaged 38% and 71%, respectively. Tillage systems had no effect on row crop yields. Sorghum after wheat produced 30.6 bu/a more than continuous sorghum.

Introduction

Crop rotations facilitate reduced-tillage practices, while enhancing disease and weed control. Long-term research at Hesston has shown that winter wheat and grain sorghum can be grown successfully in an annual rotation. Although subject to greater impact from drought stress than grain sorghum, corn and soybeans also are viable candidates for crop rotations in central Kansas dryland systems that conserve soil moisture. Because of their ability to germinate and grow under cooler conditions, corn and soybeans can be planted earlier in the spring and harvested earlier in the fall than sorghum. Thus, they provide an opportunity for soil moisture replenishment as well as a wider window of time within which to plant the succeeding wheat crop. This study was initiated at Hesston on Ladysmith silty clay loam to evaluate the consistency of corn and soybean production versus grain sorghum in an annual rotation with winter wheat and to compare these rotations with monocultures of wheat and grain sorghum.

Procedures

Three tillage systems were established for continuous wheat; two for each row crop (corn, soybeans, and grain sorghum) in annual rotation with wheat; and two for continuous grain sorghum. Each system, except no-till, included secondary tillage as needed for weed control and seedbed preparation. Wheat in rotations was planted after each row-crop harvest without prior tillage. The following procedures were used.

<u>Wheat after corn</u>
WC-NTV = No-till after V-blade (V-blade, sweep-treader, mulch treader) for corn
WC-NTNT = No-till after no-till corn

<u>Wheat after sorghum</u>
WG-NTV = No-till after V-blade (V-blade, sweep-treader, mulch treader) for sorghum
WG-NTNT = No-till after no-till sorghum

<u>Wheat after soybeans</u>
WS-NTV = No-till after V-blade (V-blade, sweep-treader, mulch treader) for soybeans
WS-NTNT = No-till after no-till soybeans

<u>Continuous wheat</u>
WW-B = Burn (burn, disk, field cultivate)
WW-C = Chisel (chisel, disk, field cultivate)
WW-NT = No-till

<u>Corn after wheat</u>
CW-V = V-blade (V-blade, sweep-treader, mulch treader)
CW-NT = No-till

<u>Sorghum after wheat</u>
GW-V = V-blade (V-blade, sweep-treader, mulch treader)
GW-NT = No-till

<u>Soybeans after wheat</u>
SW-V = V-blade (V-blade, sweep-treader, mulch treader)
SW-NT = No-till

<u>Continuous sorghum</u>
SS-C = Chisel (chisel, sweep-treader, mulch treader)
SS-NT = No-till

Continuous wheat no-till plots were sprayed with Roundup Ultra + ammonium sulfate (AS) at 1.0 lb ai/a + 2.6 lb/a in late July. Roundup Ultra was applied at 0.5 lb ai/a again in mid-October for control of cheat and volunteer wheat. Variety 2137 was planted on October 19 in 8-in. rows at 75 lb/a with a CrustBuster no-till drill equipped with double-disk openers. Wheat was fertilized with 90 lb N/a and 32 lb P_2O_5/a applied at planting as preplant, broadcast ammonium nitrate and in-furrow diammonium phosphate, respectively. Weeds were controlled with Bronate (0.75 lb ai/a) in rotation plots and Bronate + Glean + nonionic surfactant (0.5 lb ai/a + 0.25 oz ai/a + 0.25% Pen-A-Trate II) in continuous wheat plots. Wheat was harvested on July 5, 1997.

No-till corn after wheat plots received the same Roundup treatments as WW-NT during the summer and fall. CW-V plots were tilled twice with a V-blade and twice with a sweep-treader between wheat harvest and corn planting. Corn was fertilized with 100 lb/a N as ammonium nitrate broadcast prior to planting. An additional 14 lb/a N and 37 lb/a P_2O_5 were banded 2 inches from the row at planting. A White no-till planter with double- disk openers on 30-in. centers was used to plant Golden Harvest H-2404 at approximately 23,000 seeds/a on April 3, 1997. Weeds were controlled with a preemergence application of Partner 65 DF + AAtrex 90 DF (2.5 + 0.5 lb ai/a). Row cultivation was not required. Corn was harvested on September 9.

No-till sorghum after wheat plots were treated twice as previously noted with Roundup during the summer and fall. Additionally, GV-NT and GG-NT plots were sprayed with Roundup Ultra + 2,4-D_{LVE} + AS (1.0 + 0.17 lb ai/a + 3.4 lb/a) in early May. SW-V plots were tilled twice with a V-blade, twice with a sweep-treader, and once with a mulch treader during the fallow period between wheat harvest and sorghum planting. SS-C plots were tilled once with a chisel, twice with a sweep-treader, and once with a mulch treader. Sorghum was fertilized like corn, but with 90 lb/a total N. Pioneer 8500 treated with Concep III safener and Gaucho insecticide was planted at 38,100 seeds/a in 30-in. rows on May 6. Preemergence application of Partner 65 DF at 2.5 lb ai/a + AAtrex 90 DF at 0.5 (rotation) or 1.0 (continuous sorghum) controlled weeds during the season without row cultivation.

Field procedures for soybeans in the respective tillage systems were basically the same as for grain sorghum. However, soybeans received only starter fertilizer, and weeds were controlled preemergence with Partner 65 DF + Scepter 70 DG (2.5 + 0.12 lb ai/a). Resnik soybeans were planted at 8 seeds/ft in 30-in. rows on May 6 and harvested on October 6.

Results and Discussion

Wheat

Crop residue cover after planting ranged from 48 to 80% in wheat after corn and sorghum but averaged only 33% in wheat after soybeans (Table 1). In continuous wheat, residue cover ranged from 5% in burned plots to 80% with no-till. Wheat stands were good but slightly lower in WG-NT and WW-NT.

Control of cheat and broadleaf weeds was generally excellent. However, previous cheat infestation resulted in somewhat poorer control in WG-NTNT.

The precipitation pattern during the fall as well as throughout the remainder of the growing season was very favorable for wheat, particularly in rotations. However, wheat after sorghum appeared less robust than wheat following corn or soybeans. Although wheat was fertilized uniformly, average whole-plant N at late boot-early heading stage was significantly lower following sorghum than after corn, soybean, or wheat. Record wheat yields of more than 80 bu/a were harvested. Wheat after corn ranked highest, followed by wheat after soybeans, and wheat after sorghum. Prior tillage system did not affect wheat after corn or soybean. However, WG-NTV produced 16.3 bu/a more than WG-NTNT. Continuous wheat yielded more than wheat after sorghum but less than wheat after corn or soybeans. WW-C averaged 17.7 bu/a more than WW-NT.

Row Crops

Crop residue cover for row crops following wheat averaged 38% for V-blade and 71% for no-till systems (Table 2). Corn in the V-blade system tended to have a slightly higher plant population, earlier maturity, higher leaf N content, more ears/plant, and larger grain yield than no-till corn.

In sorghum after wheat, tillage system had no effect on stands. But GW-V had a slightly higher flag-leaf N content, larger number of heads/plant, and somewhat earlier maturity than GW-NT. Nevertheless, tillage effect on yield of grain sorghum after wheat was not significant. Continuous sorghum showed little or no tillage effect on any of the crop responses measured. Notably, however, continuous sorghum had a lower leaf N content, lower plant height, and fewer heads/plant and yielded an average of 30.6 bu/a less than sorghum after wheat.

Soybeans after wheat were not affected by tillage system but produced excellent yields that averaged 50.4 bu/a.

Table 1. Effects of row crop rotation and tillage on wheat, Harvey Co. Expt. Field, Hesston, KS, 1997.

Crop Sequence[1]	Tillage System	Crop Residue Cover	Yield	Test Wt	Stand	Heading	Plant N[5]	Cheat Control
		%[2]	bu/a[3]	lb/bu	%	date[4]	%	%[6]
Wheat-corn	V-blade	67	83.6	58.5	95	14	1.09	99
(No-till)	No-till	58	89.2	59.0	95	15	1.23	99
Wheat-sorghum	V-blade	48	52.8	58.4	95	15	0.86	94
(No-till)	No-till	80	36.5	57.9	86	17	1.09	81
Wheat-soybeans	V-blade	34	78.9	59.0	97	14	1.28	100
(No-till)	No-till	32	83.9	59.2	92	15	1.14	100
Continuous wheat	Burn	5	74.2	58.4	95	14	1.23	100
	Chisel	17	76.9	58.4	100	14	1.29	100
	No-till	80	59.2	58.0	89	16	1.29	97
LSD .05		13	6.4	0.54	6.7	1.3	0.18	7
Main effect means:								
Crop Sequence								
Wheat-corn		63	86.4	58.8	95	15	1.16	99
Wheat-sorghum		64	44.7	58.1	90	16	1.00	87
Wheat-soybeans		33	81.4	59.1	95	14	1.21	100
Continuous wheat		49	68.1	58.2	94	15	1.29	98
LSD .05		10	4.7	0.36	3.8	0.9	0.13	5
Rotation Tillage system								
No-till/V-blade		50	71.8	58.6	96	14150.6	1.08	97
No-till/no-till		56	69.9	58.7	91		1.15	93
LSD .05		NS	NS	NS	3.1		NS	NS

[1] All wheat planted no-till after row crops. Main effect means for crop sequence exclude continuous wheat - burn treatment. Main effect means for tillage exclude all continuous wheat treatments.
[2] Crop residue cover estimated by line transect after planting.
[3] Means of four replications adjusted to 12.5% moisture.
[4] Date in May on which 50% heading occurred.
[5] Whole-plant N levels at late boot to early heading.
[6] Visual rating of cheat control in June.

Table 2. Effects of wheat rotation and reduced tillage on corn, grain sorghum, and soybeans, Hesston, KS, 1997.

Crop Sequence	Tillage System	Crop Residue Cover	Yield	Test Wt	Stand	Maturity[3]	Ears or Heads/ Plant	Leaf N[4]
		%[1]	bu/a[2]	lb/bu	1000s/a			%
Corn-wheat	V-blade	41	121.8	60.2	23.3	96	1.23	2.37
	No-till	70	102.3	59.7	21.3	72	1.12	2.09
LSD .05		7	NS	NS	NS	16	NS	NS
LSD .15		-	12.7	0.5	1.8	--	0.11	0.28
Sorghum-wheat	V-blade	37	116.0	59.4	33.5	74	1.79	2.83
	No-till	75	121.2	59.4	34.0	78	1.60	2.57
LSD .05		8	NS	NS	NS	1	0.15	0.22
LSD .15		-	NS	NS	NS	-	----	----
Contin. sorghum	Chisel	37	90.4	58.6	34.7	77	1.25	2.12
	No-till	60	85.6	58.5	35.2	78	1.21	2.26
LSD .05[5]		8	24.8	----	NS	1.1	0.15	0.22
LSD .15[5]		--	----	0.76	NS	0.8	----	----
Soybeans-wheat	V-blade	36	49.6	57.3	----	19	33	----
	No-till	68	51.2	56.8	----	19	32	----
LSD .05		24	NS	NS		NS	NS	
LSD .15		--	NS	0.5		NS	NS	
Main effect means for sorghum:								
Crop sequence								
Sorghum-wheat		56	118.6	59.4	33.8	76	1.69	2.70
Contin. sorghum		48	88.0	58.5	34.9	77	1.23	2.19
LSD .05		5	17.5	0.8	NS	0.8	0.11	0.15
Tillage system								
V-blade/chisel		37	103.2	59.0	34.1	75	1.52	2.47
No-till/no-till		67	103.4	58.9	34.6	78	1.41	2.42
LSD .05		5	NS	NS	NS	0.8	0.11	NS

1 Crop residue cover estimated by line transect after planting.
2 Means of four replications adjusted to 12.5% moisture (corn, sorghum) or 13% moisture (soybeans).
3 Maturity expressed as follows: corn - percentage of plants silked on June 30; grain sorghum - number of days from planting to half bloom; soybeans - day in September on which 95% mature pod color occurred.
4 Corn leaf opposite and below the ear at late silking.
Sorghum flag leaf at late boot to early heading.
5 LSDs for comparisons among means for continuous sorghum and sorghum after wheat treatments.

STRATEGIES FOR IRRIGATION WATER MANAGEMENT AND CROP ACREAGE ALLOCATION WITH A LOW FLOW RATE WELL

V. Strickland and J.R. Williams

Summary

We examined the impact of a low flow rate well on the economically optimal strategy for water application and crop production on a quarter section of land irrigated with a low-drift-nozzle center pivot system. This analysis examined which combinations of irrigated corn, grain sorghum, and wheat plus several dryland crop rotations including wheat, sorghum, sunflower, cane hay, and corn would maximize net returns. A flow rate of 400 gallon per minute was modeled. The number of acres that a producer can irrigate is a function of the number of days in the irrigation season, irrigation well flow rate, and desired water application level. The only factor that the producer can manage effectively is the application amount. In situations of very low flow rates, the producer must decide if irrigating all acres with a lower application level or reducing irrigated acres to maintain a higher application rate is more profitable. The study found that irrigating all acres is more profitable under average weather conditions. However, these results should be interpreted with some caution. The production risk is higher and pumping hours are longer with this strategy than under a less restrictive irrigation schedule, and actual weather conditions are more variable than the averages used in the model.

Introduction

The decrease in irrigation well flow rates is a major source of concern for many grain producers in western Kansas. Because of the limited number of pumping hours available throughout the growing season, many producers cannot apply as many acre-inches of irrigation water on a given crop acreage as they once could. Therefore, new cropping arrangements and practices must be adopted to efficiently use the available pumping hours and existing irrigation technology.

Should a producer irrigate fewer acres with historical, production-maximizing amounts of water, or should the application of irrigation water be stretched such that all acres are irrigated, but at lower levels?

This study considered the problem by defining the number of acres that can be irrigated as a function of pumping hours, well flow rate, and water application level. The economic question addressed was whether the marginal returns from an additional acre of irrigated crop grown under a lower water application level are greater than the marginal returns generated by higher yields when a higher water application level is applied to a smaller acreage.

In order to evaluate this question, the study used a linear programing model constructed to represent a typical quarter section of land under center pivot irrigation. Linear programming is a method that can be used to determine a profit- maximizing combination of irrigation strategies with respect to a set of fixed farm constraints. These constraints can include land, operator labor, water, and available time. The optimal crop mix of wheat, corn, and grain sorghum, as well as corresponding irrigation schedules for a center pivot system with a well yield of 400 gallons per minute (GPM), were determined. The linear programing model used in this study was designed to include 224 different cropping enterprises. All crop yields and resulting net returns were functions of the type of crop, the number of acres irrigated, the irrigation schedule, and inches of water applied per acre. Both crop prices and yields were varied in order to test the sensitivity of model solutions.

Problem Description

To maximize profits, a farmer who is irrigating needs to know the most efficient and profitable way to use existing irrigation equipment within the limitations of a low well yield. The number of acres that can be irrigated with a specific amount of water (acre-inches) is a function of the well flow rate.

Three questions are critical in the decision process. How many acres are irrigated? What should be produced on those irrigated acres? How much water should be applied per irrigated acre?

More acres should be irrigated if greater profits can be generated by applying less water per acre over more acres than by applying more water per acre on fewer acres. If the choice is to irrigate the maximum number of acres that is technically feasible, this will result in a lower total water application per acre, as well as longer application cycles. Longer application cycles result in more days between irrigations on a specific acre. As a result, not all acres will be irrigated during critical crop growth stages. In many cases, these longer cycles will result in irrigation applications that are essentially continuous. Irrigation will begin soon after crop emergence and continue on a more-or-less constant basis until after yield formation. In the worst case, the irrigator is unable to shut down and take advantage of rainfall events or to catch up when equipment failures shut down the system. Therefore, the production risk is higher and pumping hours are longer than under a less restrictive irrigation schedule. One way to reduce these problems is to irrigate less than the maximum number of acres that is technically feasible but apply more water per acre.

Most previous studies have modeled water reductions as a function of restrictions on total water, not low GPM levels. Those studies underestimated the impact of low flow rates, which affect the timing of water application. This study took the approach of examining the impact of a low GPM on the amount of water that can be applied to different acreage sizes and the resulting yields and net returns.

Model and Data

Irrigation System

This analysis was based on a typical southwestern Kansas irrigated farm. Kansas Farm Management Association (KFMA) data from 1995 indicated that a typical irrigated farm with less than $5,000 of raised livestock sales had 880 irrigated acres and 551 acres of dryland crop production. Although only 160 acres were modeled, labor constraints were based on this farm size and adjusted to reflect available labor for each quarter section. A center pivot system was assumed to irrigate up to 126 of these acres with a 90% water application efficiency using a low-drift nozzle package. This irrigation system was assumed to be 1320 feet long with 10 132-foot spans between towers.

The irrigated acreage strategies modeled required that the center pivot be modified to allow sections of the sprinkler to be shut off, thus allowing for the acreage to be irrigated selectively from the pivot outward in a circle. This allows the field to be divided into smaller sections yet still be watered in concentric circles. This is in contrast to field divisions used in previous studies, which have discussed the removal of acreage from irrigated crop production in much the same way that slices are removed from a pie.

The center pivot was operated over the entire field, but the drop nozzles were shut off between towers over the portion of the field in dryland crop production. By dividing the plot with a concentric circle that could be moved to various distances from the pivot point and then planting only one crop inside or outside that circle, the irrigation system was able to move continually in only one direction. This eliminated the potential increased labor and equipment repair costs associated with reversing a center pivot in a pie- style field division.

Cropping Strategies

The model considered 224 cropping strategies. Each cropping strategy represented water application amount, yield, and production cost including irrigation costs for a specific acreage. The independent strategies included 45 for corn, 46 for grain sorghum, and 45 for wheat (Table 1). The 40 combined strategies allowed corn and grain sorghum acreage to be irrigated at the same time. Dryland crop rotations that substitute for irrigated acreage were included in 48 strategies.

Six irrigated acreage sizes were considered for each crop and irrigation amount (Table 1). Each independently irrigated cropping strategy must fall into one of these acreage alternatives. Each acreage alternative included eight irrigation water levels. Annual irrigation amounts ranged from 3 inches to 24 inches, in 3- inch increments. The only exceptions occurred on the 126-acre field size. Because the flow rate was only 400 GPM, the growing season lengths for individual crops prevented application of the higher water levels on all 126 acres. Corn and wheat had cropping strategies that apply only up to 15 inches of water for the 126-acre field size. The 126-acre grain sorghum strategies can apply only up to 18 inches. The difference in the maximum application amounts is due to growing-season length. The study assumed that grain sorghums planted will be 120-day hybrids, whereas the corn varieties will reach maturity in only 110 days. In some parts of the state, the season for grain sorghum may be shorter than that for corn, so the relationship would be reversed. The irrigation periods for wheat were established using typical planting and harvesting dates but were restricted further by average first and last freeze dates.

The combination strategies were included because corn and grain sorghum do not have completely independent irrigation schedules and can be irrigated at the same time in concentric circles. The combined irrigation strategies have only two acreage alternatives: 126 or 98.73 acres. The 126-acre strategies include three acreage splits (Table 1). Only one practical acreage split is possible in the 98.73-acre strategy: 59.73 / 39.00. The 39.00 acre section is a result of combining the areas under towers 7 to 9.

The 48 dryland cropping strategies are the results of six possible dryland crop rotations on each of the seven acreage sizes under the center pivot plus the six rotations on the nonirrigated corner acreage. The possible strategies include: wheat-fallow, continuous wheat, wheat-sorghum-fallow, wheat-sunflower-fallow, wheat-cane hay-fallow, and wheat-corn-fallow.

Yields

The KS Water Budget version T1 (KSWB) was used to simulate irrigated yields for corn, grain sorghum, and wheat. The KSWB estimates yield based on evapotranspiration and soil water availability for production on Ulysses silt loam soil. The program is based on long-term average weather, soil, and crop water use data from Tribune, Kansas. Average rainfall is assumed to be 16.4 inches. The specific date of each irrigation event, as well as the gross amount of water to be applied and the irrigation efficiency of the chosen application system are used by the simulator. Several simulations were performed for each water level and acreage combination. The timing of the application of the given water application amount was changed several times in order to find the yield and most efficient irrigation schedule that maximized net returns for the relevant acreage. The timing of specific rainfall events was not taken into consideration, because the simulation program utilizes long-term average weather data for each day.

The resulting yields from the simulations are provided in Tables 2 and 3. Grain sorghum yields, from the simulator, were adjusted downward 30 bushels to more closely reflect actual yields in western Kansas. A previous study found that 83% of KFMA farms in western Kansas produced yields less than 122 bu/a.

To maintain a consistent level of irrigation, 1 acre-inch per application, we had to vary the length of individual application cycles in the irrigation schedules for each of the acreage amounts used for the cropping alternatives. Table 4 lists the acreage size, the number of hours required to apply 1 acre-inch, and the number of days allotted for each irrigation event for each acreage size.

Dryland yields for wheat, corn, and grain sorghum were averages for the southwest district of the KFMA for 1985-1994. Dryland sunflower and cane hay yields were the middle yield levels from the Kansas State University Farm Management Guides. The dryland crop yields are reported in Table 5.

Crop Prices, Costs, and Net Returns

Estimated yields were multiplied by the respective crop's 10-year average price to estimate gross revenue. Crop prices for corn, grain sorghum, and wheat, were the 10-year average prices for the southwestern district of the Kansas Crop and Livestock Reporting Service for the 1986-1995 period. The price of sunflowers was the 8-year average from the same source for the 1988 to 1995 period. The price used in this model for cane hay was from a KSU Farm Management Guide. Prices are reported in Table 6.

Dryland crop production costs and irrigated production costs with the exception of irrigation costs, labor, and harvest costs were developed using the planning budgets in KSU Farm Management guides. Harvesting costs were based on custom rates for western Kansas from Kansas Agricultural Statistics and were functions of the harvested yield.

Irrigation costs for each water application amount were subtracted from gross revenue. Irrigation costs were estimated with the Irrigation Economics Evaluation System (IEES) developed by Williams and coworkers. The costs were for a low drift nozzle center pivot system. Energy costs associated with pumping were for a natural gas power unit.

Labor availability in each month of the year affects the selection of the best cropping system. Total labor availability in each month of the year and labor requirements were from previous publications by KSU agricultural economists. The numbers of days available per week for field work for each month were from the southwest Kansas crop reporting district. This value was multiplied by 1.05 operators and/or laborers per farm. An average 10-hour workday was assumed. The acreage modeled in this study represents approximately 8.8% of a southwest Kansas irrigated farm's total crop acreage. We assumed that the same proportion of labor would be available for one quarter section. When labor use exceeded what could be provided by the operator, labor cost was hired in the model at $9.00 per hour.

Results and Discussion

Under the flow rate of 400 GPM, the cropping strategy with 126 acres of corn irrigated with 15 acre-inches maximized returns over variable costs. A dryland rotation of wheat-sunflower-fallow was selected for the 34 nonirrigated acres in the corners. The model results indicated that cropping all irrigated acres to corn, irrigated with 15 acre-inches is more profitable than reducing the irrigated acreage and irrigating each acre with an increased amount of water.

Grain sorghum was not selected in the original model specification but entered the model when the price reached 105% of the base corn price. At this price level, the model chose to irrigate only 98.73 acres. This solution included 59.73 acres of corn and 39 acres of grain sorghum irrigated with 21 acre-inches. During the time period when the growing seasons for corn and sorghum overlap, the crops are irrigated in combination. This solution indicated that the area under the first seven towers was cropped to corn. The area from towers 8 to 9 was cropped to irrigated grain sorghum. The only time that these crops were irrigated individually was when the growing seasons did not overlap, such as when corn was emerging and grain sorghum had not yet been planted. The model also chose 26.94 acres of a dryland wheat-sorghum-fallow rotation in the circle and the same rotation on the 34 acres in the nonirrigated corners. This resulted in 60.94 total acres of dryland crop production. The area from tower 9 to 10 was cropped to a dryland wheat-grain sorghum-fallow rotation. Table 6 presents a summary of ranges through which individual crop prices can move without changing the original model solution for cropping strategy.

A small decrease in corn yields of only 9%, while holding grain sorghum yield constant, resulted in grain sorghum entering the model solution. At this yield level, the model chose a combination strategy of 59.73 acres of corn and 39 acres of grain sorghum both irrigated with 21 acre-inches. This was the same cropping combination that occurred when grain sorghum first entered the model at a higher price. The production of irrigated corn dropped completely out of the model when the corn yield decreased by 21%. At or below this point, the model chose to crop all irrigated acres to grain sorghum, irrigated at the 18-inch level. Corn yields are unlikely to fall by this amount on average without grain sorghum yields also being lower. Table 7 presents the percentage ranges through which individual crop yields can move without affecting the base model cropping decisions.

Model solutions also were determined using annual historical crop prices for each year from 1986 through 1995. For each year, the results were consistent with those generated by the original model; the strategy that planted all irrigated acreage to corn was selected. The only different result in response to annual price fluctuation was to change the dryland crop rotation planted on the nonirrigated field corners to wheat-sorghum-fallow or wheat-corn-fallow.

Table 1. Irrigated crop acreage and water application strategies for southwestern Kansas.

Independent Irrigation Cropping Strategies[1]

Total Water Application (inches/acre)	Acreage: 47.66	59.73	65.94	78	98.73	126
3	C,S,W	C,S,W	C,S,W	C,S,W	C,S,W	C,S,W
6	C,S,W	C,S,W	C,S,W	C,S,W	C,S,W	C,S,W
9	C,S,W	C,S,W	C,S,W	C,S,W	C,S,W	C,S,W
12	C,S,W	C,S,W	C,S,W	C,S,W	C,S,W	C,S,W
15	C,S,W	C,S,W	C,S,W	C,S,W	C,S,W	C,S,W
18	C,S,W	C,S,W	C,S,W	C,S,W	C,S,W	S
21	C,S,W	C,S,W	C,S,W	C,S,W	C,S,W	NA
24	C,S,W	C,S,W	C,S,W	C,S,W	C,S,W	NA

Combination Irrigated Cropping Strategies[1]

Total Water Application for Corn/Sorghum Crop (inches/acre)	Corn/Sorghum Acreage: 59.73/39.00	59.73/65.94	78.00/47.66	98.73/26.94
13/ 13	NA	C/S	C/S	C/S
13/ 15	NA	C/S	C/S	NA
13/ 18	NA	C/S	C/S	NA
13 /21	NA	C/S	C/S	NA
15/ 13	NA	C/S	C/S	C/S
15/ 15	NA	C/S	C/S	NA
15/ 18	NA	C/S	C/S	NA
15/ 21	NA	C/S	C/S	NA
18/ 13	NA	C/S	C/S	C/S
18/ 15	NA	C/S	C/S	NA
18/ 18	C/S	C/S	C/S	NA
18/ 21	C/S	C/S	C/S	NA
18/ 24	C/S	NA	NA	NA
21/ 13	NA	C/S	NA	NA
21/ 15	NA	C/S	NA	NA
21/ 18	C/S	C/S	NA	NA
21/ 21	C/S	C/S	NA	NA
21/ 24	C/S	NA	NA	NA
24/ 18	C/S	NA	NA	NA
24/ 21	C/S	NA	NA	NA
24/ 24	C/S	NA	NA	NA

[1] C,S,W- Corn, sorghum, or wheat
S - Sorghum
C/S - Corn/sorghum combination for specified acreage
NA - Not applicable

Table 2. Irrigated crop yields (bu/a) by acreage and water application level obtained from the Kansas Water Budget (KSWB) simulator for southwestern Kansas.

Acreage	Water Level (in)	Corn	Grain Sorghum[1]	Wheat
126	3	49.4	40.7	32.2
	6	93.7	58.2	46.7
	9	131.6	91.9	58.1
	12	163.8	109.4	66.5
	15	183.7	117.7	70
	18		120.2	
98.72	3	50.7	41	32.2
	6	94.4	68.2	46.7
	9	132.4	91.8	58.2
	12	165.3	109.9	67.1
	15	187.1	119.5	70.5
	18	197.7	123.5	72.6
	21	203.1	125.6	73.1
	24	204.7	126.1	73.9
78	3	59.1	41.1	32.9
	6	95.5	68.1	46.9
	9	133	91.6	58.8
	12	165.7	109.7	67.7
	15	188.7	119.5	71.7
	18	200	124.3	73.7
	21	205.6	126.9	74.4
	24	208.6	128.5	74.9
65.94	3	52.1	41.1	32.9
	6	95.9	68.1	46.9
	9	133.3	91.4	59.3
	12	166.4	108.8	67.5
	15	189	118.2	71.2
	18	200.3	123	73.6
	21	206.5	126.1	74.9
	24	210.1	128.5	75.5
59.73	3	52.1	41.4	32.9
	6	95.9	67.8	46.9
	9	133.3	91.4	59.3
	12	166.4	109.2	67.5
	15	189	118.9	71.2
	18	200.3	123.9	73.6
	21	206.5	126.8	74.9
	24	210.1	128.8	75.5
47.66	3	52.5	41.1	32.9
	6	96.4	67.8	46.9
	9	133.7	91.4	59.2
	12	166.5	109.2	67.2
	15	188.9	118.9	70.8
	18	199.9	123.9	72.8
	21	206	126.8	74.5
	24	210	128.8	75.6

[1]Adjusted yields. Refer to text for explanation.

Table 3. Combined cropping strategy yields (bu/a) obtained from KSWB for southwestern Kansas.[1]

Total Acres	Corn Acres	Sorghum Acres	Water Level	Corn Yield	Sorghum Yield
126	59.73	65.94	13	135.1	96.7
			15	158.1	106.2
			18	178.1	114
			21	183	116.1
126	78	47.66	13	135.1	96.7
			15	158.1	106.2
			18	178.2	113.9
			21	NA	116
126	98.73	26.94	13	135.2	96.7
			15	158.1	NA
			18	178.2	NA
98.73	59.72	39	18	180	117.2
			21	193.8	120.8
			24	194.7	122.1

[1]Refer to Table 1 for the feasible combination of water applications for each crop acreage combination.

Table 4. Irrigation event time requirements for southwestern Kansas.

Acreage	Hours per Event	Days Allotted per Event
126	141.75	6
98.72	111.06	4.5
78	87.75	3.5
65.94	74.18	3
59.73	67.2	3
47.66	53.61	2.5
39	43.75	2

Table 5. Dryland crop rotation yields (bu/a) for southwestern Kansas.

	Crop Yields[1]				
Rotation	Wheat	Sorghum	Sunflower	Cane Hay	Corn
Continuous Wheat	24.8				
Wheat-Fallow	37.9				
Wheat-Sorghum-Fallow	37.9	54.2			
Wheat-Sunflower-Fallow	37.9		13.5		
Wheat-Cane Hay-Fallow	37.9			2.75	
Wheat-Corn-Fallow	37.9				57.9

[1]Yields are reported in bushels/acre for wheat, sorghum, and corn; cwt/acre for sunflower; and tons/acre for cane hay.

Table 6. Stable price ranges from base model for southwestern Kansas.

Crop	Minimum	Base	Maximum
Corn	$2.30/bu.	$2.38/bu.	$2.80/bu.
Wheat	$1.15/bu.	$2.16/bu.	$3.15/bu
Grain sorghum	--	$2.10/bu.	$2.50/bu.
Sunflowers	$8.30/cwt.	$9.77/cwt.	$15.90/cwt.
Cane hay	--	$30.00/ton	$40.50/ton

Table 7. Stable yield ranges from base model for southwestern Kansas.

Crop	Minimum	Maximum
Corn	93%	115%
Wheat	56%	141%
Grain sorghum	--	112%
Sunflowers	84%	140%
Cane hay	--	142%

WATER USE EFFICIENCY OF DIFFERENT MATURITY CORN HYBRIDS AND GRAIN SORGHUM

T.P. Trooien, L.L. Buschman, P.E. Sloderbeck, K.C. Dhuyvetter,
W.E. Spurgeon, and D.J. Tomsicek

Summary

Yields and water use characteristics of longer-maturity corn (118-day relative maturity), shorter-maturity corn (97-day relative maturity), and grain sorghum (DK-56) under full and limited irrigation were evaluated from 1993 to 1996. Mean yield of longer-maturity corn was 15 bu/a greater than that of shorter-maturity corn and 41 bu/a greater than that of grain sorghum. Longer-maturity corn used the greatest amount of water, 3.4 in. more than shorter-maturity corn or grain sorghum. Average water use rates were similar among the three crops. Mean water use efficiency for longer-maturity corn was not different from that of shorter-maturity corn; mean water use efficiency of grain sorghum was 1.4 bu/acre-inches less. Water use efficiency of crops under limited irrigation was 0.7 bu/acre-inches greater than under full irrigation, but full irrigation of corn was more profitable. These yields, average water use rates, and water use efficiencies indicate no justification for choosing shorter-maturity corn over longer-maturity corn.

Introduction

Shorter-maturity corn hybrids are planted for many valid reasons. Among those reasons is the fact that shorter-maturity corn requires less water to get the crop from planting to maturity. Unfortunately, shorter-maturity corn hybrids yield less than longer-maturity hybrids. Because of this water use and yield tradeoff, whether shorter-maturity corn or longer-maturity corn uses water more efficiently has been unclear.

In areas where water is severely limited, grain sorghum is often the crop of choice because of its ability to generate some grain yield under water stress. Under full irrigation, grain sorghum yields less than corn. But the water use characteristics of grain sorghum, as compared to shorter-maturity corn, have not been well understood.

The objectives of this study were to compare the grain yield, water use, water use efficiency, and average water use rate of longer-maturity corn, shorter-maturity corn, and grain sorghum under irrigated conditions.

Procedures

This experiment was conducted at the Southwest Research-Extension Center. The soil was a Ulysses silt loam. Treatments were (1) three crops (longer-maturity corn, shorter-maturity corn, and grain sorghum); (2) two planting dates (early and late, Table 1); and (3) two irrigation amounts (full, or 100% replacement estimated ET and limited, or 70% replacement of estimated ET).

Relative maturity ratings were 118 days for the longer-maturity corn (Pioneer 3162) and 97 days for the shorter-maturity corn (Pioneer 3751). The grain sorghum (DK-56) was a medium-maturity hybrid, rated 112 to 124 days to harvest. Corn was grown from 1993 through 1996; grain sorghum was grown from 1993 through 1995.

The plots were located under a modified center pivot fitted with low-pressure in-canopy nozzles operated in the spray mode. They were approximately 2 ft above the soil surface and spaced 5 ft apart (located in alternate crop rows). Planting densities were 32800 plants/a for the longer-maturity corn, 35600 plants/a for the shorter-maturity corn, and 90000 plants/a for the grain sorghum.

Irrigations were scheduled using the alfalfa-based, modified, Penman ET equation. Precipitation was measured at the experiment site.

Grain yield was measured by hand-harvesting a 40-ft length in two rows near the center of each plot.

Soil water content was measured weekly with a neutron probe. Measured crop water use was the sum of precipitation, applied irrigation, and soil water depletion measured from the date of access tube installation (shortly after crop emergence) to crop maturity. The exception was late-planted grain sorghum in 1995. That crop did not reach maturity because it was killed by frost on 22 September. Average water use rate was calculated as the measured water use divided by the number of days from the first measurement of soil water content to physiologic maturity. Water use efficiency was calculated as the grain yield divided by the measured water use.

Economic returns to full irrigation (compared to limited irrigation) were calculated based on corn and grain sorghum harvest prices and assumed pumping costs of $3.00/acre-inch.

Results of individual years were not analyzed statistically because of the (expected) variations from year to year. Comparisons mentioned here were statistically significant at the 5% or 1% level.

Results and Discussion

Grain yield of longer-maturity corn was greater than the yield of shorter-maturity corn, and yield of shorter-maturity corn was greater than grain sorghum yield (Fig. 1). Longer-maturity corn outyielded shorter-maturity corn by 15 bu/a, and shorter-maturity corn outyielded grain sorghum by 41 bu/a. Limited irrigation significantly reduced yield by 15 bu/a. As would be expected, limited irrigation resulted in depletion of soil water content to levels that caused yield reduction. Earlier-planted grain sorghum yielded 26 bu/a more than later-planted, largely because of the loss of yield in 1995 when an early freeze killed the late-planted grain sorghum in the dough stage. The effect of planting date on yield of longer-maturity or shorter-maturity corn was not significant.

Longer-maturity corn had the greatest seasonal water use (Fig. 2), 3.4 in. more than values for shorter-maturity corn and grain sorghum. Although the predominant trend was for shorter-maturity corn to have greater water use than grain sorghum, the difference was not statistically significant. The water use of fully irrigated crops was greater (by 4.4 in.) than the water use of the crops under limited irrigation, as would be expected. The water use difference between planting dates was not statistically significant, so the results are presented as the averages of the two planting dates (Fig. 2). This study was conducted during an extended period of less-than-average ET, which was reflected by the relatively low values (for the area) of crop water use.

The average water use rates were similar among the three crops (Fig. 3). Differences in water use amounts between longer-maturity corn and the other crops were not due to different water use rates but rather to the longer growing season for longer-maturity corn. Because the water use rates are the same for longer-maturity and shorter-maturity corn, a grower with well capacity insufficient to meet ET requirements of longer-maturity corn will not benefit by switching to shorter-maturity corn. Such a switch will result in a reduction in seasonal crop water use, but a corresponding decrease in grain yield will occur.

Fully irrigated crops used water 0.04 in./day faster than crops under limited irrigation (Fig. 3). Earlier-planted crops used water 0.02 in./day faster than later-planted crops, but the effect was not consistent for all years because of year-to-year weather differences.

Comparison and testing of water use efficiency for longer-maturity corn vs. shorter-maturity corn revealed no significant difference. The water use efficiency of grain sorghum was 1.4 bu/acre-inch less than those of longer-maturity and shorter-maturity corn (Fig. 4). When considering all crops and years, the water use efficiency under limited irrigation was 0.7 bu/acre-inches greater than that under full irrigation. The water use efficiency was generally greater for the earlier planting date, but the effect was not statistically significant, so the results are presented as the averages of the two planting dates (Fig. 4).

Although use of limited irrigation resulted in greater water use efficiency, it did not necessarily result in greater profit for the irrigation. The marginal returns to full irrigation of corn were positive (Fig. 5), indicating that full irrigation of corn was more profitable than limited irrigation. That is, the increased return from higher corn yield was greater than the increased pumping cost for the additional water. For grain sorghum, however, limited irrigation was more profitable.

Conclusions

Water use efficiency and average water use rate under fully or moderately limited irrigated conditions indicate no advantage to switching from longer-maturity corn to shorter-maturity corn or grain sorghum. Other criteria should be used for such a decision.

Table 1. Planting dates for study of water use efficiency, Garden City, KS

	Corn		Grain Sorghum	
Year	Early	Late	Early	Late
1993	7 May	21 May	21 May	15 June
1994	18 April	18 May	10 May	6 June
1995	12 April	22 May	2 June	22 June
1996	11 April	13 May	-	-

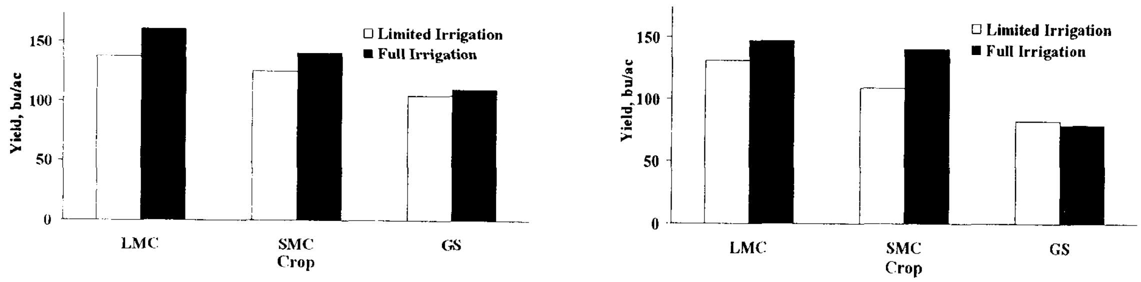

Figure 1. Average grain yields for early planting date (left) and late planting date (right). LMC= longer-maturity corn; SMC= shorter-maturity corn; GS= grain sorghum.

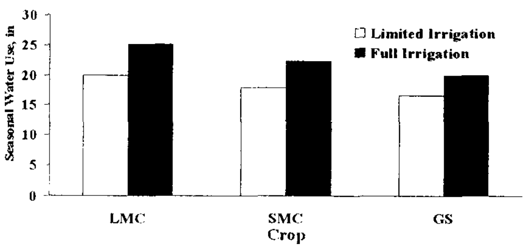

Figure 2. Seasonal water use averaged over early and late planting dates.

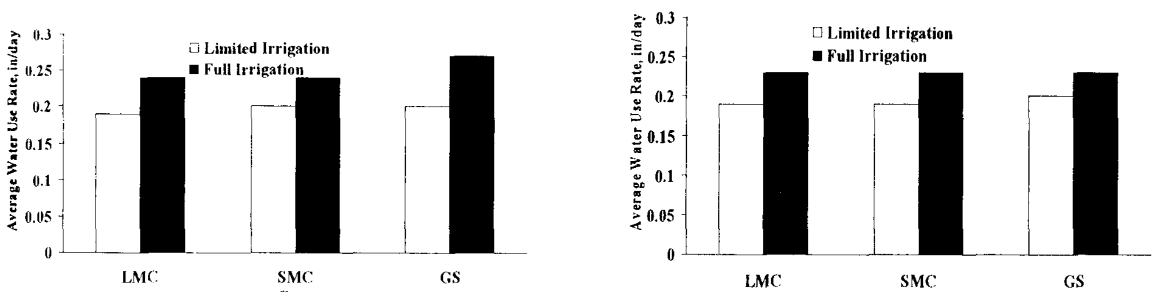

Figure 3. Average water use rates for early planting date (left) and late planting date (right).

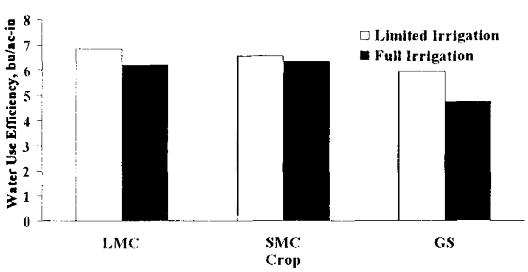

Figure 4. Water use efficiency averaged over early and late planting dates.

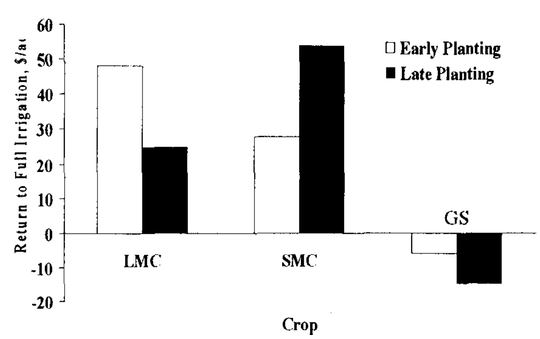

Figure 5. Average returns to full irrigation for early and late planting dates.

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

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

Summary

Runoff of phosphorus (P) from cropland can add to the nutrient enrichment and eutrophication of surface water bodies. Research was continued during 1997 to determine which tillage systems and which methods of applying P fertilizer will result in the least P losses. The tillage and fertilizer systems evaluated were a chisel-disk-field cultivate system, a ridge-till system, and a no-till system. The fertilizer treatments were a P check, 50 lb/a P_2O_5 surface broadcast, and 50 lb/a P_2O_5 deep-banded. Runoff from natural rainfall was collected before and after grain sorghum fertilization and planting in 1995-1997. Averaged across all runoff events over 3 yrs, most runoff occurred in ridge-till and no-till systems. Chisel-disk produced the least runoff. Soil losses and sediment P losses followed the pattern chisel-disk > ridge-till > no-till. Soluble P losses were highest with no-till followed by ridge-till and chisel-disk. Most soluble P losses occurred when the P fertilizer was broadcast and not incorporated. Total bioavailable P losses generally paralleled soluble P losses. Grain yield was not affected by the tillage treatments. Deep-banded P increased grain sorghum yield by an average 7 bu/a compared to broadcast P. The best P cropping practices were broadcast incorporated P and deep-banded P in the tilled system and deep-banded P in the conservation tillage systems.

Introduction

Phosphorus (P) losses in runoff water from cropland can contribute to the nutrient enrichment in lakes, streams, and rivers. High levels of P in runoff water accelerate eutrophication of fresh water bodies, producing water that has undesirable odor and taste for drinking and recreation. Excess P in surface water is a problem in the Hillsdale Lake watershed in east-central Kansas. All stakeholders in the watershed, including farmers, are being urged to reduce nonpoint sources of P entering surface water (Big Bull Creek Water Quality Incentive Project). The predominant form of P in runoff water from tilled cropland is sediment P. As a result, soil erosion control practices and use of conservation tillage systems are being encouraged. However, several recent studies have shown with conservation tillage systems, increased losses of soluble P can occur because of nonincorporated P fertilizer and decomposition from crop residues on the surface of the soil. Soluble P is the most readily available form of P for use by aquatic plants. This, coupled with greater than normal expected runoff with conservation tillage systems caused by an abundance of slowly permeable soils in the watershed, might mitigate some or all of the sediment P reduction benefits associated with conservation tillage. Consequently, best management practices for P in areas with imperfectly drained soils may require subsurface placement of P fertilizer as well as soil erosion control measures. The deeper placement would put the fertilizer P below the critical surface-water soil interface and mixing zone (approximately the top 1 inch of soil), where most P losses occur. Deeper P placement also might benefit crop yield because of better location for root uptake when surface soil is dry.

The objective of this study was to see how various tillage and P fertilization practices affect P losses in runoff water on an imperfectly drained soil..

Procedures

The study was conducted at the East Central Kansas Experiment Field near Ottawa, KS on a 1.0 to 1.5 % slope, somewhat poorly drained, Woodson silt loam soil (fine, montmorillonitic, thermic, Abruptic Argiaquolls). This site represents prime farmland in this region of Kansas. The tillage systems evaluated were chisel-disk-field cultivate (chisel in the fall or late winter, disk in the early spring, and field cultivate prior to planting); ridge-till (with ridges formed in the fall or late winter); and no-till. Also evaluated as subplots in the tillage systems were three P fertilizer treatments: a P check with no P fertilizer applied, 50 lb/a P_2O_5 surface broadcast, and 50 lb/a P_2O_5 deep-banded (coulter-knifed) at approximately 4-in. depth on 15-in. centers. This rate of P was for two crops, grain sorghum and the following year's soybean crop. Bray P-1 soil test P at the start of this study was in the medium to high range. Liquid 7-21-7 fertilizer was the source of P for all applications. Surface broadcast P in the chisel-disk-field cultivate system was incorporated by the field cultivation before planting. In the ridge-till and no-till systems, broadcast P was not incorporated except for that covered by the planting operation. Grain sorghum and soybean crops were grown in alternate blocks each year. The P fertilizer treatments were applied on 11 July 1995, 21 June 1996, and 7 June 1997. Pioneer 8310 grain sorghum was planted in 1995 and Pioneer 8500 grain sorghum in 1996 and 1997.

All runoff data were collected in the sorghum portion of the crop rotation on the previous year's soybean stubble. Runoff from five runoff events in 1995, six runoff events in 1996, and seven runoff events in 1997, spanning the period before and after P fertilizer application and grain sorghum planting, were collected (Table 1).

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

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

This period is considered most vulnerable to erosion and P losses. Runoff was collected by delimiting 50-sq-ft areas (5 ft x 10 ft) with metal frames driven approximately 3 in. deep into the ground in each 10 x 50 ft plot. The runoff from within these frames was directed to a sump and then pumped though a series of dividers (five spitters) to determine the volume and to obtain a composite sample. Soil loss and P losses (total, sediment, bioavailable particulate, soluble, and total bioavailable) in the runoff water were measured in all years.

Results and Discussion

Runoff Volume and Soil Loss

The amount of runoff varied with rainfall events, tillage systems, and years. Generally, most runoff occurred with the largest and most intense rainfall events. However, moisture and infiltration differences between tillage systems preceding the rainfall events also influenced runoff amounts. When averaged across all rainfall events and years and averaged across all fertilizer treatments, runoff was highest with the ridge-till and no-till systems and lowest with chisel-disk (Figure 1). This was because tillage in the chisel-disk system dried and loosened the soil prior to rainfall events, which increased infiltration and reduced runoff. The amounts of runoff were 18% for the chisel-disk system, 32% for the ridge-till system, and 30% for the no-till system. These higher runoff percentages for the conservation tillage systems differ from reports of up to 50% reduction in runoff volume or more with conservation tillage systems compared to tilled systems on well drained soils. The difference is that this soil has a dense clay subsoil that restricts increased infiltration with conservation tillage.

Soil losses in the runoff water (Figure 2) generally paralleled rainfall and runoff amounts, but intensity and timing of individual rainfall events also influenced losses. Overall, soil losses were highest in the chisel-disk system. Soil losses generally followed the pattern chisel-disk > ridge-till > no-till, suggesting that full-width loosening of the soil surface and incorporation of crop residue results in greater soil losses than partial (shaving of the ridge at planting in the ridge-till system) or very limited soil and residue disturbance (coulter at planting in no-till). Averaged across all runoff events and years, soil losses were 0.8 ton/a for the chisel-disk system, 0.6 ton/a for the ridge-till system, and 0.3 ton/a for the no-till system. These are roughly 25 and 60% reductions in soil loss, respectively, for the ridge-till and no-till tillage systems, compared to the chisel-disk system. Although these amounts are for only a part of the crop year, all are below the T (tolerance) level of 4 ton/a necessary to maintain productivity of this soil.

Phosphorus Losses

Losses of P in the runoff water varied with rainfall events, tillage system, fertilizer practices, and years. Total P losses when summed across all runoff events and years (Figure 3) were highest with the chisel-disk and ridge-till systems and lowest for no-till. These differences generally paralleled soil losses. Most of the total P losses were due to sediment P losses (Figure 4).

However, only a small portion of the sediment P is bioavailable P. This is shown by the bioavailable particulate P losses in Figure 5. Roughly 5% of the sediment P losses were bioavailable P.

Losses of soluble P also varied with tillage systems and P fertilizer treatments. Averaged across all runoff events and across all years, soluble P losses (Figure 6) were highest for no-till, intermediate for ridge-till and least for chisel-disk . In the chisel-disk system, where broadcast P was incorporated, losses of soluble P were small compared to those with no P fertilizer application. In the ridge-till system, where the fertilizer P was broadcast and was covered partially by the shaving of the ridge at planting, losses of soluble P were moderate compared to no P fertilizer application. In the no-till system, where nearly all of the broadcast P remained on the soil surface, soluble P losses increased nearly sixfold compared to no P fertilizer applied. Knifed P (deep-banded P) resulted in significantly lower losses of soluble P because of its subsurface placement. Total bioavailable P losses (Figure 7) followed the same general loss patterns seen for soluble P. This is because most of the bioavailable P that was lost was in the soluble P form. The largest losses of soluble P occurred with the first couple of runoff events after P fertilizer application (data not shown) and then diminished with successive runoff events. This pattern of P loss suggests that in conventional-till systems, broadcast P also should be incorporated before runoff occurs, otherwise soluble P losses could be similar to that with surface P applications in conservation tillage systems.

Grain Yield

Grain yield was not affected by the tillage systems (data not shown). However, application and placement of P fertilizer significantly influenced grain sorghum yield (Table 2). Deep-banded P increased grain sorghum yield by an average 7 bu/a compared to broadcast P and by 11 bu/a compared to the P check. This occurred with an initial P soil test level in the medium to high range. These yield responses should be incentives for crop producers to deep-band P fertilizer, which will also reduce P runoff losses.

Conclusions

The results of this study suggest that fertilizer P needs to be subsurface applied in conservation tillage systems on somewhat poorly drained soils, In tilled systems, broadcast P need to be incorporated before the first runoff event. These practices should minimize losses of P from cropland.

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

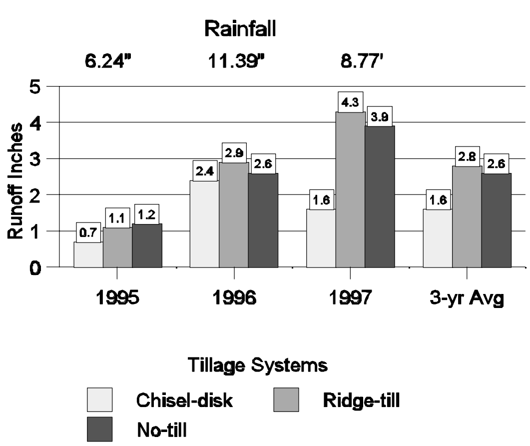

Figure 1. Effects of tillage and rainfall on amount of runoff, Ottawa, KS.

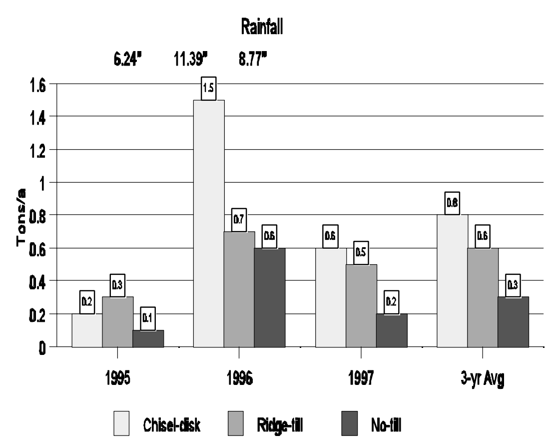

Figure 2. Effects of tillage and rainfall on soil losses, Ottawa, KS.

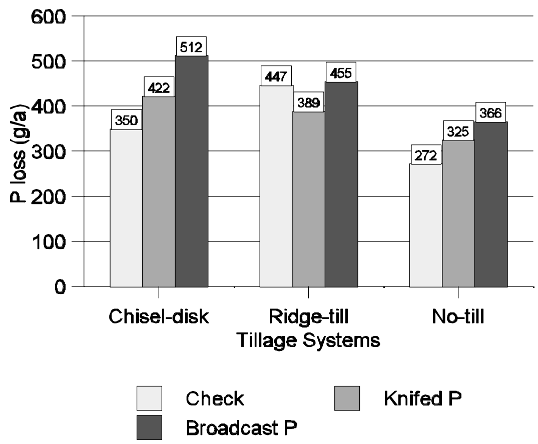

Figure 3. Effects of tillage and P rate/placement on total P losses (3-yr avg), Ottawa, KS.

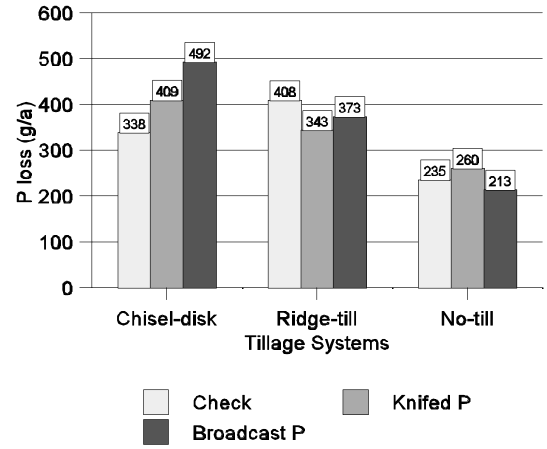

Figure 4. Effects of tillage and P rate/placement of sediment P losses (3-yr avg), Ottawa, KS.

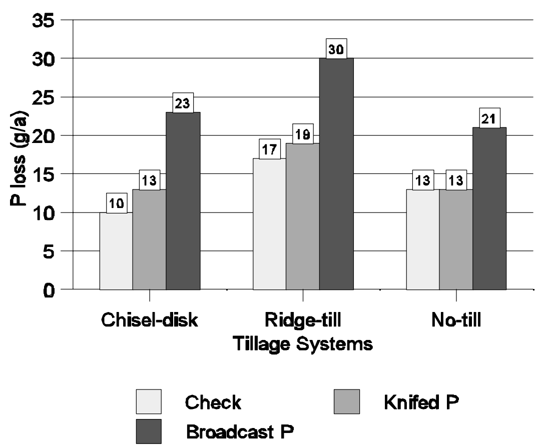

Figure 5. Effects of tillage and P rate/placement on bioavailable particulate P losses (3-yr avg), Ottawa, KS.

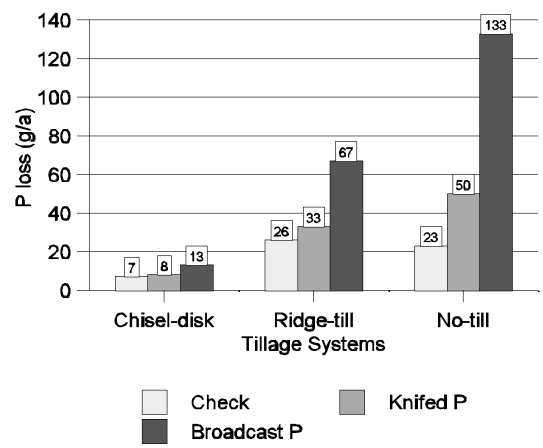

Figure 6. Effects of tillage and P rate/placement of soluble P losses (3-yr avg), Ottawa, KS.

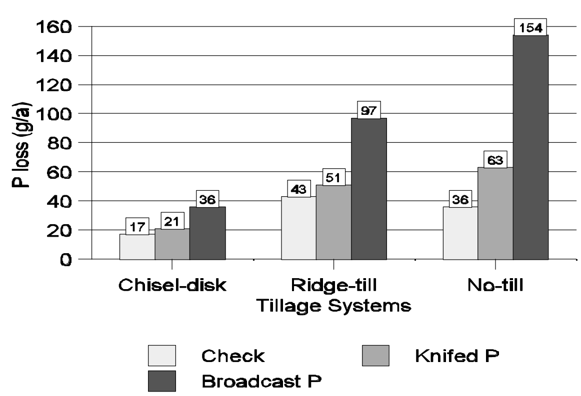

Figure 7. Effects of tillage and P rate/placement on total bioavailable P losses (3-yr avg), Ottawa KS.

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

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

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

GRAZING LAND WATER QUALITY: AN EDUCATIONAL PROGRAM FOR PRODUCERS[1]

P.D. Ohlenbusch, R.D. Jones, and E.H. Fuchs

Summary

The quality of surface water leaving grazing lands may be reduced when it contains polluting constituents. Soil erosion and sedimentation are the primary contributors to this lowered water quality in many areas. We are designing an educational program to assist producers in understanding and implementing strategies that have the potential to maintain or improve water quality, while maintaining the profitability of livestock operations. A database of over 2,300 citations on grazing land water quality has been established. The project is developing a physical inventory, a management profile, and an economic analysis of producer-volunteered operations that will constitute a confidential database including soils, vegetation, physical improvements, erosion, and other potential water-quality factors. An overall management and economic evaluation will be made to determine the potential impacts on water quality. The impacts will be prioritized, and alternative management strategies will be prepared for consideration by the cooperator. Initial findings suggest that adjacent nongrazing lands (cropland) and other nongrazing landscape features (roadways) are contributing more to water quality impairment than grazing lands.

Introduction

The quality of surface water leaving grazing lands may be reduced when it contains polluting constituents. Soil erosion and sedimentation are the primary contributors to this lowered water quality many areas. Rangeland and pasture generally become sources of nonpoint source pollution when grazing removes a high percentage of the vegetative cover, exposing the soil surface to the erosive actions of wind and water. Eroded soil subsequently becomes sediment, creating the potential for water degradation, which may lead to impaired uses. Some potential pollutants, such as nutrient accumulations, have a high correlation with the sediment content of water leaving grazing land (e.g., phosphate binding with sediment). Also, indicator bacteria may persist in stream sediments.

The objective of this project is to develop an educational program to improve grazing land water quality through voluntary actions by producers. The project utilizes sediment sources, onsite and offsite, as indicators of potential concerns about grazing land water quality. Educational programs, materials, and demonstrations are needed to assist producers and landowners in understanding and implementing strategies that are identified as having the potential to maintain or improve water quality, while maintaining the profitability of livestock operations.

Some of the strategies identified in the educational program will improve or maintain water quality with little or no additional capital investment. In these instances, where awareness is the only obstacle, producers may implement practices that will lead to improved water quality without any further incentive. Other strategies may involve an economic cost to the individual producer, either in terms of significant changes in management level or practices or significant capital expenditures. In these cases, the economic cost to each producer will be quantified to help evaluate the magnitude of economic incentives or other programs necessary to encourage the owners and users of Kansas grazing lands to implement water-quality improvement measures.

Procedures

The first phase of the project developed a comprehensive review of published literature and interim reports on grazing land water quality and associated programs. To date, over 2,300 citations are included. The review is updated regularly.

The second phase of the project involves the development of a physical inventory, a management profile, and an economic analysis of producer-volunteered operations that will constitute a confidential database including soils, vegetation, physical improvements, erosion, and other potential water-quality factors. When this is completed, an overall management and economic evaluation will be made. Potential impacts on water quality will be prioritized, and alternative management strategies will be prepared for consideration by the cooperator.

The Study Area

The first area being studied is the Black

Vermillion River-Big Blue River-Vermillion River Basin. Additional basins will be added as time and resources allow, and the project eventually will be statewide.

The vegetation within the study area was originally tallgrass prairie on 500,000-year-old glacial till. The vegetation has changed from prairie to crops and introduced forages for livestock. Smooth bromegrass, tall fescue, and native rangeland provide the major forage base. Woody plants have encroached, resulting in large areas of native and nonnative, undesirable plants. The woody plant invaders red cedar, Osage orange, and honey locust have occupied stream corridors and hillsides. The most common crops are corn, grain sorghum, soybeans, wheat, and alfalfa, and cropping systems range from traditional to no-till.

Preliminary Results

Five cooperators have been included in the initial group. Inventories and initial evaluations have been completed. Initial findings and preliminary judgments suggest that adjacent nongrazing lands (i.e., cropland) and other nongrazing landscape features (i.e., roadways) are contributing more to water quality impairment than grazing lands.

Cropland Influences

Most cropland in the study area has been terraced to reduce runoff and sediment loss. The terrace systems may or may not include waterways with grass, depending on when they were installed. In addition, pesticides from cropland may be deposited on the grazing land. The major concern is the channeling of runoff from large cropland areas into a drainage developed naturally under much lower average flow rates.

Public Works

Public works, including public roads (federal, state, county, and township), have the capacity to create potential water quality hazards for grazing land and other land uses. The classical example is the culvert, commonly used for small drainage. The result is a change in the baseline flow of water on both ends. Cutting (channel incisement) will work up slope until a new equilibrium is reached. Downstream, the falling water can create a hole that allows for accelerated erosion.

An additional aspect of public works is the channeling of water via the "borrow ditches" alongside roads, often resulting in increased discharge to an arbitrary outlet or stream. This added source of water can augment the flow characteristics of the receiving stream and exacerbate the erosion and sediment occurring downstream.

Historic Land Use

The study area was subject to two historic government programs: the Homestead Act and the Public Lands Survey System (PLSS). The Homestead Act allowed individuals to claim 160 acres of land, build a house, and till 10-20 acres (or plant trees) to gain title to the land. The PLSS determined the boundaries of the claims. The result has been two distinct kinds of erosion: from tilled land and from fence lines.

Erosion began down slope of the fields and continued when the land was abandoned, largely because permanent vegetation was seldom established. Most of the down-slope erosion has stabilized, and the upper ends have neared recovery in many cases.

Fence-line erosion appears to be the result of water flowing down livestock trails along fence lines. The erosion normally occurs along property line fences on steep slopes, along natural drainages, or on soils that are highly erodible.

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